EXPERIMENTAL STUDY ON SUPPRESSION CHAMBER THERMAL-HYDRAULIC BEHAVIOR FOR LONG-TERM REACTOR CORE ISOLATION COOLING SYSTEM OPERATION

A Dissertation

by

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ABSTRACT

In current Station Blackout analyses for Generation II Light Water Reactors, battery failure in 4-8 hours is expected to result in the failure of the Reactor Core Isolation Cooling System. The RCIC System, which uses a steam-turbine driven pump to pump cooling water to the reactor, theoretically requires DC power for the controller to operate. However, in the Fukushima Daiichi accidents at Units 2 and 3, the RCIC System performed for much longer than expected. It managed to continue working long after the loss of critical DC power, even without operator intervention.

In order to better understand the RCIC System and Suppression Pool in long-term system operation, a model of the system was constructed at the Laboratory for Nuclear Heat Transfer Systems at Texas A&M University. This experiment investigated the thermal hydraulic limitations of the RCIC System, focusing on the Suppression Pool. In 32 individual tests, several parameters were varied; these included the steam flow rate, the steam quality, the sparger design, and the pressure conditions in the Suppression Chamber.

It was found that the Suppression Pool, with a strong dependence on conditions, can experience a great deal of thermal stratification resulting from RCIC System operations. Such stratification can be both beneficial and limiting; pump suction from the bottom of the pool will be cooler when stratified, protecting the pump, while at the same time containment pressurization will be accelerated. Chugging at the beginning and bubbling later on tended to enhance pool mixing while calm conditions in the

intermediate period tended towards stratification. A chugging correlation has been adapted and modified to describe the state of mixing in the scaled pool.

The SRV-analog tests had little to no effective thermal stratification in the Suppression Chamber, whereas every RCIC-analog test had some. Pressure in the Suppression Chamber in particular was strongly associated with the degree of stratification; one pressurized case had >65 °C of thermal separation, while a similar but fully-vented atmospheric case saw only 13 °C. While steam quality and steam flowrate affected the thermal stratification, their effects were neither as pronounced nor as simple as those of the pressurization conditions.

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NOMENCLATURE

AP	Absolute Pressure
β_p	Vapor Pressure Ratio, = $(P_{vap} / P_{tot})^{0.5}$
BWR	Boiling Water Reactor
DAQ	Data Acquisition [System]
DCC	Direct Contact Condensation
DI	Deionized/Deionization [Water]
DP	Differential Pressure
Fr_s	[Steam Injection] Froude Number
Ja_{TP}	Two-Phase Jakob Number
KP	Key Point [#]
NPS	Nominal Pipe Size
NRC	[United States] Nuclear Regulatory Commission
RCIC	Reactor Core Isolation Cooling [System]
RHR	Residual Heat Removal [System]
SBO	Station Blackout
SRV	Safety/Relief Valve
TDP	Turbine Driven Pump

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1. INTRODUCTION

On March 11, 2011, the Great East Japan Earthquake struck off the eastern coast of the Japanese island of Honshu. The magnitude 9.0 temblor spawned a massive set of tsunamis; the earthquake and tsunami officially resulted in 15,889 dead, 6,152 injured, and 2,598 missing people [1]. The immediate damage has been estimated to be $300 billion, with significant long-term ramifications [2]. Also severely damaged was the Fukushima Daiichi nuclear power plant, which suffered widely-publicized accidents. The tsunami cut off all offsite electrical power and caused most of the on-site emergency diesel generators to fail; this, in turn, led to the failure of cooling systems and eventual core damage at Units 1, 2, and 3. Unit 4 suffered major damage as well [3].

In the course of events during the accident, one emergency cooling system applicable only to Units 2 and 3 functioned for time periods much longer than had been predicted in earlier analyses: the Reactor Core Isolation Cooling (RCIC) System [4]. The RCIC system is a turbine-driven system that takes steam from the reactor and passes it through said turbine to generate sufficient mechanical power to drive a pump; the pump sends water back to the reactor to maintain core cooling. While the system does not require large amounts of electric power for pumping, the system's controller does require some small amount of power. In current analyses, when the controller loses all electrical power, the RCIC system is assumed to fail. This is expected to happen in 4-8 hours in short-term station blackout scenarios as the station batteries are depleted and Suppression Pool temperatures rise; normally, “one should not expect the RCIC system to run much beyond 8 hours in a station blackout (SBO)" [4]. However, the RCIC system in Unit 3 performed its duty for 19.5 hours before finally going offline; in Unit 2, the system ran for nearly 3 days, long after the station's batteries went offline [3]. It is not clear how or why the systems performed so well.

1.1 PROBLEM STATEMENT

The goal of this research is to investigate parts of a genericized RCIC system to gain insight into extended operations. In at least some cases, as evidenced by the Fukushima events, the system can perform much longer than anticipated. The focus will be on the thermal-hydraulic behavior of the Suppression Pool as it relates to RCIC System operation.

1.2 TECHNICAL APPROACH

This research intends to establish some of the physical thermal hydraulic limitations of the RCIC System, with a highlight on the interplay between the Suppression Pool and RCIC System. It will examine potential thermal stratification in the Suppression Pool, pump inlet conditions, and two-phase steam/water injection through the RCIC Sparger. While neither the control system nor an actual turbine will be examined, these tests are expected to yield certain phenomena that affect system operability. Once known, such data can be used in plant safety analyses to gain a greater understanding of the system, assist in the development of procedures in off-normal or accident conditions, and to inform decisions about modifications to improve overall plant safety.

The data gathered in the experimental tests will be subject to further analysis focusing on key locations. Their time-dependent conditions shall be examined and the evolution of their thermal-hydraulic profiles investigated. Ultimately, a correlation will be developed to relate the overall mixing state of the Suppression Pool, a key interfacing system affecting RCIC System operability.

2. BACKGROUND

The Reactor Core Isolation Cooling System is found in some, but not all, GE Boiling Water Reactors with the Mark I Containment. It was originally designed to ensure adequate cooling water is supplied to the reactor in isolation events; i.e., when the isolation valves are closed for the steam lines and feedwater. This results in the reactor, which produces significant amounts of decay heat long after shutdown, being isolated from the outside world – and its primary ultimate heat sink. In such an isolation event, the RCIC system is engaged. It draws steam from the reactor via the in-containment portion of the Main Steam Line, passes it through the RCIC Turbine's governor valve and then the turbine, and exhausts it through a sparger into the Suppression Pool [5]. The Suppression Pool in a BWR with the Mark I containment partially fills the torus, and can store a large volume of water – 76,000 cubic feet at Monticello [8], and more than 125,000 cubic feet at Peach Bottom [9]. It is inside the containment boundary. An illustration of the BWR Mark I Containment can be seen in Figure 1.

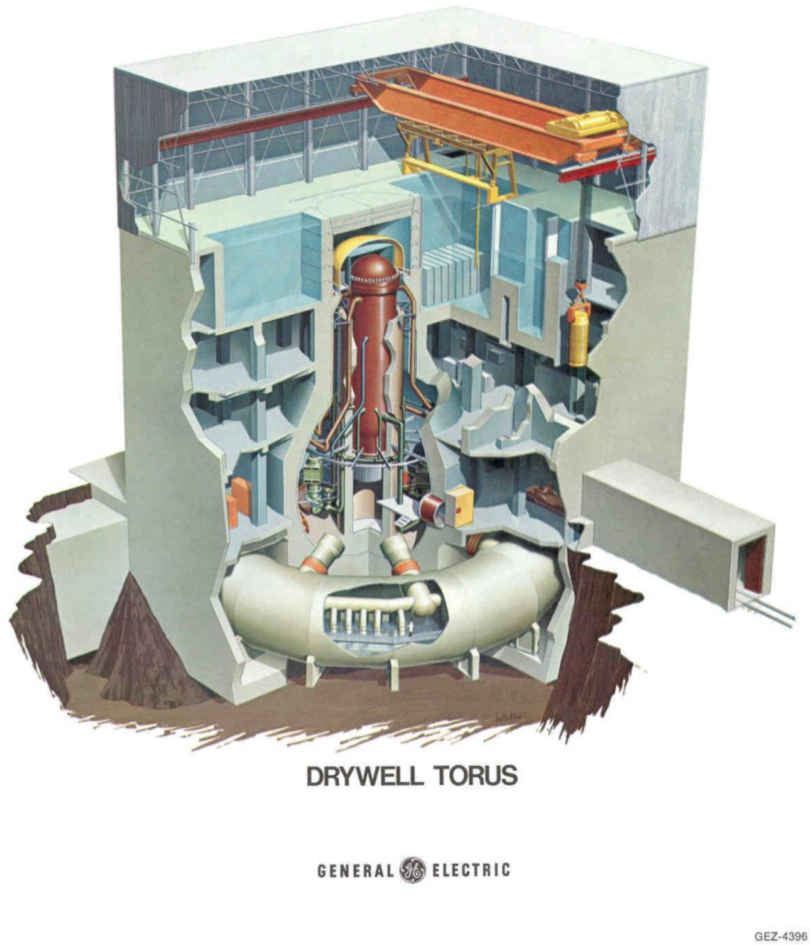

Figure 1: BWR Mark I Containment [11]

The RCIC Pump sits on a common shaft with the RCIC Turbine, and draws its motive power directly from the turbine. It is a conventional multistage centrifugal pump, and can be aligned to draw its suction from multiple sources. The initial default alignment is to draw water from the Condensate Storage Tank. Once that source is depleted, it can be realigned to draw from the Suppression Pool. Past the pump, the makeup water flows into the reactor pressure vessel via injection into a feedwater line

[5]. As there is no control valve past the pump to regulate water flow, regulation is performed by controlling the turbine speed with the throttling governor valve. In addition to these main flowpaths, there are several others for system support – system cooling, lubrication, hydraulics, etc. The cooling function is noteworthy, as cooling water is the same water supplied by the RCIC Pump [5].

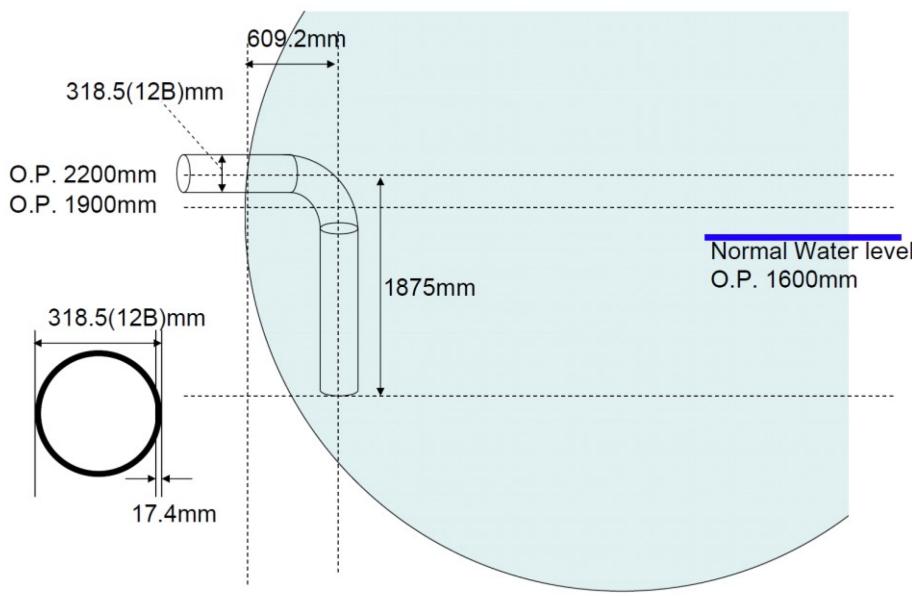

Figure 2: RCIC Turbine Vent Line from Fukushima Daiichi Unit 2 [6]

The outlet into the Suppression Pool is a sparger that appears to be unique for each plant. Based on information made public by TEPCO, the sparger design may even differ from unit to unit at the same plant; this was the case at Fukushima Daiichi. There do, however, appear to be generic classes of design employed. The simplest is a vertical pipe, open at the end, pointed downwards and depositing steam well below the surface of the pool as used in Fukushima Daiichi Unit 2 [6]; this is shown in Figure 2. Another design maintains the verticality, but caps off the end of the pipe and has small holes bored in the side, again well below the water surface; this design was featured in Unit 3 [7] and is shown in Figure 3. Variations on these designs may angle the pipe or use alternate ends. It is not known if any plants use a design having more in common with the SRV T-Quencher designs (an example of a T-Quencher from Monticello, which discharges near the bottom of the Suppression Pool, is shown in Figure 4 [8]). A diagram of the RCIC System used in the Mark II Containment, much the same as the Mark I system, can be seen in Figure 5.

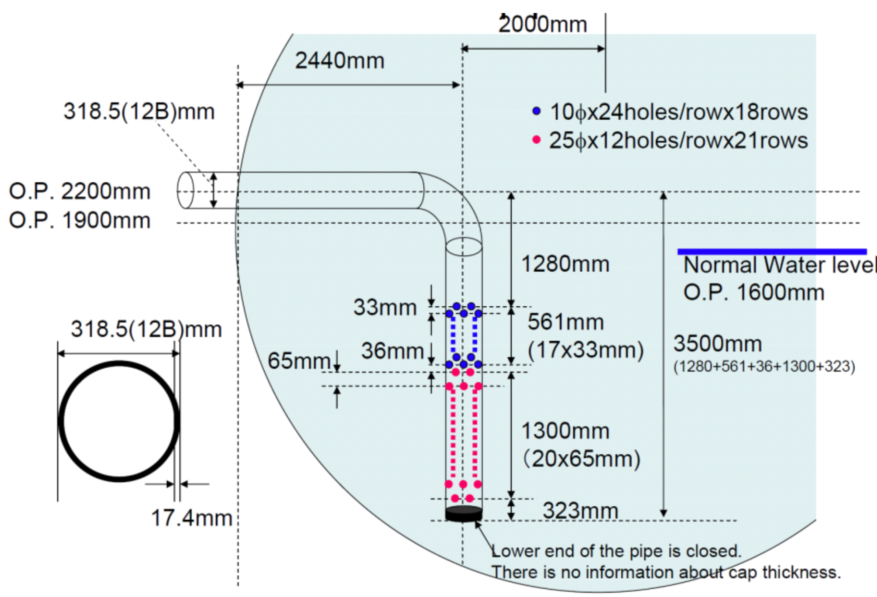

Figure 3: RCIC Turbine Sparger from Unit 3 [7]

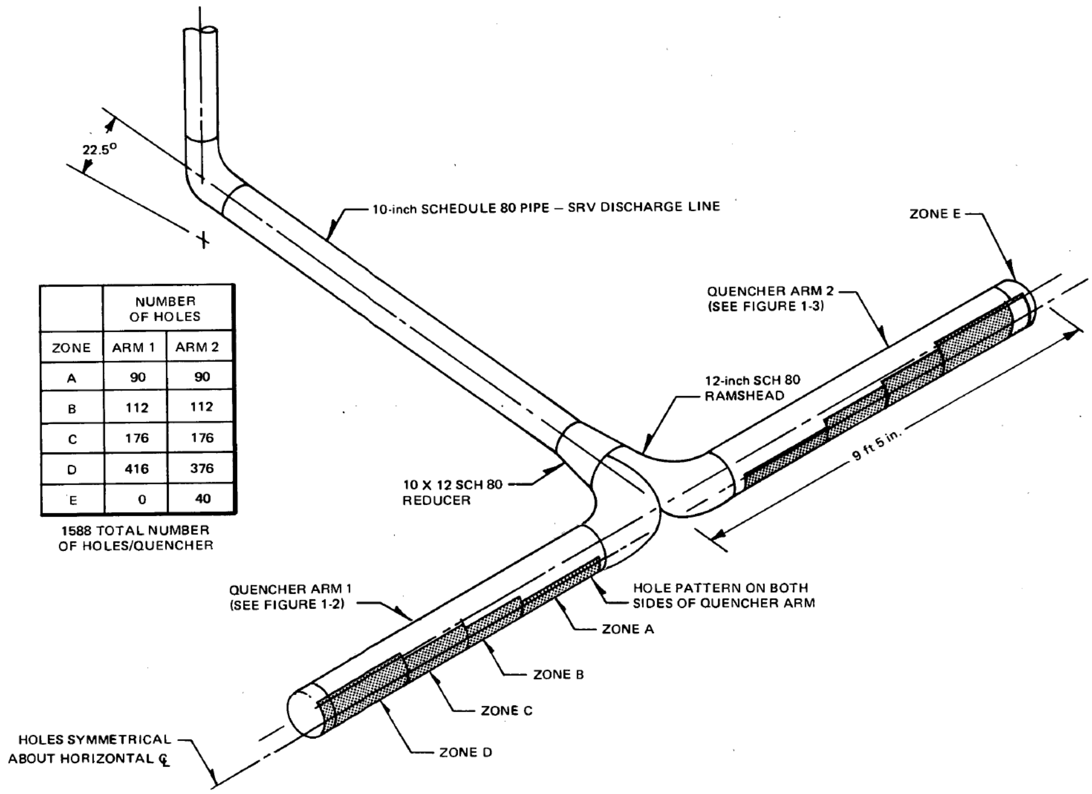

Figure 4: Monticello T-Quencher [8]

In addition, the relative positions of spargers and suction inlets in the Suppression Pool are unclear, and may have a high degree of plant dependency. If, for example, the RCIC suction draws from a part of the Suppression pool in the immediate vicinity of the SRV T-Quencher with the lowest opening setpoint, then it may attempt to draw water into the pump from a localized hot spot. Other thermal stratification issues may come in to play as well.

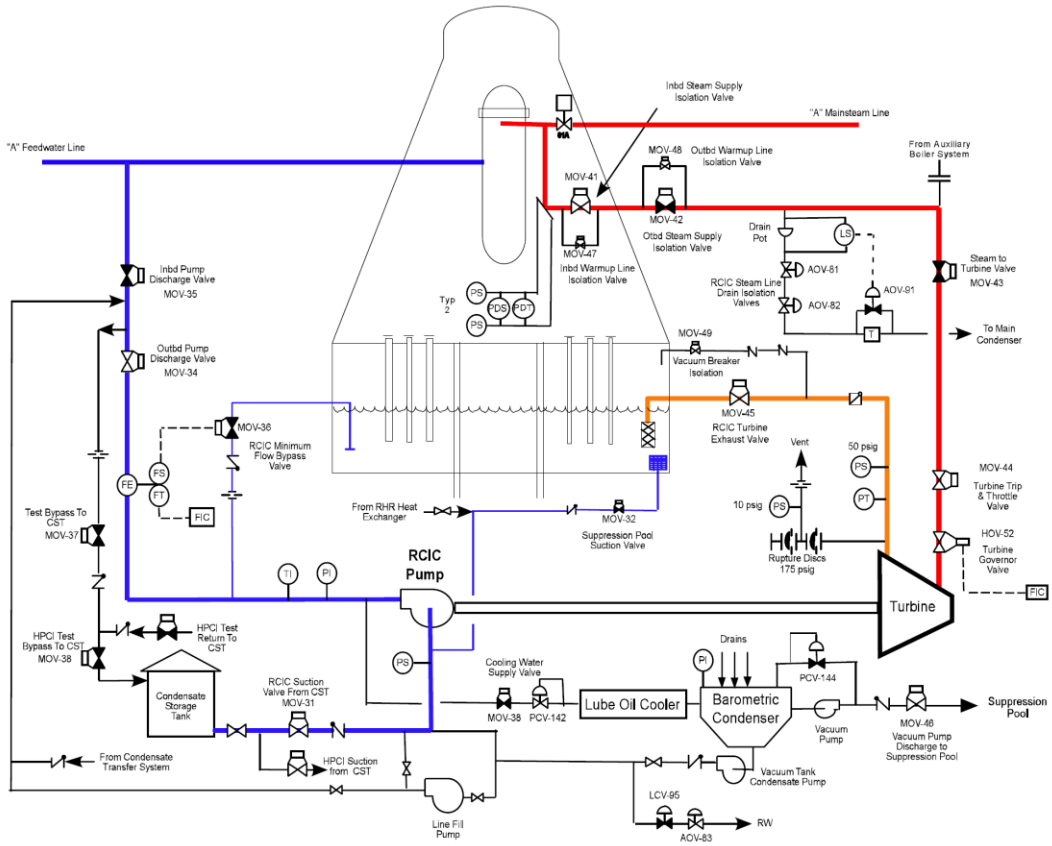

Figure 5: RCIC System in a BWR Mark II Containment [12]

No AC power is required to start or operate the system; only DC power is necessary to operate the system controller [10]. Without DC power, the controller is expected to cause the turbine governor valve to open fully. Given sufficient steam pressure, this would result in the turbine accelerating until an overspeed condition is reached. At the turbine overspeed setpoint, a mechanical turbine trip system is actuated, which shuts off flow into the turbine. The mechanical overspeed trip does not reset itself; once it trips, an operator needs to physically reset it [10]. In existing analyses, this is a major limiting condition. In station blackout (SBO) scenarios, the station batteries are predicted to be depleted in 4-8 hours after the loss of all AC power; this will leave the RCIC controller without a viable source of DC power.

There are two major capacities for RCIC systems installed in existing plants, and between them 400 to 800 gpm of makeup water can be supplied [10]. Both small and large sizes are designed to be able to supply sufficient cooling water to the reactor from shortly after reactor trip when the system is at high pressures and temperatures (1150 psi at saturation temperature) down to much cooler, lower pressure states (150 psi, saturated) [5].

2.1 RCIC CONTROL LOGIC

The RCIC System control logic is described here because it influences experimental facility operational procedures. The system, by design, will automatically start when a reactor vessel low-low water level signal is received after a reactor shutdown is initiated [5]. It can also be started manually from the control room, or physically by operators acting directly on the equipment using "blackstart" (system startup through the manual/physical alignment of valves and direct local control of system components by operators in the absence of electrical power) procedures.

Operation of the RCIC system will generally be expected to continue until a trip signal is sent to the turbine. There are 5 such automatic signals that come in to play: high reactor vessel water level, turbine overspeed, low pump suction pressure, high turbine exhaust pressure, and an Auto Isolation Signal [5]. Each of these signals require DC power to operate correctly. The overspeed trip can occur as a control signal that closes a steam valve with the ability to remotely reactivate the system, or as a mechanical overspeed trip (at a higher setpoint) that, once actuated, requires operators to physically reset the trip on the turbine after actuation before the system can start once again. All the remaining trips, with the exception of the high reactor water signal, will require operators to reset the system before it restarts. The high reactor water level signal allows the system to automatically restart once the level again drops to the low-low mark without any operator intervention [5].

In addition to the automatic signals, operators can take more direct control of system operation. They are given controls to manually set a desired output flowrate or turbine speed; not only can they control the system from the control room, but a local hand wheel on the trip and throttle valve for the turbine allows operators to physically control the steam flow into the turbine [10].

The ability for such manual, physical control can be an important feature, especially when electrical power sources are unavailable. The governor systems appear to have been designed with this in mind, and upon loss of electrical power is set to have the governor valve open fully. At that point, it is intended for an operator to locally take over the control functions using the trip and throttle valve if an overspeed trip is to be avoided [10]. This is achieved in the way the electro-hydraulic control system is designed. A certain non-zero voltage (-.75 to -1.00 V DC) is required to be present on the actuator terminals in order to maintain the pilot valve at its centered, steady-state position. When the voltage disappears, springs move it slightly to allow oil to flow to the remote servo, opening the governor valve; eventually, it will open fully [10].

2.2 TERRY TURBINES

The RCIC system employs a non-condensing Terry turbine as produced by Dresser-Rand, formerly the Terry Steam Turbine Co. A Terry turbine resembles a simple water wheel or Pelton wheel, and was developed in the very early 20th Century. It is an impulse-type turbine with jet and reversing chambers mounted on the casing, and "buckets" milled into the outer end of a rotating wheel [10].

2.2.1 Terry Turbine Design

Steam passes through the turbine's governor valve, and proceeds to enter the turbine assembly. It is accelerated through a nozzle, transforming some of its enthalpy into kinetic energy. Almost the entirety of the pressure drop in the turbine is across the nozzle; the more it accelerates the flow, the more efficient the turbine becomes. A converging-diverging nozzle designed to accelerate steam to supersonic conditions is, therefore, well suited to the turbine. The nozzle directs the flow to be nearly tangential to the rotating wheel and into U-shaped buckets milled into it. The flow imparts energy to the wheel as it is redirected at the bottom of the bucket and turned around. Upon departing the bucket, the flow enters a series of one or more reversing chambers on the stator assembly. The reversing chamber redirects the flow back towards the wheel, and into a subsequent bucket [10]. After the set of reversing chambers, the steam is released into the casing space, and exhausted from the turbine. Historically, there were usually four reversing chambers for each nozzle assembly, and 4 to 8 nozzle assemblies in the turbine [13]. Terry turbines are illustrated in Figure 6 and Figure 7.

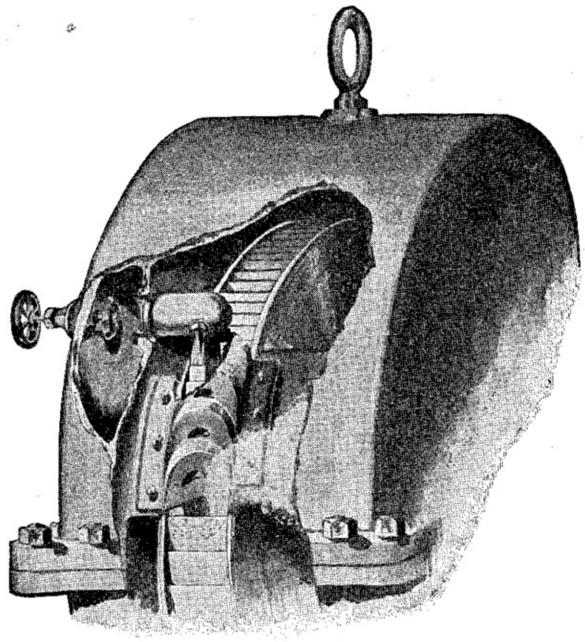

Figure 6: Terry Turbine with Steam Jet [13]

Non-condensing turbines such as the Terry turbine are not efficient turbines; they do not take advantage of the massive amounts of energy stored in steam's latent heat. In emergency systems such as the RCIC system, efficiency is not an important characteristic, and constitutes a lower priority than ruggedness or functionality. It does not initially consume a large fraction of the steam generated by the reactor; the majority of the generated steam will be dumped by the relief valves into the Suppression Pool. The RCIC system is sized to provide sufficient makeup water to replace that which boils off; it is not intended to maintain reactor water levels when significant leakage (pipe breaks) is present [5], [10].

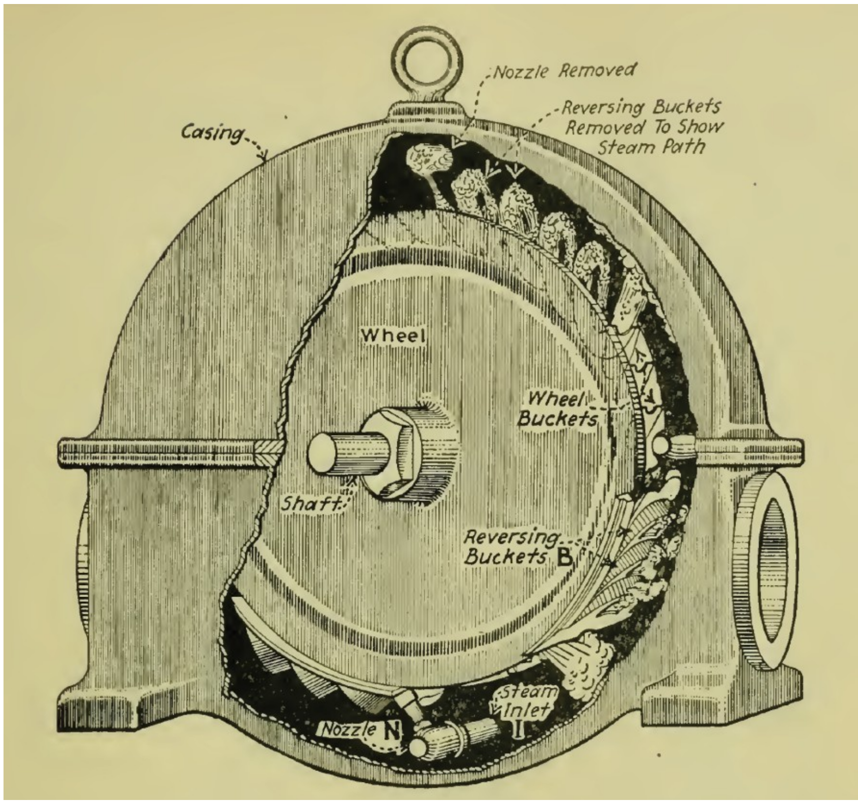

Figure 7: Terry Turbine Steam Path [14]

2.2.2 RCIC Turbine

The RCIC Turbine is designed to operate across a wide range of input conditions. The turbine wheel has a nominal diameter of 24 inches [10], and has different numbers of steam inlets and jet/reversing chamber assemblies based on the required power output. The two different RCIC size classes use the same turbine wheel, but different casings. The smaller casing allows for up to five jet-reversing chamber assemblies, while the larger casing allows for up to ten [10]. The wide operating range places high demands on the controller; successful operation of the system requires the controller to be responsive and well-maintained [10]. This is the result of significant amounts of excess mechanical power supplied by the turbine under some conditions; the turbine is designed to supply sufficient pump power from inlet steam pressures of 100 to 150 psi. When greater pressures are supplied, up to more than 1150 psi, "the turbine is capable of several times the rated horsepower" [10], and therefore the controller must be well-designed in order to maintain system operability and stability. Startup transients are an important consideration in the design, as the system must go from stopped to full rated flow in 30-90 seconds.

Documentation shows that the valve for the turbine's mechanical overspeed trip can double as a throttling control valve; it is a trip and throttle valve independent of the governor valve. However, based on Electric Power Research Institute (EPRI) diagrams of the mechanical overspeed trip system, it would appear that the mechanical trip cannot provide regulating functions. It instead appears to be a two-state system: ready, and tripped [10], [11]. Rather, the throttling function is provided by a local valve hand wheel on all systems, as well as an electric motor on some [10].

2.3 RCIC SYSTEM RELIABILITY

The RCIC system has limitations beyond DC power failure. Some potential limitations may not be immediately apparent. One potential avenue of interest, not actively pursued here, involves the system's lubrication oil. The RCIC turbine-driven pump (TDP) assembly and associated plumbing constitutes a containment boundary, and sits in a shielded room in the reactor building. Cooling to that room may be limited in some scenarios. In prolonged operation of the system, the ambient temperature may rise to a high enough temperature that the lubrication cooling is insufficient (if cooling is based on room temperatures; in Peach Bottom, cooling is based on pump inlet water [5]); the lubricant would then heat up. If hot enough, it could be unable to perform its functions correctly. As a result, the bearings and seals could fail, halting operation of the system.

As the heart of the system is the RCIC Turbine and Pump assembly. It can logically be expected to have limitations similar to other TDP systems: valve misalignments, pump cavitation or deadheading, turbine damage, lubricant problems, seal failure, air ingress, etc. The turbine, a Terry turbine, is considered to be very robust; however, even without damage, the system may not perform in severely off-normal conditions.

In fact, the system may have difficulties performing in relatively normal conditions. In 2000, a study was published examining the performance of TDP systems in nuclear power plants. It found that, in the 1987-1998 period, RCIC turbine driven pumps in BWR plants had a mean probability of failure on demand of 2%; from 1987-1995, the mean failure rate was 1.3E-5/hour [15]. The vast majority of failures, 70%, were in the governor. The turbine accounted for 27%, and the remaining 3% was in the pump. Overall, the causes of the majority of failures were age/wear (30%) and maintenance/procedures (27%). A significant (23%) fraction of failures had undetermined/unknown causes. The remainder of the causes of failure were dirt/contamination (7%), design defects (10%), and other (3%) [15].

The high proportion of failures related to the turbine is somewhat surprising, given that the Terry turbines are designed to be very robust. Testing has been performed in the past, and they were found to be fairly rugged. When high fractions of water are injected into the steam flow, a condition that can damage turbines not built to withstand it, the water spraying out of the Terry turbine exhaust made an impressive display for the investigators. However, the turbine itself, in post-excursion disassembly and inspection, was found to be completely unharmed [16].

Mechanical and power failures are not the only adverse conditions facing RCIC systems; operational conditions should be considered as well. These include out-of-bounds or incorrect control signals from the control room (for example, incorrect start/stop signals) and hostile inlet/outlet conditions for both the turbine and pump. For example, the switchover from the Condensate Storage Tank to the Suppression Pool for pump suction may fail, and there may be insufficient net positive suction head or vapor could then be drawn into the pump. The pump suction may draw water at temperatures too close to saturation, either from a localized hot spot in the pool or an overheated pool, and then give rise to pump cavitation. Alternately, there may be too little driving pressure for the turbine, too much back pressure, or liquid may enter the turbine inlet. This is not expected to damage the turbine, but its performance may suffer.

If water slugs are present, the governor may be unable to compensate for rapid speed changes fast enough, and the turbine could experience an overspeed trip; the controller has historically had difficulties with more than 1% moisture content [10]. At higher moisture contents, the performance of the nozzles can be expected to suffer; they are not jet ejectors intended to operate with two-phase flow. Interestingly, two-phase flow through jet ejectors is under consideration to *enhance* the efficiency of refrigeration cycles [17], which might provide some insight into the two-phase behavior of traditional nozzles. In addition, conditions in the turbine exhaust sparger in the Suppression Pool may generate hot spots in the pool, or possibly cause flow disruptions. Rapid condensation in the exhaust line may have only limited impacts in system operation, as there are both check valves and vacuum breakers installed to prevent the development of major vacuum conditions in the line [5].

2.4 DIRECT CONTACT CONDENSATION

When steam comes into contact with subcooled water, it will tend to condense. Given sufficient water subcooling and steam purity, the steam can condense very rapidly, even violently. This method of condensation, called Direct Contact Condensation (DCC), has been employed by the nuclear industry in a number of safety systems, including the RCIC System. As a result, interest in the subject has been more than simply academic; comprehending the complex phenomena that can present in it is important for a complete understanding of the operation of such systems, making it important for plant safety.

A number of efforts have been made to classify, categorize, and correlate the phenomena seen in DCC systems. Some treatments, both experimental [18] and analytical [19], have examined stratified/separated flows, while others have investigated vapor injection into pools. With steam injection into a pool, published results tend to find it "difficult to analyze the DCC phenomena around the sparger by simple analyses due to its geometrical complexity and complicated flow patterns" [20]. There is an apparent sensitivity to the design of experimental facilities in the results relating not just to the sparger design and orientation, but also to the steam injection feedback (a "hard" steam injection rate being fixed, while "soft" steam injection responds to pressure transients); some systems can experience severe water hammer issues [21]. Some tests have focused on pressure pulses from violent condensation and their potential effects on structures, such as those in [22]. A common line of inquiry involves the effective heat transfer coefficient. Others involve pool circulation patterns (such as [23]), and some explore steam plumes from a variety of outlet sizes and orientations as in [24].

Upon inspection, a number of DCC regimes have been identified by researchers in the field. Notably, these studies have limited to no examination of the effects of system pressurization (limited rather than nonexistent; for example, Celata et al. did investigate pressurization [18]), saturated two-phase steam-water injection, or extensively superheated steam injection in DCC systems. In the de With study [25], it was reported that 15 different regimes have been identified, and for the sake of simplicity were grouped into seven regimes. Each regime is identified by broadly similar shapes, locations, and behaviors of the steam/water interface. In traditional regime maps, the key variables are steam mass flux and bulk water subcooling; the de With maps add the diameter of the steam injector as a third variable; this showed the transitions between often significantly different regime maps and resolved some of their noncorroborating features.

The regimes include variants of chugging, bubble, and jet regimes. In the traditional regime map established by Chan and Lee (presented in Figure 8) [26], seven separate regimes were established; one, the chugging regime, was further subdivided into three regions. At high steam fluxes, they identified two jetting regimes; one at low pool temperatures which was unstable and showed steam bubble detachments, and another at high pool temperatures which showed no bubble detachment. At sonic conditions, the steam jet was very stable. When they reduced the steam mass flux, the conical jet shape of the steam bubble at the exit of the vent tube (vertically downward in their tests) became more bubble-shaped, resembling ellipsoids, and had frequent detachments and oscillations in both warm and cool pool temperatures. Even lower steam mass fluxes demonstrated chugging:

"Further reduction in the steam mass flux caused the point of detachment to occur closer to the pipe exit and ultimately right at the exit. This was taken as the boundary for the steam chugging regime, because the vapor region could only exist periodically in the pool, and the pool water would periodically enter the pipe" [26].

Chugging was noted to cease as the pool warmed up; at that point, an oscillating bubble formed around the pipe exit. Greater pool temperatures, as it approaches saturation, limits condensation and allowed steam to escape from the pool surface [26].

Chugging is associated with (sometimes large) rapid drops and subsequent rises in pressure in and in the immediate vicinity of a submerged vent tube. Damped "ringout" oscillations follow the initial spikes; these are associated with the presence and radius oscillation of small gas bubbles in the pool [27].

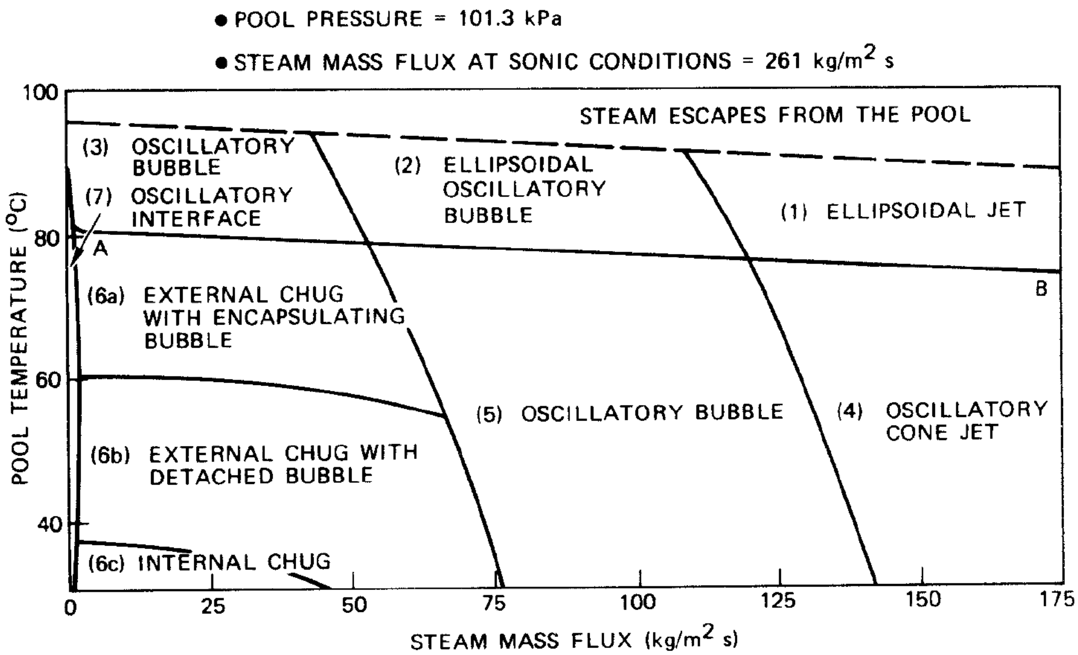

Figure 8: Chan and Lee DCC Regime Map [26]

Another DCC regime map was assembled by Aya and Nariai [28]. In conjunction with their experiment, they developed correlations defining the boundaries of the regimes in their map. Their proposed analytical approach produced regime boundaries that, in some parts of the map, began to diverge from the experimental results. Further complicating matters is their use of a significant header volume between the main flow restriction and the vent tube; this volume appears in the correlation, and the correlation is resultingly unclear in its applicability to systems without such a header. The correlations presented tended to be complicated; the boundary between condensation oscillation and chugging was given as Eq. (1) [28] in terms of pool subcooling, where the Hodgson Number in the experiment, N_H (a derived time constant for oscillating bubbles divided by the measured pulsation period), was determined to be 0.44. Thermal conductivity was expressed as λ, and ξ expresses a coefficient of flow resistance. It was based on a previous empirical correlation involving oscillating condensing bubbles. The regime map is given in Figure 9.

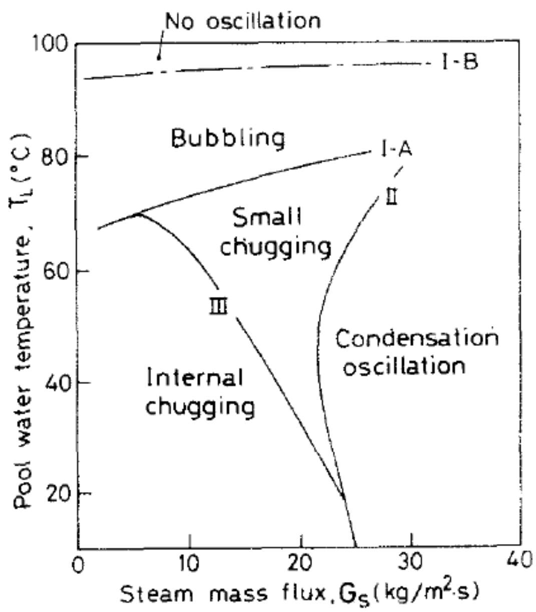

Figure 9: Aya and Nariai DCC Regime Map [28]

$$
\begin{aligned}
&\Delta T_T^{2/3} = K\left(\frac{\rho_s}{G_s}\right)^{1.3} \\
&where \\
&K = \frac{N_H}{1.54\xi\{\ \}^{1/3}} \\
&\{\ \} = \frac{C_{PL}\lambda_L\rho_s^{0.9}\left(\frac{\partial\rho_s}{\partial p}\right)^2\left(\frac{V_D}{\frac{\pi}{4}d_V^2}\right)}{L^2\nu_L^{0.9}\rho_L^{1.9}d_V^{2.1}}
\end{aligned} \tag{1}
$$

Liang and Griffith [29] produced a DCC regime map with correlations as well. In comparison with other regime maps, the Liang and Griffith maps were largely expressed in terms of the analytical correlations produced in their research. The presented relationship for the transition between chugging and bubbling/jetting was remarkably different from that of Aya and Nariai; it was much simpler and expressed in terms of (not entirely standard uses of) standard thermofluid nondimensional numbers.

The Liang and Griffith expression for the chugging regime is given in Eq. (2) [29], and expanded/restated in Eq. (3) at the regime boundary in terms using definitions of the nondimensional numbers compatible with those herein, and was based on a transient conduction model. It was noted that the model applies to horizontal injection, and that vertical downward injection, owing to the effects of buoyancy, required less steam to transition past the chugging regime. They also investigated the effect of noncondensables in the steam, and found that even small amounts were effective at preventing chugging; this can be seen in Figure 10 [29].

$$0.06 \mathrm{Re}_{sw}^{\frac{1}{2}} \mathrm{Pr}_{w}^{\frac{1}{2}} Ja_{dens}^{-1} \leq 1 \tag{2}$$

$$0.06 \mathrm{Pr}_{w}^{\frac{1}{2}} \left(\frac{\mu_s}{\mu_w} \right)^{\frac{1}{2}} \left(\frac{\rho_s}{\rho_w} \right)^{\frac{1}{2}} Ja_{w}^{-1} \mathrm{Re}_{s}^{\frac{1}{2}} = 1 \tag{3}$$

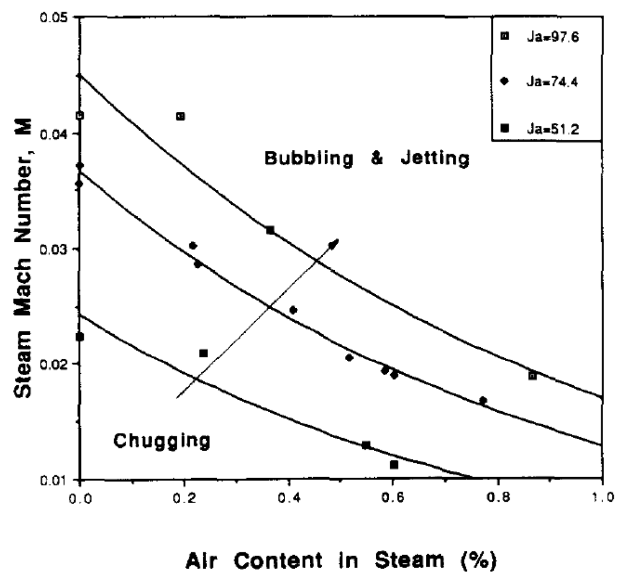

Figure 10: Influence of Noncondensibles on Chugging [29]

From these previous efforts, it can be seen that system differences can play a major role in the resultant DCC regime map. This can limit the applicability of the maps to systems that have a great deal of similarity, including scale. This is a disappointing result, as the chaotic fluid motions chugging can be very effective at dispersing material.

2.5 THERMAL STRATIFICATION IN THE SUPPRESSION POOL

Thermal stratification in the Suppression Pool may or may not be a problem from the consideration of plant operations; this has yet to be determined. There is, however, some evidence that it can exist [8], [30]. It is more than the presence of hot or cold spots in the pool; it is the bulk presence of significantly different temperatures over significant regions in the pool. For the purposes of this research, it can be said to be expressed vertically, horizontally/laterally, or in any irregular shape. Due to the difference in density between warm and cold water, vertical stratification is expected to be more stable than longitudinal expressions. However, that does not preclude the potential for such stratification; the pool is a very large body, and transient conditions may persist for long periods.

Stratification may be an issue for several reasons. If, for example, pumps draw water from the warmer regions, then they may exceed their inlet constraints earlier than expected from a consistent bulk pool temperature. Conversely, if they draw from relatively cool regions, they may operate longer than expected. Furthermore, when heat is injected into a stratified, warm region, the heat is effectively being absorbed by a smaller volume of water than anticipated. The parts of the pool that remain cool essentially do not participate as much or, in severe cases, at all in the thermal loading. It may seem as if large parts of the pool are absent. In such cases, it may fail to fulfill its pressure suppression/steam condensing functions early as uncondensed steam would begin to escape from the pool surface, and lead to pressurization of containment much quicker than predicted in analyses. In addition, attempts to condense steam in regions with out-of-specification temperatures may lead to instabilities and large, potentially damaging, vibrations as in the 1972 Wurgassen incident [31].

There have been some investigations that shed light into stratification in the Suppression Pool. Tests at the Monticello Nuclear Generating Station were conducted circa 1978 to examine pool mixing with and without modifications to T-quencher devices and to RHR lines. Monticello has a single 2004 MWth BWR/3 reactor with the Mark I containment [32]. Its Suppression Pool has a limiting water volume of 76,000 cubic ft; tests were performed with 69,000 cubic feet [8].

Without RHR operation, it was found that steam flow through unmodified T-quenchers resulted in significant vertical pool thermal stratification; a temperature difference from pool top to bottom of 52 °F was observed at the end of the steam injection [30]. When the RHR was engaged, the pool's thermal stratification disappeared.

Further testing used modified T-quenchers. These had holes bored into one end with the aim of inducing circulating currents in the Suppression Pool from SRV discharges; modifications with the same end goal were made to the RHR system as well. Test results found that, without the RHR, the modifications to the T-quenchers was sufficient to cause a degree of pool circulation after a few minutes. Tests with the modified RHR system revealed that the modifications induced “considerable pool mixing” [8]; it was so significant that within 6 minutes of the end of steam injection, the pool came to an essentially uniform temperature.

These full-scale tests demonstrate the effects of injector geometry for steam injection into the Suppression Pool. Given an appropriate injector/sparger design, the Suppression Pool can be thoroughly mixed in all directions via steam injection.

2.6 FUKUSHIMA DAIICHI RCIC PERFORMANCE

The RCIC systems in Fukushima Daiichi Units 2 and 3 performed their duties in a very challenging situation. They both operated much longer than expected, and did so without any electrical power or operator intervention for a prolonged period.

In Unit 2, the RCIC system initially started and stopped as designed on reactor water levels. The tsunamis generated by the earthquake began to reach the plant 41 minutes after the earthquake; by 55 minutes after the quake, parts of the building had flooded. This resulted in the eventual loss of all AC power as diesel generators went offline, and most DC power as the distribution system was damaged. The RCIC system had been restarted by operators about the time the first tsunami hit the plant, and subsequently continued operating until its ultimate failure. Workers were sent to the RCIC room to verify operation on multiple occasions, but were unable to examine the RCIC system in detail or even approach the equipment as the room itself was partially flooded. After a number of hours, the RCIC source was realigned from the Condensate Storage Tank to the Suppression Pool. Eventually, the Suppression Pool's indicators revealed that it had reached saturation. By 70.5 hours after the earthquake, trends in reactor water levels revealed that the RCIC had failed. All told, it operated for nearly three days, and did so largely without available DC power or operator direct intervention

[3]. In addition, the reactor had not depressurized; it remained at high pressure until it was depressurized manually to initiate seawater injection [4].

The RCIC system in Unit 3 initially behaved as in Unit 2. It started and stopped normally as the designated water levels in the reactor were reached. However, not all DC power was lost after tsunami inundation; there was sufficient power and connectivity that operators were able to start RCIC operation after the tsunamis struck; the system was restarted 1.3 hours after the earthquake. The RCIC System shut down 20.8 hours after the earthquake after running for 19.5; operators were then unable to restore it [3]. Investigations have concluded that the system likely tripped on a high turbine exhaust pressure signal; sufficient DC power was available (albeit becoming unstable) for such signals [33]. As in Unit 2, the reactor in Unit 3 did not depressurize in the period of RCIC operation.

It is not clear why the RCIC Systems performed as they did, or what eventually caused the Unit 2 failure. It has been speculated that the Unit 2 reactor overfilled, and that spillover into the then-unregulated turbine provided an unintentional yet beneficial feedback control mechanism. The water injected into the turbine would degrade its performance, slow it down, and lead to less water being injected into the reactor. In turn, this would limit the spillover into the Main Steam Line and from there to the RCIC turbine. So long as any transients were slow and stable, this could potentially reach a stable operating point.

2.7 RECENT EXPERIMENTS

Testing has been done at the Lappeenranta University of Technology to explore the phenomena associated with a condensation pool, especially one of the type employed in the Olkiluoto BWR containment. A number of these POOLEX tests were performed, where the facility consisted of a vertical cylindrical vessel filled with water, into which steam is injected downward through a vertical tube open at the bottom. In the blowdown tests, full condensation in the blowdown pipe was observed at very low temperatures, which transitioned through chugging to condensation oscillation as the pool temperatures were increased [34]. Water hammer was observed in the tests, and stresses severe enough to cause plastic deformation in some components were estimated for some pulses.

Further POOLEX testing was done to study thermal stratification in the facility [35]. Strong vertical thermal stratification was observed in the water in the STB-20 test, peaking at a difference of 37 °C difference from pool top to bottom when the steam was shut off. The steam flow was not constant during the test, but gradually reduced to maintain condensation within the pipe rather than outside it in the pool. The pool temperatures are illustrated in Figure 11 [35].

POOLEX data have been used as benchmarks. Test STB-31, for example, was simulated in CFD to compare different codes and DCC models, finding differences of a full order of magnitude for the condensation rate [36].

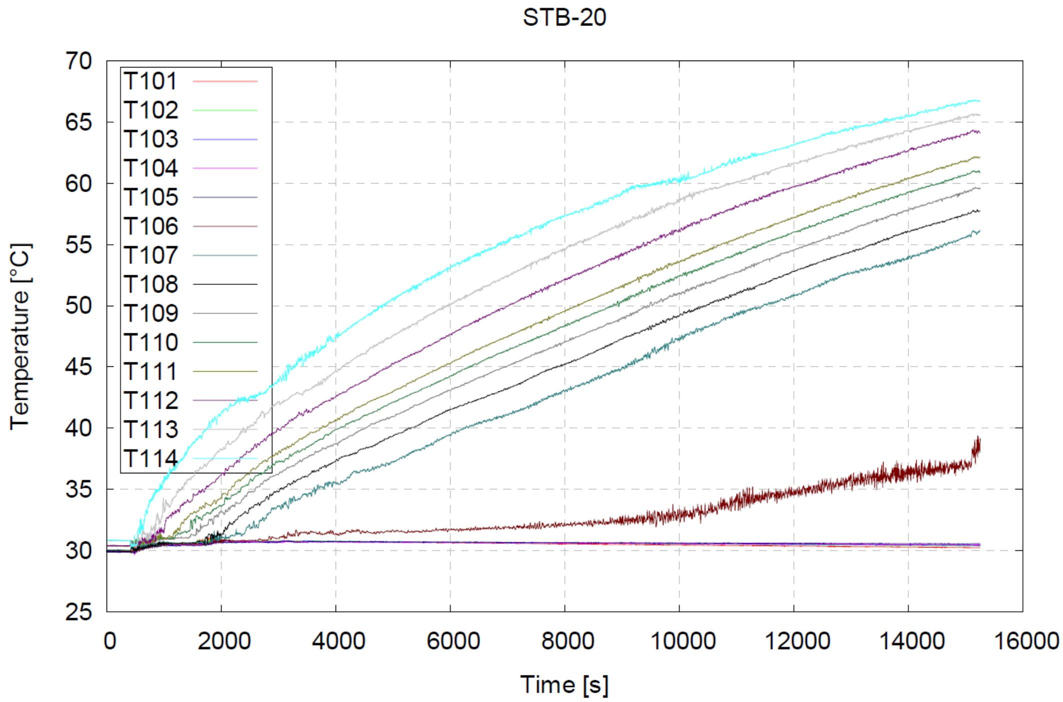

Figure 11: POOLEX STB-20 Stratification Test Pool Temperatures [35]

More recent testing at the Lappeenranta University of Technology has used the PPOOLEX facility [37]. It shares some similarity to the POOLEX facility, but models more features of containment. Notably, the vessel is separated into a drywell and wetwell, and the drywell is vented to the wetwell through the blowdown line. Thermal stratification was found to be significant, but had a slightly different development than the most comparable of POOLEX stratification tests [37].

Additional recent studies in Japan at the University of Tokyo demonstrated the potential for transient thermal stratification in the Suppression Pool with spargers based on the RCIC turbine exhaust discharge. These, however, were conducted in a scaled facility rather than a full-size power plant. Numerical and experimental data showed a fair amount of vertical stratification near the injection point [38]. Early on during steam injection, low points in the pool maintain a near-constant temperature. With a more pronounced vacuum and varying flow rates, the thermal stratification profile changes. A high steam flow rate produced little stratification in the test chamber. At a more moderate rate, stratification only appeared after a fair amount of thermal energy had been injected into the pool; it later vanished as the bulk temperature increased. At low injection rates, stratification was apparent from almost the beginning of the test. Then, towards the end of the test, the stratification disappeared in stages: first, the higher-elevation temperatures jumped to the top-level temperatures, then, progressively, the lower-level temperatures did the same [39].

Another set of experiments has been performed at the Società Informazioni Esperienze Temoidrauliche (SIET) laboratory in Italy. Those tests focused, among other (less-related to this work) areas, on the RCIC sparger designs rather than the complete system and Suppression Pool, and explored the effect of the presence of noncondensibles in the exhaust flow. The open-bottom (Fukushima Daiichi Unit 2-style) sparger had a diameter of 20 cm (vs. 28.3 in Unit 2), and the tube was large when compared to the pool. The multiple-hole (Unit 3-style) preserved the hole sizes of the plant system, but reduced their number; the tube was similarly large when compared to the pool [40]. Those tests have an admitted distortion for pool circulating currents due to the limited pool dimensions and its shape.

Both sparger types in the SIET tests produced a measurable vertical dependence for the pool temperatures [40], [41]. The open-bottom type produced some stratification, which was eliminated by the addition of 3% air to the steam flow [41]. The more complex (multiple holes with differing diameters venting solely from the side of the sparger) design produced significantly more thermal stratification. Chugging was found to end as the pool warmed up beyond 45 °C, at which point stratification began. Even as the pool (open to the atmosphere) approached saturation, the lowest portions of the pool in the SIET facility appeared to remain unmixed [40].

3. EXPERIMENTAL FACILITY DESIGN AND CONSTRUCTION

In order to investigate the operation of the RCIC System in BWR units with the Mark I containment, an experimental facility was designed and constructed at the Laboratory for Nuclear Heat Transfer Systems at Texas A&M University. In the RCIC System, steam from the reactor is drawn off of the Main Steam Line, directed through the RCIC Turbine, and exhausted into the Suppression Pool. The turbine, in turn, drives a pump on their common shaft. This RCIC pump draws water either from the Condensate Storage Tank or from the Suppression Pool and pumps it back to the reactor. This maintains the reactor's water level as decay heat in the core boils it off.

In the experimental facility, the alignment to draw water from the Condensate Storage Tank will not be explored in this endeavor; only the pump suction's alignment to the Suppression Pool will be considered. The experiment, therefore, is analogous to a RCIC system operating in its closed-loop mode in the long-term. The role of the reactor will be played by the laboratory's steam generator, which directs steam through a manual control valve (an analog to the RCIC Turbine's governor valve), through an analog to the RCIC turbine (currently an orifice), and through a sparger in a large pressure vessel analogous to the RCIC sparger in the Suppression Pool. A second sparger setup performs as an analog to an SRV. The Suppression Chamber analog and proximate equipment are shown in Figure 12.

Figure 12: Completed Suppression Chamber and Nearby Plumbing

Water from the analog to the Suppression Pool is drawn into a centrifugal multistage pump, analogous to the RCIC pump. Here, the pump will not be directly connected to the turbine analog, and instead will be fully separated from it. This allows for independent investigation of both the pump and turbine sides of the system. From the pump, water will be returned to the steam generator to complete the closed loop. In addition to recirculation lines, there is an injection line to the steam path upstream of both the RCIC and SRV sparger analogs. This will allow the investigation of potential water carryover into the Main Steam Line from an overfilled reactor. The recirculation flow is used to prevent deadheading the pump as well as to assist in preventing overpressurization of the downstream lines. It can also be used to circulate the water in the Suppression Chamber Analog.

The experimental system uses deionized water throughout, and is thoroughly instrumented to examine all variables of interest.

3.1 EXPERIMENTAL EQUIPMENT

In the standard alignment, steam is directed from the outlet of the steam generator system to the manual steam control valve. This is entirely in standard-wall (Schedule 40) 1.5-inch NPS Stainless Steel 304 piping, and the entirety of the steam piping is covered with 2-inch thick rigid fiberglass pipe insulation. From the control valve, the steam continues in a straight horizontal path through the Foxboro vortex flowmeter and past its associated pressure and temperature taps until it encounters the liquid trap and facility branch-off point; this consists of a tee where liquid in the line drains downward to the trap valve and the steam flows vertically until it reaches the appropriate height. The branch-off, not used in this experiment during data collection but used for cooldown operations, is located near the bottom by the liquid trap valve. The change in elevation is due to physical limitations of the laboratory space; the plumbing must be directed up and over a region that cannot have permanent installations blocking access. Once the requisite elevation is achieved, the steam line returns to a horizontal path, and encounters a block valve. From the block valve, the piping is directed over the clear area to the Suppression Chamber Analog area, where it is turned downward until it meets the various branches of the Suppression Chamber Analog assembly. The top branch connects to the top 1.5-inch flange on the Suppression Chamber Analog through a normally-closed ball valve. The lower branch flows contains the water injection point, and downstream of that point the line branches off once again to two ball valves; one for each sparger assembly. Pressure and temperature are monitored at the bottom of the vertical section of the steam line, right at the lower (second) branch off point upstream of the water injection. One of the sparger lines, analogous to an SRV, aligns the steam line directly to the SRV sparger when its ball valve is opened. The other, a RCIC analog, passes the steam through the RCIC Turbine analog and then to the RCIC sparger analog. Both spargers deposit their steam below the surface of the water in the Suppression Chamber Analog, which contains a major support structure for the spargers as well as internal instrumentation. A simplified P&ID of the experimental system, omitting some components, is given in Figure 13. Complete P&IDs for the entire system are given in Appendix A.

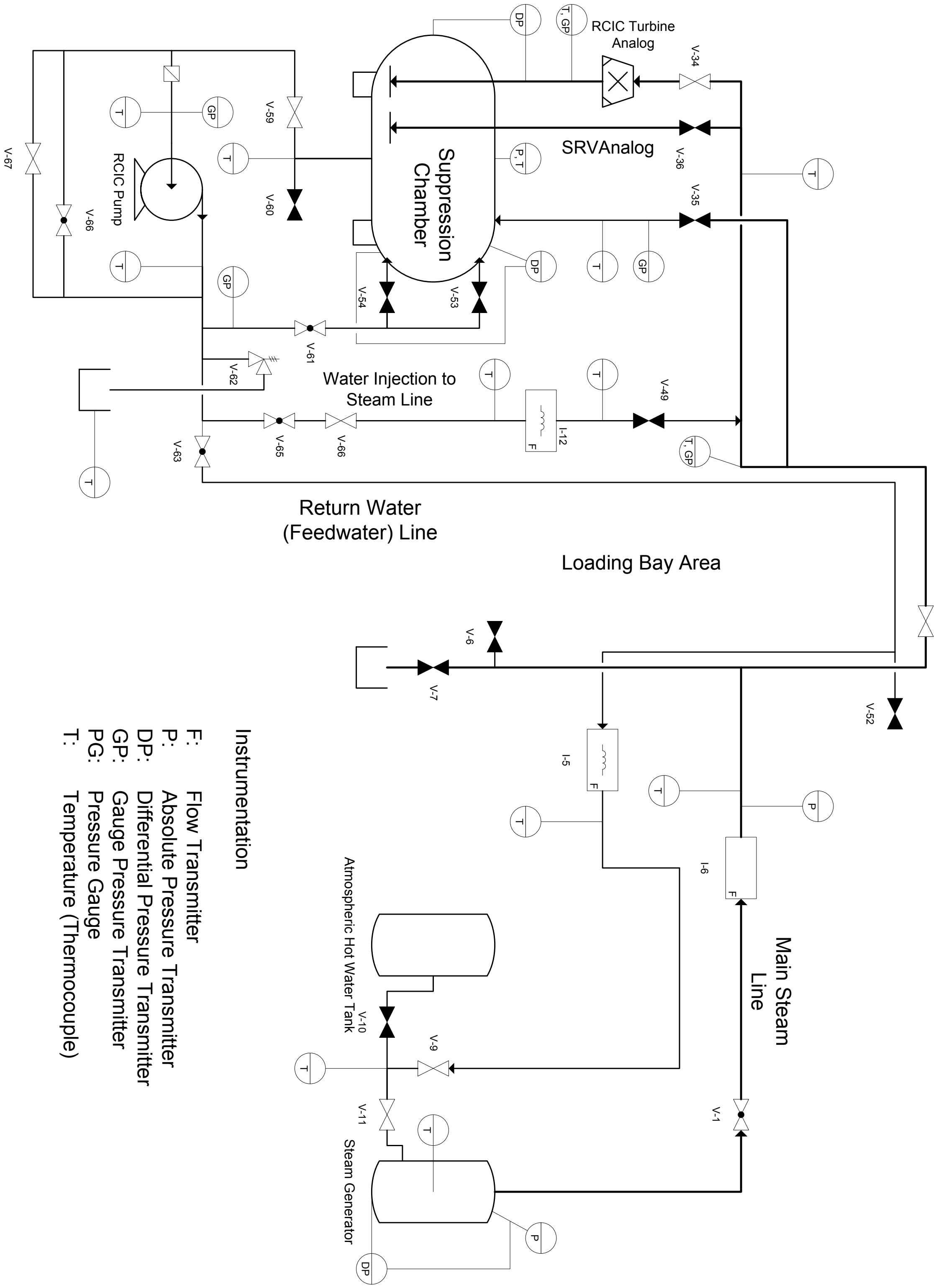

Figure 13: Simplified Experiment P&ID

The water line consists of several pipe sizes. All are Schedule 40, and the majority is 0.75-inch NPS. All of the water lines are insulated, largely with 1.5-inch thick rigid fiberglass pipe insulation. The water is drawn from the outlet of the Suppression Chamber Analog (the bottom-most flange) through a 0.75-inch line that immediately becomes a 1-inch line. The water temperature at the vessel outlet is measured by a thermocouple. From there, the line traverses a block valve and joins with recirculation flow coming from the pump outlet through stainless steel tubing. It then goes past a thermocouple and pipe size reduction to 0.75-inches to enter the pump inlet. From the outlet of the pump, the water temperature is again measured with a thermocouple and then the pipe size is expanded to 1-inch. This 1-inch segment handles the major branch-offs: a 0.5-inch recirculation line to an upper and lower flange on the front of the Suppression Chamber Analog, the aforementioned stainless steel tubing recirculation lines back to the pump inlet, a visual pressure gauge and relief valve, the injection line, and the return flow (to the steam generator) control valve.

From the return flow control valve, the flow is directed vertically and the pipe size is reduced to 0.75-inch NPS, and it travels horizontally alongside/slightly below the steam line until it too crosses the reserved/clear area. It then drops down and enters a length of 0.5-inch NPS pipe for the Yamatake magnetic flowmeter. From the flowmeter and its associated thermocouple, there is a short vertical segment of 1-inch pipe to provide a U-trap meant to keep the meter full of water at all times. The size is then reduced back to 0.75-inch NPS, horizontally, until it reaches the vicinity of the steam generator. There, it drops to near the level of the bottom of the steam generator, and encounters a block valve. From there, the pipe size is reduced to 0.5-inch NPS and there is a visual pressure gauge and a branch point with a thermocouple. Both branch points have block valves; one connects to the hot water tank, and the other connects to a low penetration in the steam generator to complete the loop.

The injection line to the main steam line takes water from the pump's branching outlet and passes it through a control valve and a block valve. Then, it reduces the pipe size down to 0.25-inch NPS. The flow encounters a thermocouple, passes through a Badger M2000 magnetic flowmeter, encounters a second (downstream) thermocouple, and then hits another block valve. From the block valve, the water injection flow is directed to a tee in the steam line, where the steam and water mix.

The relevant process variables, i.e., pressures, temperatures, and flows, are measured by appropriate instruments. These include flowmeters, pressure transmitters, and thermocouples. Their measurements are then processed and recorded by a data acquisition system. More detailed information on the subsystems and components in the experimental facility are given in the following sections.

3.1.1 Water Deionization System

The entirety of the water used in the RCIC experimental facility is deionized water. This DI water is provided by passing city water through a Culligan ® mixed bed system consisting, in order of the flow, an activated charcoal filter, a cartridge filter, two mixed bed resin tanks in series, and a final cartridge filter. An indicator lamp turns from greed to red when it senses that the resin needs regeneration. Due to the level of dissolved material in the supply water, the DI system can only purify about 350 gallons of water between regenerations.

In order to fill the system with DI water, the valve connecting the DI system to the hot water tank is opened, as are the valves between the hot water tank and steam generator. Then the hot water tank is filled, which drains into the steam generator. Once the steam generator is filled, all of the valves on the steam generator and DI system are closed. Next, using the laboratory's air compressor, the steam generator is pressurized to a moderate level with air. Slowly, the valves aligning the return water line from the Suppression Chamber Analog to the steam generator are opened, allowing the pressurized water to flow in reverse through the water line back to the Suppression Chamber Analog. In turn, valves for the branching lines are opened and closed to purge all the air from the lines. Before the water level in the steam generator drops too low, the block valves are closed to trap the water in the lines, and the steam generator is depressurized. The valves are then realigned, opening up flow through the DI system to the hot water tank and steam generator. In addition, the valves on the return water line from the Suppression Chamber Analog to the steam generator are reopened. The water in the steam generator and hot water tank can then siphon over into the Suppression Chamber Analog as the DI system adds water to the vessels. This is a slow process, as the DI system processes 1 to 2 GPM. Filling approximately 700 gallons into the Suppression Chamber Analog, as well as any additional necessary fill for the steam generator and hot water tank, takes a minimum of two complete regeneration cycles and more than 7 hours of fill time.

3.1.2 Flowmeters

There are three primary flowmeters used in the experiment; a vortex flowmeter is on the steam line, and two magnetic flowmeters are on water lines. An additional magnetic flowmeter was used for monitoring flows while cooling the system down, but is not available in the actual tests' alignment.

3.1.2.1 Vortex Flowmeter

The vortex flowmeter on the steam line is a Foxboro 83W wafer-style meter in the 1.5-inch steam line nearly 100 inches downstream of the main steam control valve. It uses a standard analog 4-20 mA signal to the DAQ, and can register saturated steam flow at atmospheric pressure up to nearly 96 g/s when properly configured. At higher fluid densities, the maximum measurable mass flowrate increases. At 6 and 8.25 inches downstream of the meter are pressure and temperature taps, respectively, for use in calculating the correct flow value from the signal generated by the meter.

A vortex flowmeter, as implied by its name, measures fluid flow by utilizing vortices; these vortices are generated as fluid flow past an engineered obstruction in the flow path. The meter measures the frequency of vortex shedding, which is directly related to the flow rate. This is achieved by the use of a small piezoelectric differential pressure sensor near the obstruction; the shedding of vortices alternates from side to side of the obstruction and generates time-varying differential pressures across the sensor at the frequency of the shedding [42]. When combined with the fluid's thermophysical conditions as measured near the meter i.e., pressure and temperature in a pure superheated steam system to determine density and the meter's correction factors, the flow can be fully characterized. The equations for the flow characterization and correction factors appear in Eqs. (4), (5), (6), and (7) [42].

$$URF = CRF \cdot CF \cdot \frac{URV}{Time} \cdot \frac{1}{\rho_f} \tag{4}$$

$$CRF = BCF \cdot K_{ref} \tag{5}$$

$$BCF = TCF \cdot MCF \cdot UCF \tag{6}$$

$$TCF = 1 - 3 \cdot \alpha \cdot \left(T - T_0\right) \tag{7}$$

In the equations, URF is the upper range vortex shedding frequency while URV is the upper range value of the flow, i.e., kg/s. K_{ref} is the reference K-factor characteristic of the meter, which needs to be corrected for changes in temperature, pipe wall thickness and nearby disturbances. Only the temperature correction factor given in Eq. (7) will be nonunity in Eq. (6); it corresponds to thermal expansion in the meter material (expansion rate of α) at fluid temperatures T other than reference T_0. Both CF and Time are used as unit scaling factors.

3.1.2.2 Magnetic Flowmeters

A magnetic flowmeter works by passing a conductive liquid through a magnetic field. By the laws of magnetic induction, this generates a voltage perpendicular to both the magnetic field and the flow of the conductive liquid; it is picked up by electrodes in proper locations. With a known electrode spacing and magnetic field, the voltage will be directly proportional to the flow velocity [43].

Of the two magnetic flowmeters, one is a Yamatake MagneW 3000 PLUS system with a 0.5-inch NPS wafer-style detector. The system consists of an MGG18 detector connected to a remote MGG14C converter. It can measure flowrates up to 28.01 gpm with an error of ± 0.2% to 0.5%, given a minimum liquid conductivity of 3 micromhos/cm [43]. The range, however, is set to 0-5 gpm on its analog 4-20 mA output. Liquid temperature is measured a few inches downstream of the meter to assist in fully characterizing the mass flow. This meter is situated to measure the flow from the Suppression Chamber Analog back to the steam generator.

The second magnetic flowmeter is a Badger M2000; it is used for measuring the liquid injection flow into the steam line. It uses a 0.25-inch flange connection, and can register flowrates from 0.02 to 5 GPM; its accuracy can be better than ± 0.25 % [44]. In addition, it can handle process fluid temperatures of up to 150 °C, and requires a minimum fluid conductivity of 5 micromhos/cm [44]. Temperatures are measured 6 inches upstream and 2 inches downstream.

3.1.3 Pressure Transmitters

Four different primary models of pressure transmitter are used in the RCIC facility: one Dywer 682-3, four Dwyer 673-7 gauge pressure transmitters, three Honeywell ST3000 STA940 absolute pressure transmitters, and three Honeywell ST3000 STD924 differential pressure transmitters. In addition to the electronic pressure transmitters, there are a number of simple visual pressure gauges placed throughout the facility. These, however, are not intended for any actual measurement and are present only for operator convenience as well as sanity checks.

The Dwyer 673-7 pressure transmitters are factory set to a fixed range from 0 to 100 psig (the 682-3 goes up to 250), and transmit on an analog 4-20 mA line. No end-user adjustments are possible, and they do not communicate with a Honeywell Smart Field Communicator. The 673-7 transmitters have a maximum case pressure of 200 psig, and therefore can survive exposure to pressures beyond their ability to communicate. This is an important feature, as one was originally installed on an outlet to a high-pressure multistage centrifugal pump; that line may see pressures approaching 150 psi before the relief opens.

Four such Dwyer gauge pressure transmitters are deployed in the experimental facility: one on the RCIC pump analog's discharge (originally, it was later upgraded to the 682-3 and moved to the pump suction), another on the outlet to the RCIC turbine analog, a third on the Suppression Chamber Analog's top vapor space, and a fourth on the Main Steam Line on the branch-off point in proximity to the Suppression Chamber Analog, far downstream of the vortex flowmeter. Especially in light of the age and calibration difficulties for these transmitters, their transmitted data are not considered high-quality for the purposes of this experiment and are therefore seen as rough monitors rather than as accurate measurements.

Both of the Honeywell models can be used with a Honeywell Smart Field Communicator. This allows for fast and simple connections to the transmitter, quick adjustments to the output ranges, simplified calibration procedures, and in general they are easier to work with than if they did not have that capability. With the communicator, reading and adjusting ranges is a matter of connecting the leads and pressing a short sequence of buttons. No potentiometers need to be adjusted. In addition, the output can be directed to hold at specified values to assist in calibrating the 4-20 mA analog current loop.

The STD924 model can measure differential pressures ranging from -20 to +400 inH2O. This range may seem limited in higher-pressure situations, such as high-pressure choked flow through a restriction, but combined with a capability for withstanding a high common-mode case pressure, these transmitters are very useful for measuring liquid levels in pressure vessels. Two of them are used for exactly that: one on the steam generator to measure its water level, and another on the Suppression Chamber Analog to measure its level. The third is installed to measure the differential pressure from the RCIC Turbine Analog's outlet to the Suppression Chamber Analog's bulk vapor space pressure, which is not expected to be large.

The STA940 model can measure absolute pressures ranging from 0 to 500 psia; however, none of the three used here are set to such a broad range. One measures the pressure in the steam generator, a second measures the pressure in the vapor space of the Suppression Chamber Analog, and a third measures the pressure in the Main Steam Line at the appropriate location shortly downstream of the vortex flowmeter. The widest range is set for the transmitter on the steam generator, transmitting from 0 to 150 psia; the narrowest set range is on the Suppression Chamber Analog, being 0 to 100 psia. The main steam line pressure transmitter's range is set to 0 to 130 psia.

3.1.4 Thermocouples

In this experimental facility, a total of 44 thermocouples are used to measure temperatures at various locations. Of them, 24 are installed in the interior of the

Suppression Chamber Analog proper, with an additional 25^{th} that can effectively considered to be internal much of the time. The remainder are distributed throughout the system; near the Suppression Chamber Analog, one is on the vessel's outlet, one on the RCIC pump analog's inlet, another on its outlet, one is on the Main Steam Line at its branchoff point, another near 6 feet downstream of the water injection point in the steam line, another on the outlet of the RCIC Turbine Analog, one is immediately upstream and another immediately downstream of the Badger M2000 magnetic flowmeter on the water injection line to the steam line, and one even monitors the bottom temperature of the blowdown drum. Four monitor temperatures inside the steam generator, another measures the temperature on the water return line to the steam generator at the point of injection, another on that line is immediately downstream of the Yamatake magnetic flowmeter, one measures the steam temperature at an appropriate location downstream of the vortex flowmeter, and one even monitors the room temperature of the laboratory.

All of the thermocouples used in this experiment are Omega type T (copper-constantan) thermocouples with special limits of error for accuracy within 0.5 °C [49]. They are all of the ungrounded type, with stainless steel sheathing. However, they do not have the same lengths nor do they have the same sheath diameter. The lengths range from 12 inches to 120 inches, and the diameters range from 0.032 inches to 0.062 inches. With the exception of the room temperature thermocouple, all the loop resistances are well below 100 ohms.

The SCXI-1102/b/c modules used in conjunction with SCXI-1303 terminal blocks on the Data Acquisition System are built to enable open thermocouple detection.

This uses high resistances to pass a very small current through the thermocouple; when the thermocouple is disconnected or damaged, it will result in a (safe) offscale high voltage on the positive terminal. However, with long extension wires, high thermocouple loop resistances, or when very high accuracy is desired, it is recommended that such detection be disabled, as it can result in measurement errors [45]. As a result, it has largely been disabled in this experimental facility.

Additionally, as the thermocouples used here are universally of the ungrounded type, it is recommended that they be ground referenced on one terminal (the negative terminal). The SCXI-1303 terminal blocks make this a simple matter, and such ground referencing has been enabled for all of the thermocouples.

3.1.5 Pump

The pump used in this experiment is a five-stage centrifugal pump, and should provide a reasonable analog to the multistage centrifugal RCIC pump. It is a Dayton 5UXF5 with a 0.75 HP electric motor running off of 115 VAC, and can produce up to 93 psi of boost pressure; the performance curve is shown in Figure 14. Both the inlet and outlet of the pump are 0.75-inch NPT connections. The speed of the motor, nominally 3450 rpm, is not controlled by the user; as a result, any pressure and flow regulation must be done using valves connected to the system.

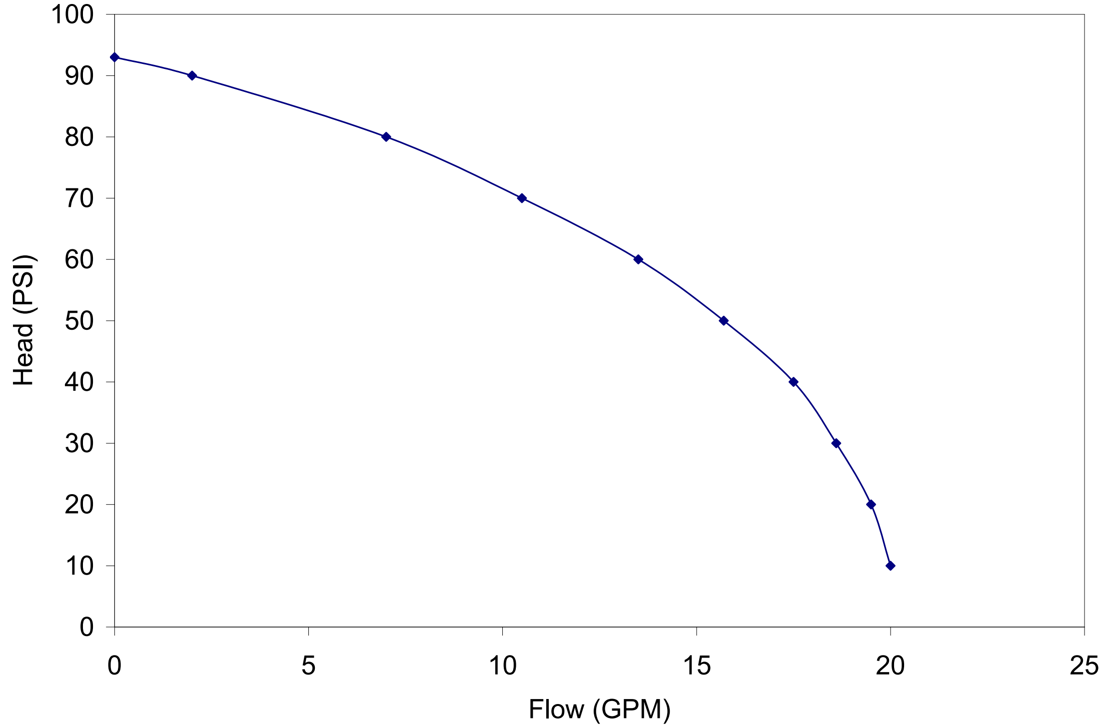

Figure 14: Pump Performance Curve (Data from [46])

While some of the wetted materials on the pump are cast iron and the listed maximum liquid temperature is 194 °F [46], it was predicted that corrosion would not be a major issue for the duration of the experiment. It was also assumed that the liquid temperature limit could be exceeded at elevated inlet pressures without causing significant damage to the pump for the duration of the experiment. In the event that damage does occur, all of the components of the pump are serviceable/replaceable.

3.1.6 Steam Generator

The steam generator pressure vessel used in this experiment is a Kennedy Tank and Manufacturing Co., acquired in the past for use on other experiments; it has a capacity of 130-135 gallons and limits of 135 psig and 350 °F. It can be represented as a vertically-mounted cylinder, with a diameter of 24 inches and a height of 60 inches; the top and bottom both have curved heads that bring the height to approximately 72 inches in addition to the legs below and the equipment mounted above. It was made out of schedule 10 stainless steel 304 pipe. The entire assembly is wrapped in two-inch thick rigid fiberglass insulation. The steam generator pressure vessel and associated equipment is shown in Figure 15.

Figure 15: Steam Generator System

The steam is generated by six strategically placed electric immersion heaters; they are wired for 3-phase 480 VAC, and can produce a grand total of 157 kW of heat nominal. They are submerged beneath the water level in the main vessel, and heat the water to boil it. The heaters are not all of the same size; two are two kW in capacity (screw-in type), one is three kW (screw-in type), and the remaining three are fifty-kW heaters (8-inch flanged type). Of the fifty-kW heaters, two can be powered in 25-kW intervals, while the third has 6.25-kW intervals. This allows for a staggered resolution of available heating powers by using different combinations of heaters: 2, 3, 4, 5, 6.25, 7, 8.25, 9.25, 10.25, 11.25, 12.5, 13.25, ..., 157 kW. The heaters and electrical control panel were manufactured by Watlow Process Systems.

As it was originally wired, a total of 6.25 kW from the 7th and 8th circuit of the third 50-kW heater were unavailable. This brought the total available power down to 150.75 kW at 480 VAC 3-phase. This was rectified after shakedown testing.

In addition to the main vessel, there is a smaller separator attached to the main steam output line. It is a separate pressure vessel manufactured by Clark Reliance and is connected to the main steam line upstream of the control valves. Both it and the steam generator are ASME-code rated. Wet steam from the steam generator flows into it through a 1.5-inch line, it removes entrained liquid from the output flow, and the liquid is returned to the steam generator while the exiting steam continues its journey; thus, the steam exiting from the overall steam generator system is nearly dry saturated steam.

There are a number of instruments that monitor the steam generator. For bulk temperature measurements, there are four thermocouples placed at different vertical locations penetrating the vessel; these give the DAQ the temperature readings from the cooler water near the bottom of the main vessel to the steam space near the top. The DAQ also monitors two pressure transducers on the steam generator: an absolute pressure meter connected to the top for pressure determination, and a differential pressure meter tapped to the top and bottom of the main vessel for water level determination.

In addition to the instruments connected to the DAQ, there are visual gauges attached to the system: pressure gauges at the top and bottom of the main vessel, and a magnetic float-based level indicator. The level indicator is also used by the interlock circuitry for the heaters; the heater interlock cuts power when a thermal overload is detected in the heaters or when the level float falls below the cutoff level, triggering a reed switch.

There are several lines that connect to the steam generator: the main steam line, two Kunkle relief valves, a manual blowdown line, a vacuum breaker line, an air line featuring a pneumatic quick-connect fitting, a drain line, and a fill/return water line.

The Kunkle relief valves are ASME-code rated, each set to lift at 115 psi. They both open to a large atmospheric blowdown drum partially filled with water to condense any escaping steam during their operation. This prevents hot steam from being ejected directly into the laboratory space. The blowdown line, however, does not direct steam into the drum. Instead, it directs the steam to an outdoor location away from laboratory personnel.

The vacuum breaker is meant to prevent a significant vacuum from developing in the steam generator when it is shut off and cools down. It consists of a ball valve, a check valve, and a filter. The ball valve should be closed when the system is under pressure to prevent leakage back through the check valve. At any other time, it should be open, allowing one-way airflow through the check valve into the steam generator. The inlet has a filter on it to prevent dust or other contaminants from entering the system. When used properly, this system should prevent a vacuum from developing in the steam generator, and thus preventing vacuum damage to the vessel.

3.1.7 Suppression Chamber Analog

The Suppression Chamber Analog is, in this experiment, the analog to the Torus/Suppression Chamber in BWR plants with the Mark I containment. Unlike the actual Suppression Chambers, it is in the shape of a cylinder rather than a torus. It is a large (approximately a 1,400 gallon capacity and empty weight of near 3,000 pounds) pressure vessel originally constructed in 1952 by Wyatt Metal & Boiler Works. It is made of 304 Stainless Steel, and has a pressure rating of 88 psi with a temperature rating of 400 °F. It is a horizontally-mounted cylinder with an inner diameter of 59 inches and a length of 96 inches from head weld to head weld; from each head weld, each head extends out approximately 3 inches before the curvature changes, extending the cylindrical section to approximately 102 inches total. The longest length is from head to head through the centerline; this length is about 122 inches internally. The vessel's legs near either end elevate the bottom center 18 inches above the surface beneath it. For reference here, the front face will be deemed the head with the ASME-API stamped plate, and the right-hand side will be the right-hand side of the vessel when facing toward the front head from the rear head. It has a number of useful penetrations, including a 6-inch NPS flange underneath at the front end where it feeds the pump suction. In addition, the front face has four 0.75-inch NPS flanges arranged rectangularly about the head. The centers of these four flanges are spaced 17 inches horizontally and 52.25 inches vertically, and extend several inches out from the head. The rear face has a 6-inch NPS flange near the top center. The top of the tank has four penetrations, in order from front to back: nearest the front, a 1.5-inch NPS flange without pipe significantly extending past the inner weld; a 20-inch manhole at the top center giving personnel access to the interior of the pressure vessel; a 2-inch NPS flange with tubing extending several inches into the interior, and a 4-inch NPS flange near the back end, also without tubing extending into the vessel. In Figure 16, the vessel can be seen during the construction phase of the experiment.

Figure 16: Suppression Chamber Analog During Facility Assembly

3.1.7.1 Vessel Internals

The vessel is heavily instrumented, and has 24 thermocouples placed strategically throughout its interior. In order to position the thermocouples and provide support for the sparger systems, a support structure was assembled inside the vessel. The support structure system was pieced together out of stainless steel channel strut and stainless steel fasteners. It has four feet made out of heavy stainless steel blocks to weigh down and secure the entire assembly; there are no mechanical attachments to the vessel itself. Instead, the feet have silicone rubber pads adhered to their edges with JB

Weld to provide a cushion and dampening where the blocks sit on the bottom of the vessel's interior. Some of the internals can be seen in Figure 17.

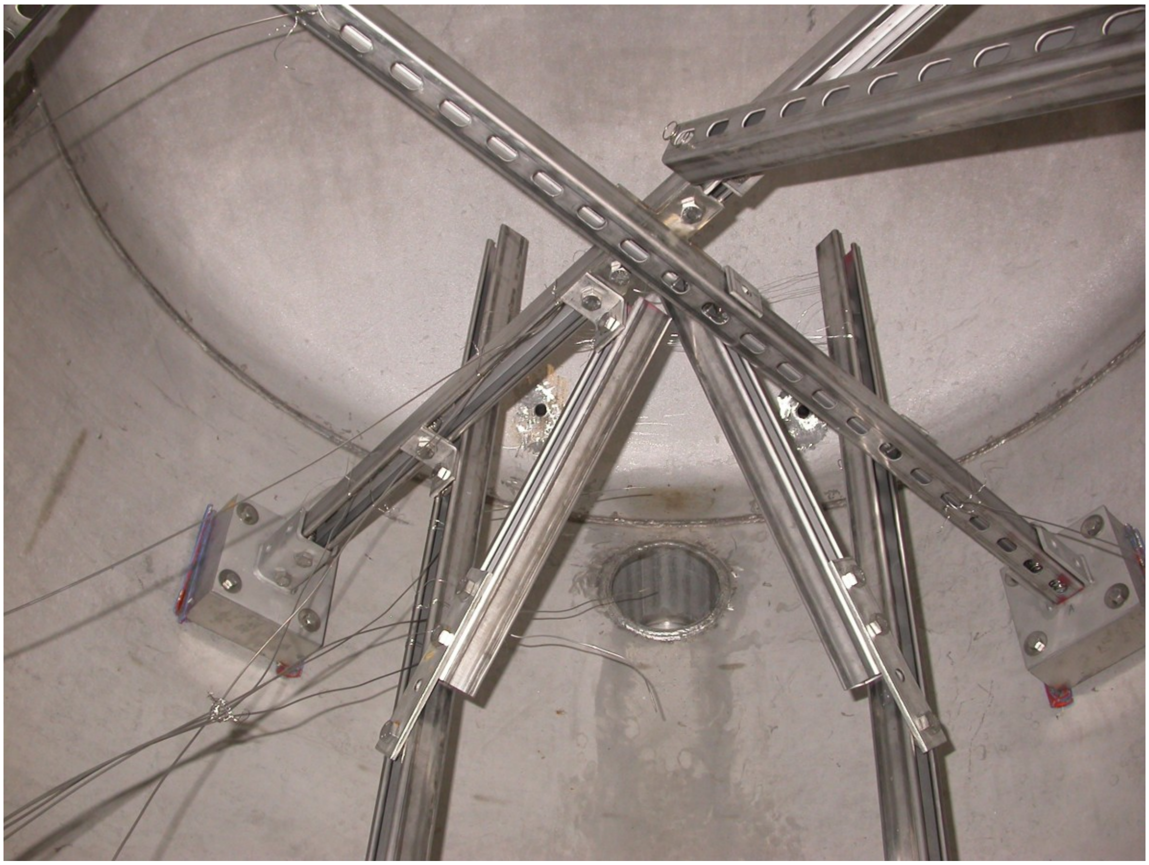

Figure 17: View of Vessel Internals Near Front Head

The feet are connected to channel strut pieces that, when attached, form an “X” shape; there are two such assemblies, each with feet only on the bottom of the X. They are roughly positioned to be above the vessel's legs at either end, and have channel strut pieces run lengthwise along the vessel attached to each leg of the X. Under normal operating conditions, two of the lengthwise pieces will be below the water's surface and two above it. The lower two pieces sit roughly 16.75 inches above the very bottom center of the cylindrical portion of the vessel, and span 102 inches. The lengthwise gap between them is roughly 16 inches. In addition to these major elements, there are a number of minor pieces bolted to them to increase the structure's overall strength and rigidity, and to provide mounting points to anchor the sparger systems.

There are two separates sparger systems in the vessel: one for the RCIC line, and one for the SRV line. Only one is intended for operation at any given time. Both spargers are anchored to the support structure within 12 inches of their outlet ends. The SRV line comes in through an adapter on the 2-inch pipe flange on the top of the vessel, and drops straight down through a length of 1.25-inch pipe, which is then reduced to 1-inch for half of the vertical drop. It then meets a 1-inch tee that is 3 inches wide, and each end of the tee has an additional 2 inches of 1-inch pipe extending from it. These outlets are aligned to be pointed lengthwise along the vessel toward either head, and their centers are 7 inches above the vessel's bottom. The alignment of the vertical section is not perfect, however, and the tee actually sits almost 2 inches off-center towards the right when viewed from the front head looking toward the back. It is 24.5 inches from the back head weld.

The RCIC sparger system uses a simpler sparger type: a single open pipe end. The pipe enters through an adapter on the rear side 6-inch flange and proceeds horizontally to an elbow, which angle the pipe down vertically. After the adapter, the pipe expands to a 1.5-inch line, and stays that size. Shortly before the outlet, there is a 1.5-inch tee in the line used to insert a thermocouple into the flow, which goes straight through the tee without bending. A pipe stub of less than two inches extends past the tee; the thermocouple is therefore less than 4 inches from the outlet. The outlet end itself, still pointing vertically towards the vessel bottom, sits 11 inches inward from the back head weld and 15 inches above a jet shield intended to protest the vessel wall from any steam jet and violent phenomena associated with it. The shield is made from a 6-inch long piece of 6-inch schedule 10 stainless steel pipe cut in half lengthwise. This is kept a small distance above the vessel bottom by using silicone rubber feet adhered to the shield with JB Weld as well as bolts mounting it to the main support structure. Both the SRV and RCIC analog spargers can be seen in Figure 18; the RCIC sparger analog is in the foreground along with its jet shield, and the SRV sparger analog is in the background.

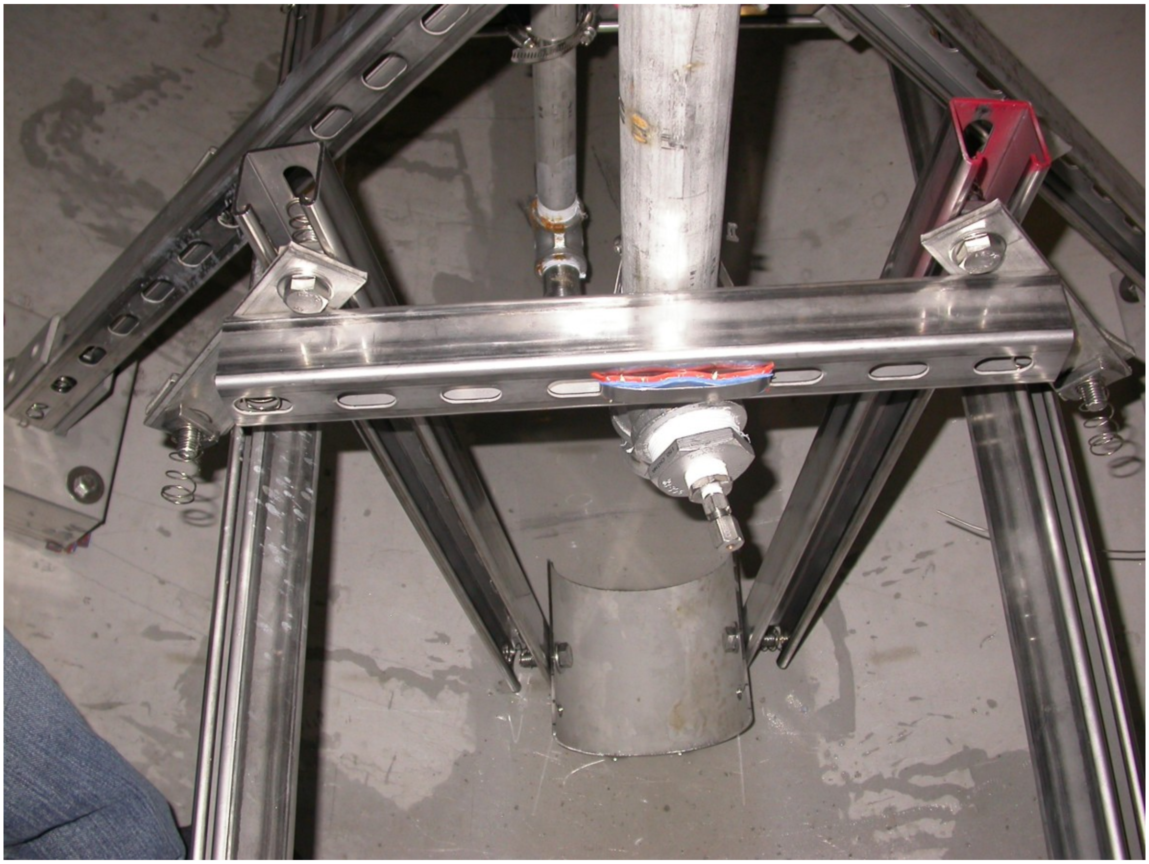

Figure 18: View of Spargers from Vessel Rear Head

Aside from the thermocouple in the RCIC sparger, there are 23 other thermocouples spaced throughout the vessel to examine any thermal stratification that may appear. A 24th, while not in the vessel proper, can be considered to be in the vessel under the valve alignments for most operating conditions. It sits in a pipe attached directly to the 1.5-inch top flange just a few inches from the flange, and the valve between it and the main steam line is normally closed. The internal vessel thermocouples enter through two multiconductor feedthroughs installed in the four-inch flange on the top of the vessel; they have 120 inch leads, allowing their sensitive ends to be placed relatively far from their entry points.

Table 1: Vessel Internal Thermocouple Positions

SP Thermocouple	x-position	y-position	z-position
SP 1	Inside RCIC Sparger		
SP 2	0	0	58
SP 3	0	0	22
SP 4	0	0	15
SP 5	0	0	8
SP 6	0	12	15
SP 7	0	-12	15
SP 8	12	0	15
SP 9	24	0	15
SP 10	36	0	15
SP 11	48	0	22
SP 12	48	0	15
SP 13	48	0	8
SP 14	48	12	15
SP 15	48	-12	15
SP 16	60	0	15
SP 17	72	0	15
SP 18	84	0	44
SP 19	84	0	22
SP 20	84	0	15
SP 21	84	0	8
SP 22	84	12	15
SP 23	84	-12	15
SP 24	96	0	15

With an expected water level near half-full, there are two thermocouples in the tank proper to measure vapor space temperatures: one close to the top of the tank just below the back head weld, and a second roughly 12 inches back from the front head weld, 15 inches below the top of the tank. The remaining internal thermocouples are spaced throughout the liquid space. A line of 9 thermocouples is set up along the vessel axis, 15 inches above the bottom and spaced 12 inches apart. As a result, they span from the back weld to the front weld. At three points along that thermocouple line, there are an additional 4 thermocouples offset from the line: one 7 inches above, a second one seven inches below, a third at the same height and axial location but 12 inches to the left (toward the side wall), and a fourth similarly situated, but 12 inches to the right instead. These sets are placed such that one is, axially, at the back head weld, the second is in the middle between the welds, and the third is 12 inches back from the front head weld. This should be sufficient to give at least a minimal indication of thermal gradients in three dimensions in the liquid pool, and to highlight potential hot spots within it. The internal x,y,z positions of the thermocouple ends in the vessel are given in Table 1 and depicted in Figure 19. The positions are given in inches; the x-position is measured from the rear head weld pointing toward the front head, the y-position is from the center of the vessel pointing to the right as one looks towards the front head from the rear, and the z-position is the height measured from the bottom centerline inside the vessel.

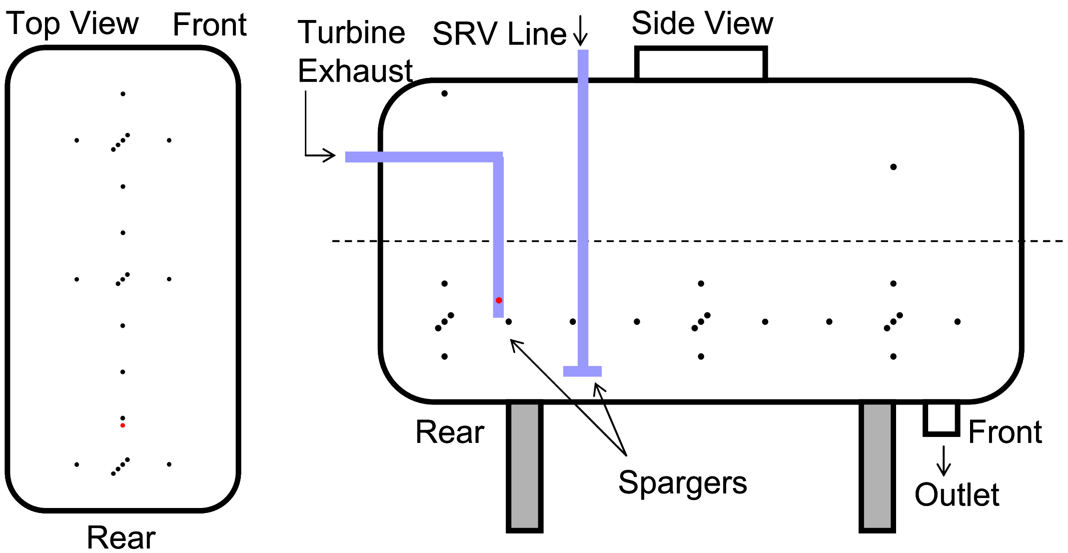

Figure 19: Thermocouple Layout

3.1.7.2 External Instrumentation

Besides the thermocouples inside the vessel, several instruments positioned externally monitor vessel conditions. An Orion magnetic level indicator, very similar to the one used in the steam generator system, is mounted to the front head to give a visual indication of the vessel's water level. In addition, a Honeywell DP transmitter is used to formally measure the liquid fill level and log it in the data acquisition system. It has the high pressure side connected to a column of water terminating at the top of the vessel, open to the vessel's internal pressure in the upper vapor space. The low pressure side is connected to the liquid space, and measures the hydrostatic head of the water fill above it. The head difference between the two depends on the fill level, and can be easily calculated under standard conditions.

A second Honeywell DP transmitter is connected across the RCIC Turbine Analog outlet and the bulk vessel vapor space. This allows monitoring of pressure fluctuations appearing in the RCIC sparger, especially those that can be expected to occur in a chugging regime or when liquid is injected through the turbine analog.

A third Honeywell pressure transmitter, an absolute pressure transmitter, is connected to the top of the vapor space in the vessel and observes the bulk pressure in the vessel.

In addition, there is a Dwyer gauge pressure transmitter installed on the 1.5-inch flange that monitors vessel/flow pressure at that point. However, it is of lower quality and precision than the Honeywell transmitters. While its data does get recorded by the data acquisition system, it is used more as a monitor of general conditions than as a full-fledged measurement.

3.1.7.3 Pressure Relief, Vacuum Breaking, and Blowdown

The aforementioned 1.5-inch flange on the top front of the vessel serves a number of functions. Besides the pressure and temperature readings taken there, it feeds the relief, vacuum breaking, blowdown, and generic main steam line functions. On the 1.5-inch pipe, a cross piece branches components out onto a number of lines. With everything attached, it resembles a crown or antlers on the pressure vessel. The top line is connected to a valve, normally closed, that opens into the main steam line. This can be used to pressurize the vapor space, or alternately, to depressurize it by running the main steam line in reverse. Both the left and right branches then tee off to connect to the relief valves. There is a total of two relief valves, each a 0.5-inch Kunkle springoperated ASME relief set to 88 psi. They are, with the exception of the pressure setting, identical to those on the steam generator. They open to an atmospheric blowdown drum, somewhat smaller than that of the steam generator system, also partially filled with water to condense any steam present in the release. In addition, a manual blowdown line drains to the drum. This line comes from the tee on one of the vessel's relief valve lines. There is also a line draining to the drum from a non-code relief valve on the outlet of the RCIC Pump analog, set to keep the pump's maximum case pressure (150 psi) from being reached. The tee on the other line, past the relief valve, connects to a check valve aligned to allow flow into the vessel. Much like the steam generator, this is set up as a vacuum breaker, except that it does not have the shutoff valve and it is much larger – the full 1.5-inch pipe size. It too is fed from a filter, again scaled up in size. This is arranged so that a surprise vacuum condition will not damage the vessel; it is possible to align the pump to spray water into the vapor space in the vessel. It is conceivable that this could cause a rapid steam void collapse even under pressure; therefore, there is no operating condition in which the vacuum breaker should ever be closed off from the vessel.

3.1.7.4 Insulation

The vessel and the attachments, aside from the blowdown drum, are all well-insulated. This is intended not only to protect laboratory personnel from potentially high temperatures, but to thermally isolate the system as well. A layer of 2-inch thick fiberglass tank wrap insulation was applied around the pressure vessel, not without difficulty. Both heads and all the penetrations are insulated. The vessel's legs are insulated as well, but only part of the way. It was assumed to be sufficient to insulate them only part of the way down below the vessel, as they are carbon steel (limited thermal conductivity) and beyond insulating a few inches the marginal additional heat retention is not expected to be high.

3.1.8 RCIC Turbine Analog

The turbine in the RCIC system of BWR plants with the Mark I containment is a non-condensing Terry Turbine as described earlier. The analog to this in the current experimental setup is an orifice followed by a loop. The orifice consists of a 7/16" (originally 0.348-inch) hole drilled in the center of a 0.25-inch thick stainless steel disc. The edges of the hole are chamfered at 135° (67.5° with respect to the axis). The disc itself is sandwiched into a 1-inch NPS Class 150 flange. Downstream, the flange has a 6-inch length of 1-inch Schedule 80 pipe connecting to an even thicker elbow. This elbow, in turn, is connected to a 3-inch length of 1-inch Schedule 80 pipe that connects to another (standard) elbow; two more 3-inch pipe lengths and elbow complete the loop (here, closer to a rounded square). From the final elbow, there is a 6-inch length of 1-inch Schedule 80 pipe connected to an end flange; this pipe is parallel to the first 6-inch length with flow in the same direction, but shifted to be below the first length.

While not an ideal representation of the turbine, the orifice was deemed to be sufficient for the purposes of this experiment. It preserves a choke point as would exist in the nozzles of the real turbine, and provides some swirl in the flowpath downstream of the choke point. As a result, the upstream flows into the turbine analog are isolated from downstream conditions when there is a sufficient pressure drop across the turbine analog to result in choked flow, and the outlet conditions are very turbulent; both are expected from the genuine article. Although no work is done in the analog, the low efficiency of Terry turbines means the work done in a real system is itself limited. In addition, while the transient dynamics of the turbine are not preserved, the steady-state operations considered here do not involve transient responses.

The use of thick-wall rather than standard pipe as well as the more robust first elbow downstream of the orifice is a response to potential erosion issues. As the experiment expects some two-phase choked flow through the orifice, erosion from sonic velocity droplets impacting the first elbow and the pipes to a lesser extent, was expected. While thicker walls will not prevent such erosion, is does provide a more robust barrier and resulting additional operating time before replacement would become necessary.

3.1.9 Data Acquisition System

The Data Acquisition System consists of the collection of both hardware and software that combine to interpret and record all the relevant data produced during operation of the experiment. This includes each of the 44 thermocouples as well as the 16 4-20 mA pressure and flow transmitters.

3.1.9.1 Hardware

The primary hardware consists of a National Instruments SCXI system connected to a PC. This is the nerve center of the data acquisition system, and is shown in Figure 20. The SCXI system itself consists of an SCXI-1000 chassis with four modules installed: two SCXI-1102 modules, one SCXI-1102B module, and one SCXI-1102C module. The primary difference between the 1102, 1102B, and 1102C is the specific lowpass filter specified for each one; the 1102 has a bandwidth of 2 Hz, while the 1102B and 1102C have bandwidths of 200 Hz and 10 kHz, respectively [47]. These modules each have 32 nominal voltage/thermocouple inputs in addition to a cold junction sensor input from the attached terminal block, and each channel has an independent amplifier and filter [47]. Each module in use is connected to its instruments via an SCXI-1303 terminal block and appropriate wiring; one of the SCXI-1102 modules is unused in this setup.

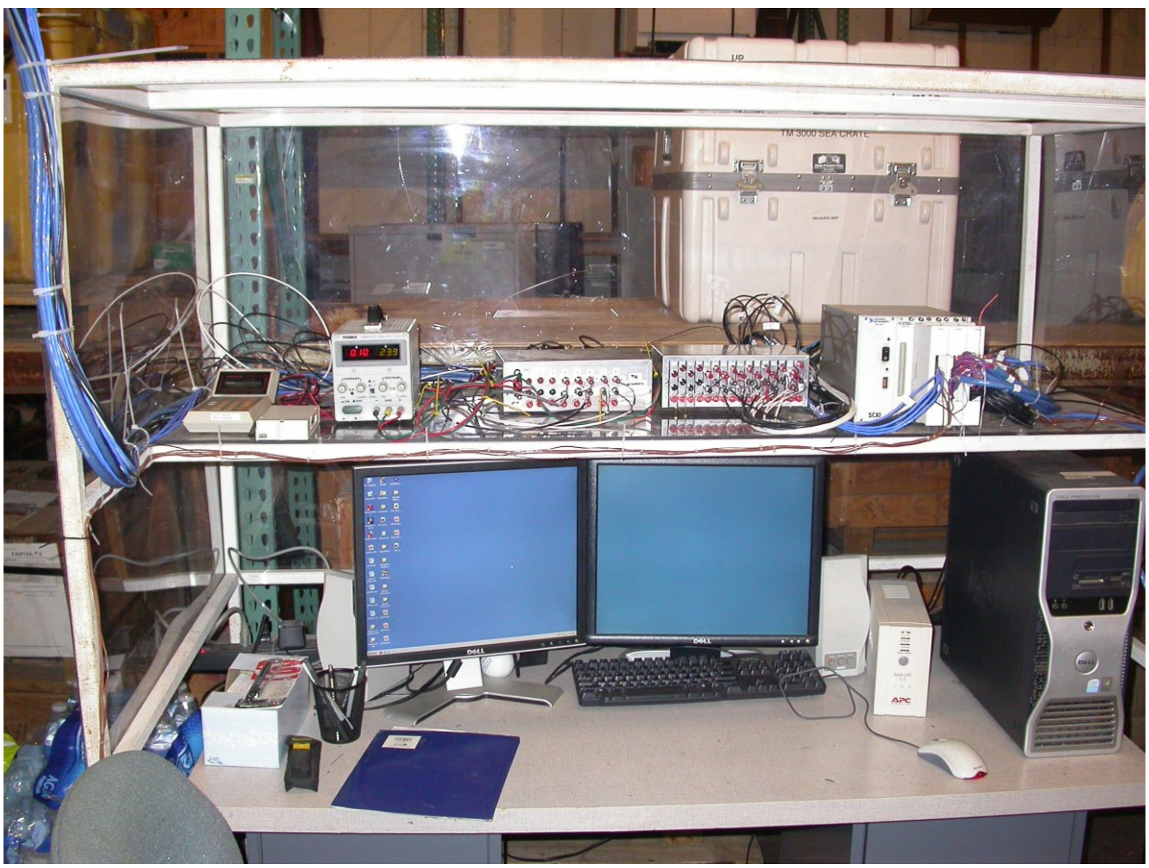

Figure 20: Data Acquisition System

The PC is connected to the SCXI-1000 chassis through a shielded cable connected from the back of one of the SCXI-1102 modules to an NI PCIe-6341 card in the PC. The analog input signals are multiplexed onto a single channel between the chassis and PC; when using LabVIEW software with the DAQmx drivers, much of the multiplexing and demultiplexing is invisible to the end user. However, care should still be taken in signal configuration to reduce the effects of sometimes unexpected or unclear phenomena such as extra settling time due to channel-to-channel gain transitions, as recommended by NI [48]. Essentially, signals of certain type and expected level should be clustered together physically on the terminals; for example, one would group channels 0-15 for one class of signal, and channels 16-31 for another in an SCXI-1303 terminal block. One would want to avoid putting a small signal on channel 0, a large one on channel 1, a small one on channel 2, etc.

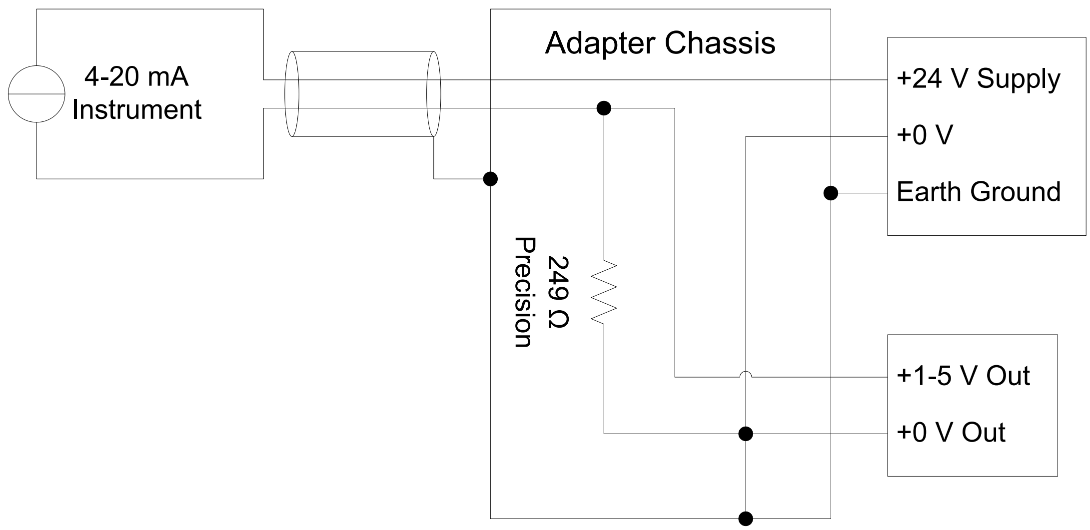

Figure 21: Current to Voltage Signal Conversion

While thermocouples can be connected directly to the terminal blocks with the current hardware, current loops cannot. Therefore, in order to use instruments with 4-20 mA analog outputs, some intermediate hardware is needed. For each channel, this consists of little more than a 249-Ohm precision resister in the loop as illustrated by Figure 21 (only one channel is shown; the chassis contains multiple identical channels). Nominally, a 250-Ohm resistor would be used to convert the signal to 1-5V; here, the use of 249 Ohms gives a little bit of additional headroom for offscale high signals, and is what would be used internally in the 1102 module to permanently make it a 4-20 mA channel [47]. The instrument's current is passed through its connected downstream resistor, and the voltage drop across said resistor is measured by the SCXI system by connecting both ends of the resistor to the input terminals for that specific channel. This generates a voltage signal slightly less than 1-5 V, depending on calibrations.

3.1.9.2 Software

The primary software environment is 32-bit LabVIEW 2012 SP1 running under 64-bit Microsoft Windows 7 Enterprise with SP1. The DAQmx drivers are more recent, being version 14. As the system is limited in its CPU resources (Pentium D 930), care was taken in designing the LabVIEW VI (Virtual Instrument, stored in a .vi file) to reduce CPU utilization while still maintaining functionality. Figure 22 shows the user interface for the data acquisition program.

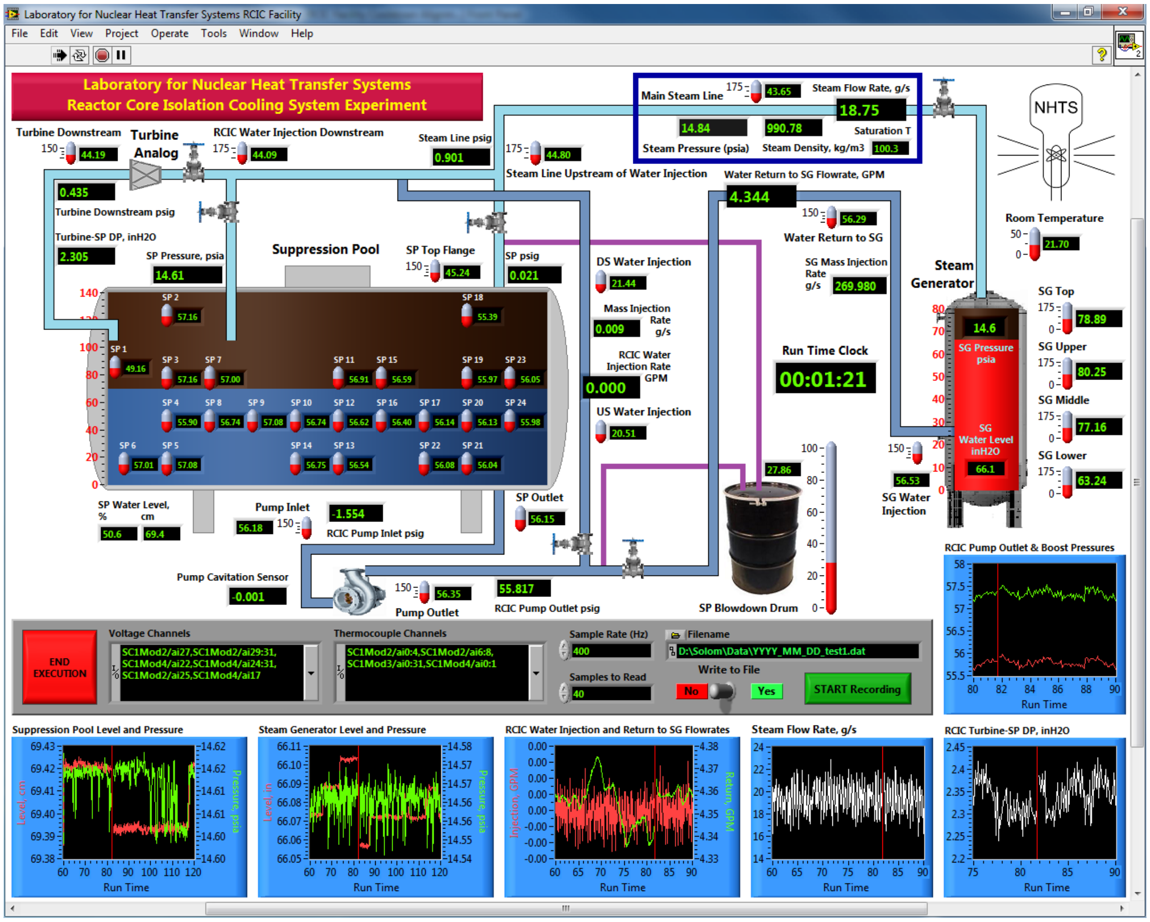

Figure 22: Data Acquisition Program UI

The LabVIEW VI produced for this experiment was based off of those for earlier experiments performed in the Laboratory for Nuclear Heat Transfer Systems, primarily the earlier Counter-Current Flow Limitation experiments. It uses similar conventions in both the User Interface and data logging output. However, it does some processing that was not done in earlier experiments. Most notably, in its averaging scheme, it not only logs the raw mean value for the channel (either raw voltage or internally determined temperature, depending on whether the channel is for general voltage or for a thermocouple) but the standard deviation in the averaged sample set as well. This can assist not only in determining aspects of a channel's uncertainty, but can also assist in characterizing the amount of rapid fluctuations occurring in a channel that happen on timescales between those of the sample rate and the logging rate.

Each channel's processing follows a similar path. A collection of samples is taken and then passed on to the averaging scheme, which reports both the mean and standard deviation in either the temperature (thermocouples) or voltage (other instruments). Both the mean and standard deviation are recorded. Then, the mean value is passed on to a block that contains a calibration profile for that particular signal, transforming the raw voltage to a fraction from 0 to 1 of the instruments full scale (0 corresponding to 4 mA, 1 corresponding to 20 mA). This value, in turn, is passed to a block transforming it with the instrument's set range, thereby reporting the value determined by the instrument (i.e., 20 psia, 0.5 gpm, etc.). For some instruments, that is all that is needed. For thermocouples, such processing is done internally by DAQmx and is unnecessary downstream. For others, however, additional processing may be needed. For example, to transform the differential pressure readings into levels, the reported value must be subtracted from a reference level as the DP transmitters are set up to read the level on the low pressure side. Unit conversions may also need to be done, especially when the values for one instrument are used as part of another's calculations. The final computed value for each instrument is recorded as well.

This is very important for the vortex flowmeter. Both pressure and temperature compensations are applied, and steam density is actively computed using a dll from the X Steam Tables. In such cases, some of the intermediate values are recorded as well.

Besides logging all the relevant data, the LabVIEW VI presents much of it to the operator in the form of numerical indicators and charts. The indicators are overlaid on a simplified graphic of the RCIC System Experiment. This allows the operator not only to observe the live data, but also provides critical information enabling the determination of valve positions and any other relevant manual control.

All of the 4-20 mA instruments used by the data acquisition software for this experimental facility are given in Table 2; it gives the address/channel occupied in the data acquisition system as well as each instrument's basic information. The same is done in Table 3, except that it does so for the thermocouples in the system.

Table 2: Current Loop Instruments

Model	Range	Purpose	DAQ Channel	P&ID Label
Honeywell ST3000 STA940	0 - 150 psia	Steam Generator Pressure	SC1Mod2/ai27	I-1
Honeywell ST3000 STD924	0 - 110 inH2O	Steam Generator Level (DP)	SC1Mod2/ai29	I-2
Honeywell ST3000 STD924	1 - 80 inH2O	Suppression Pool Level (DP)	SC1Mod2/ai30	I-3
Honeywell ST3000 STA940	0 - 100 psia	Suppression Chamber Pressure	SC1Mod2/ai31	I-4
Yamatake MagneW 3000 PLUS	0 - 5 GPM	Water Return to Steam Generator	SC1Mod4/ai22	I-5
Foxboro 83W	0 - 2400 Hz	Main Steam Flowrate	SC1Mod4/ai24	I-6
Honeywell ST3000 STA940	0 - 130 psia	Main Steam Line Pressure	SC1Mod4/ai25	I-7
Honeywell ST3000 STD924	-20 - 400 inH2O	RCIC Turbine Exhaust to Suppression Chamber DP	SC1Mod4/ai26	I-8
Dwyer 682-3	0 – 250 psig	Pump Discharge Pressure Monitor	SC1Mod4/ai27	I-9
Dwyer 673-7	0 - 100 psig	Suppression Chamber Pressure Monitor	SC1Mod4/ai28	I-10
Dwyer 673-7	0 - 100 psig	RCIC Turbine Exhaust Pressure Monitor	SC1Mod4/ai29	I-11
Badger M2000	0 - 1.0 GPM	Water Injection to Steam Line Flowrate	SC1Mod4/ai30	I-12
Dwyer 673-7	0 - 100 psig	Steam Line Pressure Monitor	SC1Mod4/ai31	I-13
Dwyer 673-7	0 - 100 psig	Pump Inlet Pressure Monitor	SC1Mod4/ai17	I-14
Omegadyne PX309-005G5V	0 - 5 psig	Hot Water Tank Level	SC1Mod2/ai28	I-15
Yamatake MagneW 3000 PLUS	0 - 15 GPM	HX Hot-Side Flowrate	SC1Mod4/ai23	I-16

Table 3: Module 3 Thermocouples

Thermocouple	DAQ Channel	P&ID Label
SP 24*	SC1Mod3/ai0	T-9
SP 23*	SC1Mod3/ai1	T-10
SP 22*	SC1Mod3/ai2	T-11
SP 21*	SC1Mod3/ai3	T-12
SP 20*	SC1Mod3/ai4	T-13
SP 19*	SC1Mod3/ai5	T-14
SP 18*	SC1Mod3/ai6	T-15
SP 17*	SC1Mod3/ai7	T-16
SP 16*	SC1Mod3/ai8	T-17
SP 15*	SC1Mod3/ai9	T-18
SP 14*	SC1Mod3/ai10	T-19
SP 13*	SC1Mod3/ai11	T-20
SP 12*	SC1Mod3/ai12	T-21
SP 11*	SC1Mod3/ai13	T-22
SP 10*	SC1Mod3/ai14	T-23
SP 9*	SC1Mod3/ai15	T-24
SP 8*	SC1Mod3/ai16	T-25
SP 7*	SC1Mod3/ai17	T-26
SP 6*	SC1Mod3/ai18	T-27
SP 5*	SC1Mod3/ai19	T-28
SP 4*	SC1Mod3/ai20	T-29
SP 3*	SC1Mod3/ai21	T-30
SP 2*	SC1Mod3/ai22	T-31
SP 1*	SC1Mod3/ai23	T-32
RCIC Turbine Analog Outlet	SC1Mod3/ai24	T-33
Steam Line 6-ft Post-Water Injection	SC1Mod3/ai25	T-34
Pump Inlet	SC1Mod3/ai26	T-35
Pump Outlet	SC1Mod3/ai27	T-36
Suppression Chamber Outlet	SC1Mod3/ai28	T-37
Steam Line Upstream of Water Injection	SC1Mod3/ai29	T-38
Water Injection Line Pre-Flowmeter	SC1Mod3/ai30	T-39
Water Injection Line Post-Flowmeter	SC1Mod3/ai31	T-40

*Location given in Table 1

Table 4: Module 2 and 4 Thermocouples

Thermocouple	DAQ Channel	P&ID Label
Room Temperature	SC1Mod2/ai0	T-1
Steam Generator Top	SC1Mod2/ai1	T-2
Steam Generator Upper	SC1Mod2/ai2	T-3
Steam Generator Middle	SC1Mod2/ai3	T-4
Steam Generator Lower	SC1Mod2/ai4	T-5
Steam Generator Water Injection	SC1Mod2/ai6	T-6
Suppression Chamber Top 1.5-inch Flange	SC1Mod2/ai7	T-7
Suppression Chamber Blowdown Drum	SC1Mod2/ai8	T-8
Main Steam Line Near Vortex Flowmeter	SC1Mod4/ai0	T-41
Water Return to Steam Generator Line Near Flowmeter	SC1Mod4/ai1	T-42
Hot Water Tank Outlet	SC1Mod2/ai5	T-43
Auxiliary Hot Water Pump Inlet	SC1Mod4/ai13	T-44

3.1.9.3 Cable Shielding and Grounding

Proper cable shielding is a paramount issue when assembling an instrumentation system. While current loops have some immunity to noise that is lacking in pure voltage transmission, such immunity is not absolute. In addition, with weak voltage signals such as those generated by thermocouples, noise picked up in long cable runs can swamp the signal. Therefore, in order to obtain high quality data, the transmission paths must be protected from noise – the cables must be properly shielded and all grounds set up correctly.

In this facility, all cables save five are shielded. The five unshielded cables connect to the four thermocouples in the steam generator and the one room temperature thermocouple. Each of these was installed in earlier experiments, uses relatively short cables, and functioned well in previous endeavors.

The other cables are shielded, and connect their shields to ground only at one end in order to prevent ground loops. For the cables carrying the 4-20 mA signals, they all ground on the chassis to the converter box containing the instrument's 249-ohm resistor. The thermocouple cables land their grounds on the ground connector in their respective SCXI-1303 terminal blocks. While some of the thermocouple cables bundle eight twisted pairs into a single shielded cable, crosstalk between pairs is not expected to be an issue. The short unshielded distances at some of the cables' connector ends is also not expected to cause any appreciable noise injection.

3.1.10 Calibrations

In order to have any confidence in the recorded data, all the instruments must have some sort of calibration. Therefore, where applicable, calibrations have been carried out.

The Honeywell ST3000 Series 900 transmitters were calibrated in two phases: sending them out to calibrate their pressure readings, and a signal calibration on their 4-20 mA outputs to implement in the data acquisition software. Of the six shipped to a calibration service, two of the existing transmitters were found to have defective electronics in need of replacement. Once their measurements were calibrated, signal calibration profiles could be developed as well. The signal calibration profiles were developed in the same way for the pressure transmitters as for the magnetic flowmeters. Using a small LabVIEW VI developed for this particular task, two-point calibration profiles can be easily computed. With the Honeywell Smart Field Communicator or (if present) a built in menu system, the transmitters were set to output their full-scale (100%, 20 mA) signals. These were recorded by the software and time-averaged over a period of at least 100 seconds. Then, they were each set to output their low-end (0%, 4 mA) signal. Again, the signal was recorded and time-averaged for a minimum of 100 seconds. Assuming full linearity straight through from the measurement to the analog output to the analog to digital conversion in the DAQ, such two point calibrations are sufficient to fully derive the curve.

Not all of the instruments could be so easily calibrated. Each of the gauge pressure transmitters, unable to connect with a Smart Field Communicator, had to have a more creative approach. Some of them, easily disconnected from the system, were able to follow a similar paradigm (a two-point, low-pressure and high-pressure, approach). Their low-end (0% of full scale) points were developed from exposure to atmospheric pressure. The high-end points, however, were somewhat different. By connecting an Omega DPI 603 calibrator (last calibration date: July 19, 2005), and holding at 90.00 psig, points for 90% of full scale (18.4 mA nominal) were found and two-point calibration profiles were estimated. Since the last known calibration date for the calibrator is so far in the past, is not considered reliable. However, it is not expected to have drifted very far.

The remaining two Dwyer gauge pressure transmitters were not easily removed from the system for calibration. For them, a sort of point-and-a-half technique was employed. By measuring the height of the water column above them, a low-end pressure can be estimated. For the transmitters in question, this is between 0.05% and 1.5% of full scale. The high points were estimated with a bit of a creative leap. It was assumed that their nominal 20 mA output actually corresponds to a 20.00 mA current at 100% full scale output. An additional assumption was that the measured current on the DPI 603 calibrator was accurate. Then, the transmitter was disconnected from the circuit and the calibrator wired in with its ~12 mA current generator enabled. The result was scaled to 20 mA, and assumed to correspond to the nominal 20 mA signal from the transmitter. As this is not expected to be a very accurate technique, the resulting data from the Dwyer transmitters are not expected to be of high quality and are not used analytically.

The most intricate calibration technique used in this experimental facility may belong to the Foxboro vortex flowmeter. As documented in the manual, the procedure involves the calculation of an expected upper range frequency, the temporary setting of DIP switches, the removal of the electronics unit from the flowmeter body, disconnecting the sensor unit and in its place connecting a function generator, and operating the function generator at the predetermined upper range frequency and then at zero while adjusting the appropriate potentiometers. Once complete, the temporary connections must be disconnected, the electronics returned to the housing and the DIP switches set appropriately [42]. For this setup, an upper range frequency of 3000 Hz was used (later reduced to 2400 Hz), as it is the maximum that the flowmeter can handle, and the calculated result for an absolute limiting flowrate was close to it. In addition, the function generator available does not isolate its signals as required by the transmitter but rather ground-references them. Therefore, in order to provide the requisite isolation to allow the signals to float, the function generator was plugged into a UPS; the UPS was then unplugged from the wall to remove the ground reference during operation. Furthermore, the frequency was monitored by an oscilloscope to verify that the reported frequency on the function generator was indeed within tolerance.

Profiles for reading thermocouples are built in to the LabVIEW packages, and the thermocouples themselves are assumed to have maintained their “Special Limits of Error” [49] tolerances with little drift or degradation. There is little to do other than to ensure that the electrical connections are sound and that the DAQ hardware on the receiving end is reading the signals correctly. The current DAQ card, where the actual measurements take place, is an NI PCIe-6341 X Series data acquisition card. It replaced an older NI PCI-6034E DAQ card that would no longer accept a calibration or produce consistent, high quality data. The new card was procured with a two-year calibration compliant to ANSI/NCSL Z540-1-1994 (the NI “Compliant Calibration” calibration service level), and is therefore believed to have excellent accuracy.

3.2 SHAKEDOWN TESTING

After the loading of DI water into the system, two major shakedown tests of the experimental facility were performed. The first aligned the system to the SRV sparger analog, and warmed the system up to a relatively mild degree when compared to later tests (final pool temperatures near 63 °C for the SRV-alignment shakedown test). The second test aligned the system to the RCIC analog, and warmed the system up to near saturation conditions.

3.2.1 Liquid Fill

A full complement (half of the Suppression Chamber's capacity) of DI water was filled into the system prior to the major shakedown tests. The Suppression Chamber Analog had previously been filled to capacity with clean city water, which was fully drained before the DI water was added. An attempt was made to do some flushing with DI water to remove contamination in the system, but it was minimal and as a result there is expected to be some degree of residual salts, particulates, etc. from the city water. During the fill, it was discovered that the high purity of the DI water was such that the water's conductivity dropped below the point at which the empty pipe detection circuitry in both the Yamatake and Badger magnetic flowmeters would function correctly. This led to a small bit of unmonitored flow into the system, but further examination of other instruments led to the conclusion that total volume injected in that period was somewhat more than one gallon. The empty pipe detection circuitry was subsequently disabled in both flowmeters. Across the three days in which system filling was conducted (two resin bed regeneration cycles were necessary), the Suppression Chamber Analog was supplied with nearly 768.6 gallons, bringing the water level in the vessel to slightly higher than the halfway mark (31.8 out of 59 inches).

3.2.2 SRV Shakedown

The first shakedown test performed was a primary alignment with the SRV sparger analog. At certain points, operational verification of most of the flowpaths was ascertained. The pump and recirculation paths were found to be operational, as was the water injection into the steam line. The RCIC turbine and sparger analog alignment was not tested, as this was planned for a second shakedown test.

During this test, it was determined that the wiring connecting the Yamatake magnetic flowmeter's detector to the converter had an easily resolved problem: on one end, two of the wires were connected to each other's terminals. This resulted in the flow being measured in reverse, and indicated as such on the converter. As there is a limit to how much reverse flow can be transmitted on the 4-20 mA line (roughly 5%), the flow back to the steam generator recorded by the DAQ is not correct; the limit had been exceeded by a fair amount, according to the converter. This issue was quickly and easily resolved.

A second issue, perhaps more serious than the first, was identified as well. Based not only on indications from the vortex flowmeter assembly, but by a rough heat balance on the temperature rise in the Suppression Chamber Analog pool, the steam generator was not providing as much heating power as it should have. It was set at full power; every heater was turned on for a nominal power of 157 kW. However, at the full delivered power, steady state output (without makeup water from the return line being injected) was near 50 g/s; this was equivalent to roughly 109 kW based on steam table data. Further investigation revealed 5 blown fuses in the main electrical control panel, disabling 50 kW of heater power. It is not known why 5 of the fuses blew; examination revealed no problems on those circuits. It was in those examinations that it was discovered that two of the 6.25 kW heater circuits were wired to only operate at half power. It is not known why those heaters were wired in that manner. Even with the fuses replaced, this brings to total nominal power of the steam generator to 150.75 kW. After shakedown testing, an electrician restored full operating power (157 kW) to the steam generator

With a steady state steam flow around 50 g/s, intermittently lower when water was pumped back into the steam generator, the bulk water temperature in the Suppression Chamber Analog pool went from an initial temperature of 24 to 63 °C. The entire test lasted nearly 2.5 hours, but heat (steam) was only injected into the Suppression Chamber Analog for a little more than half that time.

The test itself was not quiet, even with 2-inch thick fiberglass insulation surrounding the Suppression Chamber Analog. There were sounds emanating from within the vessel that seemed to be produced by violent void collapse near the sparger. This is not a surprise, as the bulk water temperature was highly subcooled.

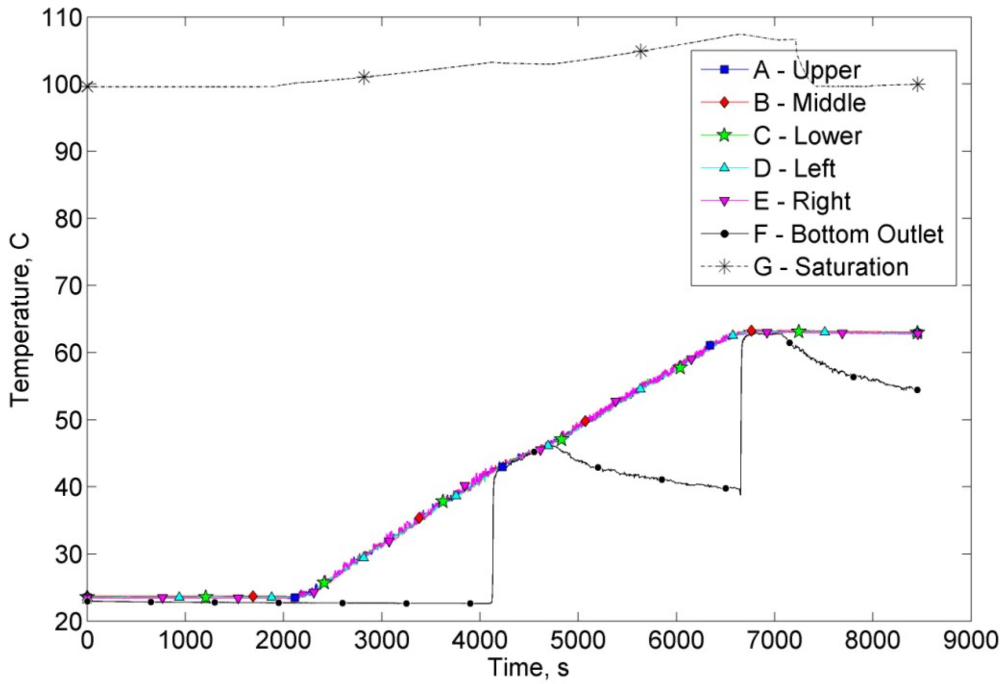

Figure 23: SRV Shakedown Pool Thermal Progression

From the beginning of the shakedown test to its end, the Suppression Chamber Analog pool temperatures seem to have been remarkably even; very little thermal stratification appears to have been present. The pool appears to have been well-mixed; a thermal profile for the test is given in Figure 23. The only deviations are at the pool outlet; due to intermittent operation of the RCIC Pump, water in the line at the measurement point was able to cool down between pumping operations. Whether or not this mixing would be maintained through increased final temperatures was left undetermined at shakedown; such a test was conducted in the data-gathering tests.

3.2.3 RCIC Shakedown

The second shakedown test aligned the facility to the RCIC sparger analog. Before the test, the blown fuses in the steam generator were replaced and the miswiring in the Yamatake magnetic flowmeter was corrected. Several days had passed since the first shakedown test, and yet the bulk pool temperatures were still significantly higher than room temperature. After using the pump in recirculation mode to thoroughly mix the pool, the temperatures were near 48 °C; the room temperature of the lab was 21 °C. Some time was allowed to pass before proceeding with the test in order for the circulation currents in the vessel to die down. For comparison to the earlier shakedown test, a target steam flow rate of roughly 50 g/s was chosen. The steam generator started with a full water load, and the return flow was not engaged until the level had dropped sufficiently for makeup water to be necessary for continued operation. The steam and makeup water flow rates can be seen in Figure 24.

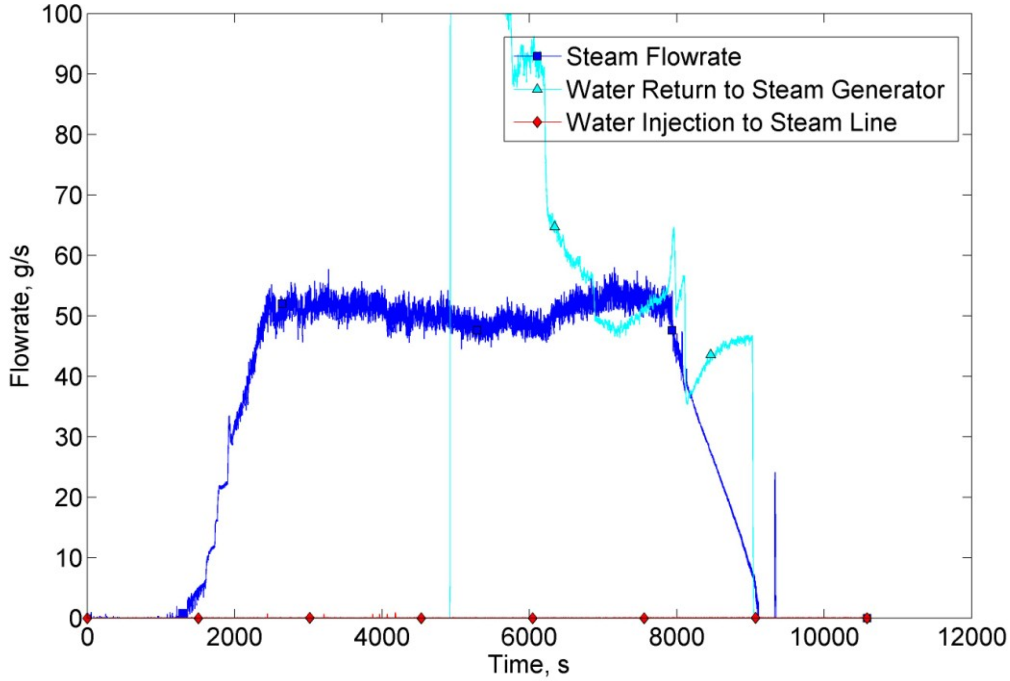

Figure 24: Shakedown Steam and Water Flowrates

This test seemed to be louder than the first, and the void collapses sounded to be more violent as well. As there are additional instruments in this alignment, they may be able to shed some light on the phenomena occurring in the sparger. Major (audible through earplugs) violent events seem to have some recorded presence in the data; they seem to produce spikes appearing in both the sparger's internal temperature as well as in the differential pressure reading from the Suppression Chamber Analog to the turbine analog's outlet. An example of this can be seen in Figure 25. The largest spikes occurred roughly every 2-5 seconds; smaller events (still audible to operators) seemed to be occurring more frequently.

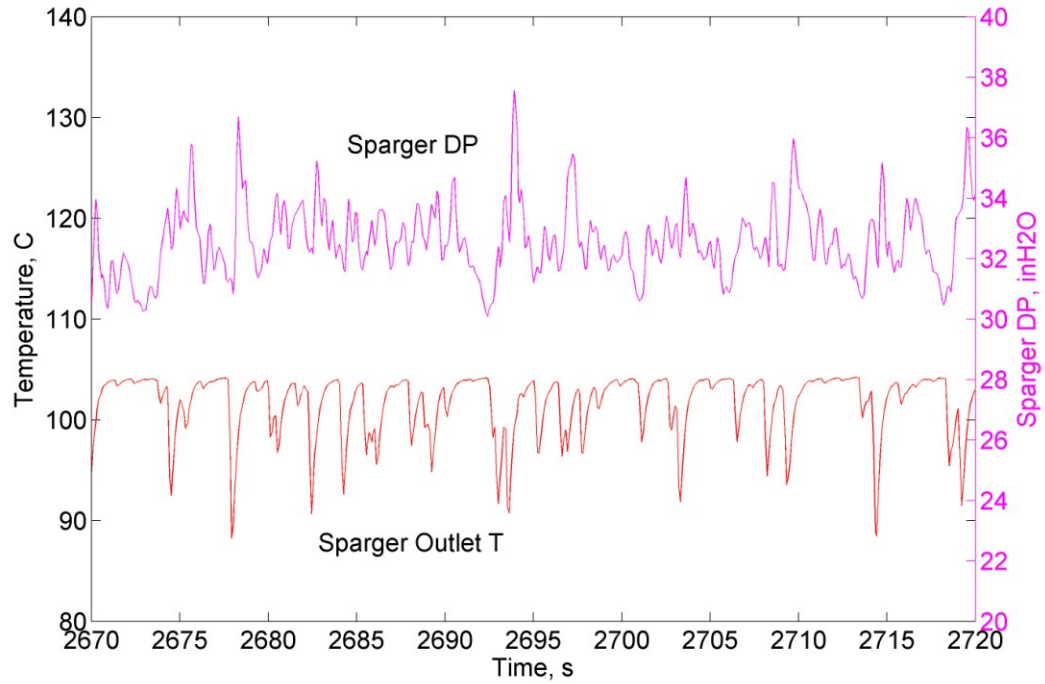

Figure 25: Steam Chugging Spikes

After some time, major chugging events appeared to cease as the pool temperatures warmed up. At the time period in the test focused on in Figure 25, the bulk pool temperatures were between 50 and 60 °C. Later in the test, when they were in the vicinity of 70 °C, corresponding spikes in both the differential pressure and sparger temperature vanished; Figure 26 (with the pool mid-level near 90 °C) has a distinct lack of corresponding spikes on both measurements. However, other phenomena of interest were taking place. While the lateral pool temperatures were very close to each other throughout the test (seen in Figure 27), vertical stratification appears to occur.

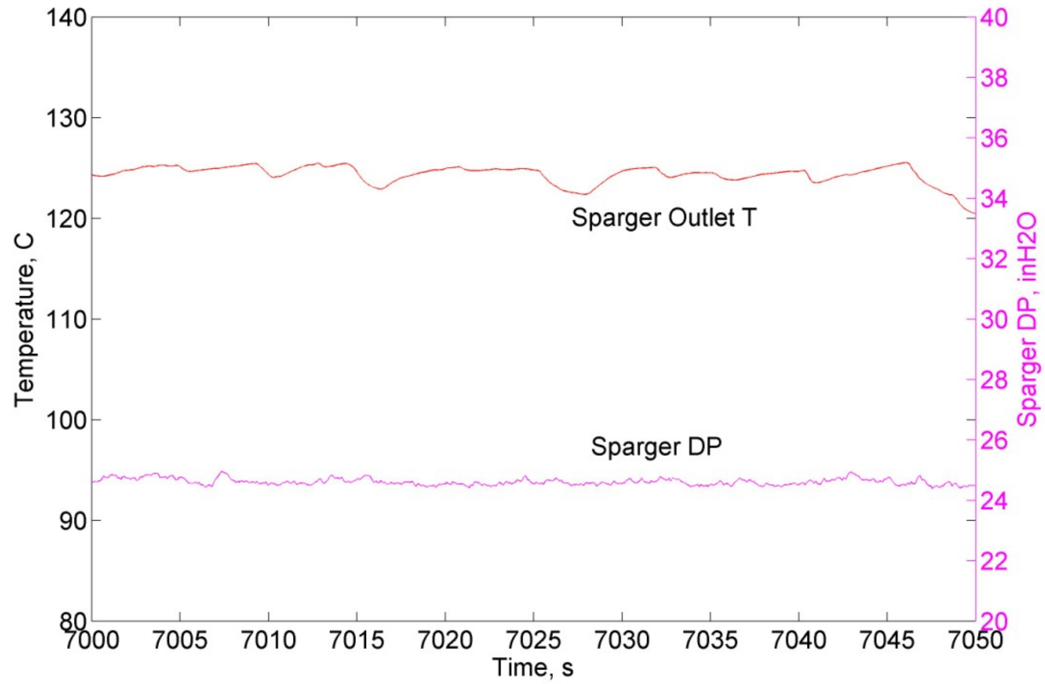

Figure 26: Stable Flow without Chugging

The thermocouples near the mid-level of the pool (z = 15 inches in Table 1), with the notable exception of Thermocouple SP8, are all very consistent. Thermocouple SP8, which in Figure 27 reads much higher than the others and appears very noisy, is rather close to the outlet of the RCIC sparger analog. It would appear to be picking up very local disturbances near the sparger's outlet.

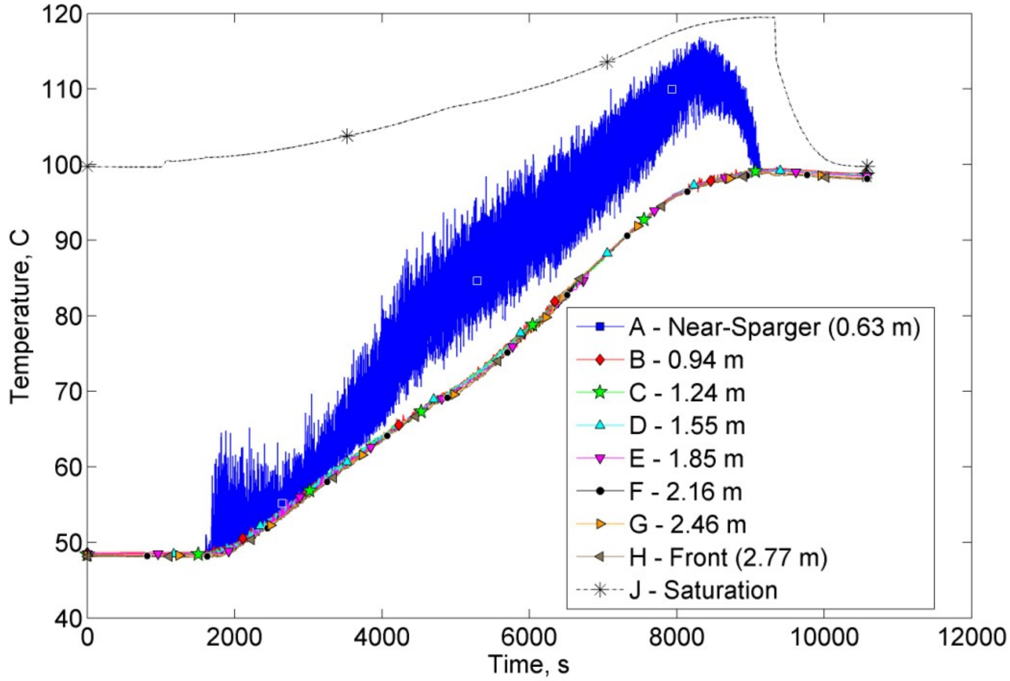

Figure 27: Lateral Pool Temperatures

The thermal profiles appear somewhat different when looking at a comparison of vertical thermocouples. This is seen in Figure 28. Readings from the five submerged thermocouples at the x=0 inch position are compared.

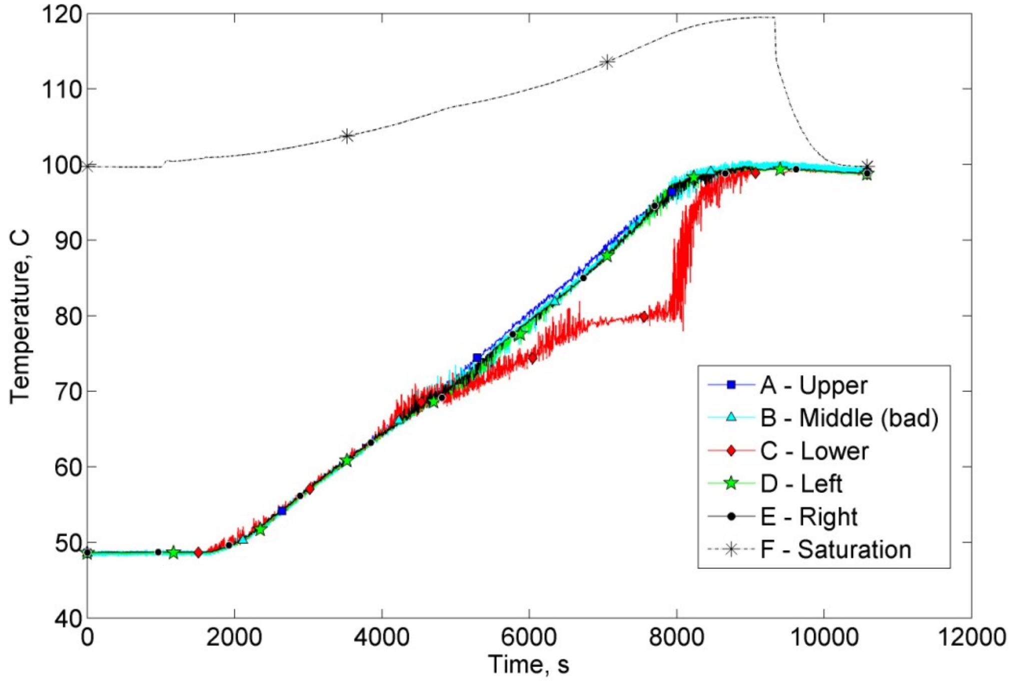

Figure 28: Sparger-End (Rear, x = 0 Inches) Temperature Profile

The vertical stratification is not seen only at the sparger end of the vessel; it appears in the middle as well as the front end. If anything, the vertical stratification is more pronounced in the x=48 inch position than at x=0; this is depicted in Figure 29.

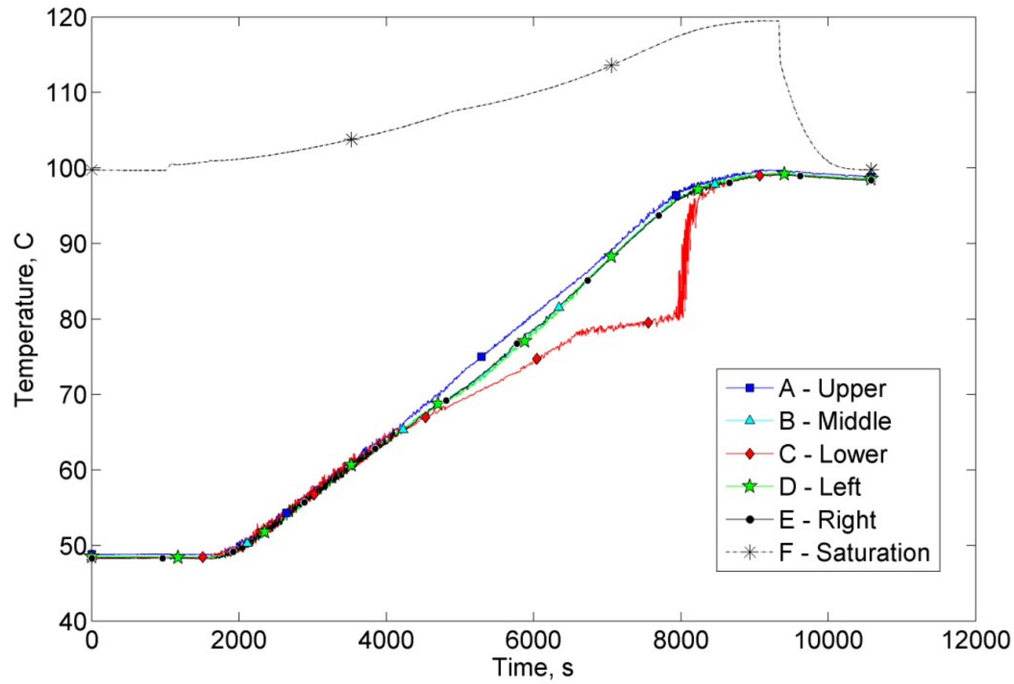

Figure 29: Pool Temperatures, Pool Center (x = 48 Inches)

Separation between top, middle, and bottom-level temperatures is clear in the front end of the vessel as well. These temperatures, measured at the x=84 inch position, show the same appearance and disappearance of vertical stratification as the others. They are shown in Figure 30, along with the vapor space temperature at that axial location.

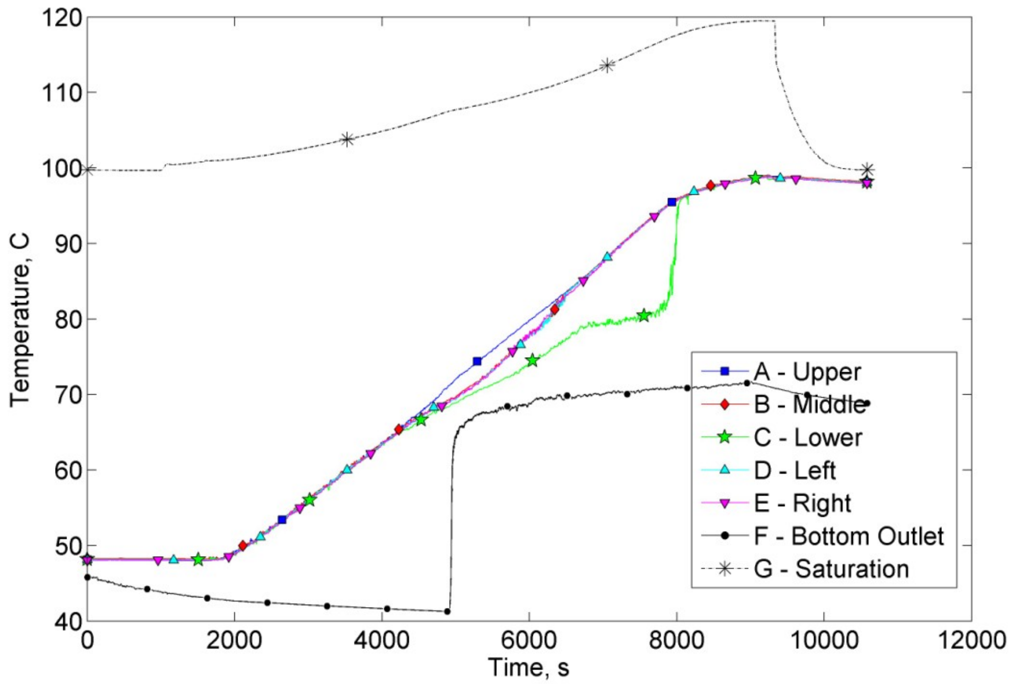

Figure 30: Pool Temperatures, Vessel Front (x = 84 Inches)

The most interesting feature of the vertical temperature comparisons is the appearance and sudden disappearance of vertical thermal stratification. It appears that early in the test, at cooler pool temperatures, the apparent chugging in the sparger was an effective method for agitating the pool and maintaining uniformity. Once the chugging largely ceased, a significant amount of pool mixing would therefore end as well. With stabilized condensing flows through the sparger, if a jet does not traverse much below the outlet, the bottom of the pool may remain relatively stagnant and cool. However, it is not permanent; at some point, there appears to be a remarkably sudden rise in the lower pool temperatures. The reason behind this was at first unclear, but based on subsequent testing, the condensation rate around the sparger would tend to decrease as pool temperatures increase. Steam bubbles would then emerge from the sparger and rise towards the pool surface until they either reach it or condense, producing currents that would tend to agitate the pool. They would therefore mix the water and bring the temperatures back to uniformity.

3.3 IDENTIFIED ISSUES

Several, mostly minor, issues arose during the operation of the experimental facility.

3.3.1 Pump

The pump employed in these tests experienced multiple, independent failures and had somewhat misleading characteristics given in its data sheet. The original seal installed in the pump is a Buna-N mechanical seal, which failed with a large tear through the rubber on the shaft side during the first attempt at Test #1 (later completed as Test #15). Upon replacement, it was discovered that the seal itself is rated for much lower temperatures than those listed for the pump as-delivered; therefore, SEAL FAILURE IS TO BE EXPECTED WHEN OPERATING THE PUMP AT HIGHER TEMPERATURES STILL WITHIN ITS GIVEN LIMITS. As a result, the failed seal was not replaced in-kind but rather was upgraded to a Viton seal, with a listed temperature limit of 250 °F.

During the pump disassembly, it was found that significant corrosion had already begun attacking the cast iron components. This was not surprising, as the system at the beginning of testing can be expected to have significant oxygen in the water. Furthermore, the pump contains the only cast iron in a largely stainless steel system;

given the difference in galvanic potentials between the materials, corrosion is to be expected. This results in the pump being a potential source of water contamination if the water is not re-purified in long-term reuse schemes.

Later on during testing, the pump developed an unrelated failure between Test #4 and Test #5. During a period of lower-temperature cooldown operations, the centrifugal switch in the motor shattered, and the motor became completely inoperable. Pieces were found embedded in the stator coils, and the motor was deemed unfit for repair due to the potential electrical hazards. As the pump is relatively inexpensive, instead of replacing only the motor, a brand new replacement pump (including the motor) was procured. Since it was the same pump model, the seal was immediately replaced with a new Viton version to prevent premature failure.

3.3.2 Air Compressor Oil

The air compressor employed in this experiment for both system air pressurization as well as air purging is a reciprocating type. Even with significant filtration, lubrication oil from the compressor made its way into the test facility. This is evident based upon the characteristic oily odor it gave the Suppression Chamber volume; facility operators found the odor to be present when decompressing the Suppression Chamber. It was stronger when significant amount of air had been pumped into the system through the compressor. As a result, the compressor can contribute to system contamination.

3.3.3 Thermocouple SP4

During shakedown testing, it was found that Thermocouple SP4 read with greater noise than any of the others installed in the system, and the noise was found to not be an issue with the wiring but with the thermocouple itself. The noise appeared to be centered around the correct reading, and it may be possible to filter most of it out in post-processing. Furthermore, the correct reading can be inferred from the nearby lateral thermocouples. Therefore, due to the inherent difficulty and risk of damage to other components in replacement operations, it was decided to leave the thermocouple in place and label it as an 'unreliable' source of data.

3.3.4 Magnetic Flowmeter Failure

Near the end of the testing program, the magnetic flowmeter measuring feedwater flow to the steam generator began producing wildly erratic and incorrect results. Experimental testing was immediately aborted, and the flowmeter was removed from service. Diagnostics revealed that one of the electrodes was no longer electrically connected to its terminal inside the detector head, necessitating manufacturer service and repair. In order to continue the testing program with the little time left, an alternate flowmeter was installed. It too is a Yamatake MagneW 3000 PLUS; however, it has a lower labeled temperature limit of 120 °C. As a result, care must be taken by operators to ensure that its thermal limits are not exceeded until the original meter can be repaired and reinstalled.

3.3.5 Limit for Vortex Flowmeter

The noise issue with the vortex flowmeter necessitating the use of a flow silencer was resolved for the primary power levels employed in the tests performed for this research (see Section 3.4). However, extended very-low-power (32 kW) testing revealed that it could still be an issue. It was only observed to be a problem at the end of testing in the standard alignment, when the steam density is greater and the velocity resultingly lower. It is also approaching the lower limit for the flowmeter's accurate Reynolds number range. Problems did not occur until the vortex shedding frequency was below 200 Hz (between 150 and 200 Hz); it is advisable for future efforts to either avoid this operating range or to make alterations to the system to address it.

3.3.6 Level Indication

Level indication in both the Suppression Chamber and the Steam Generator was performed by using differential pressure measurements with Honeywell STD924 transmitters. Observation during system operation, and by specific testing of the issue, found a common mode pressure dependency. When a common pressure, i.e., system pressurization, appeared on both the high pressure and low pressure ports on the transmitters, the differential pressure reading was altered. Ideally, the measured differential pressure does not have any dependence on common pressures appearing on both ports, only the pressure difference, but this was found to not be the case. As pressures changed, the level readings were seen to vary by several centimeters, even though the actual water levels were not changing. While this could correspond to incorrect volume readings of 100 gallons in the 1,400 gallon vessel (when the level is near the middle of the vessel), the error is still on the order of 1% for the full range of the transmitter. The change in reading (offset) for the Suppression Chamber is shown in Figure 31, where the system pressure was increased and then decreased without any changes in pool inventory.

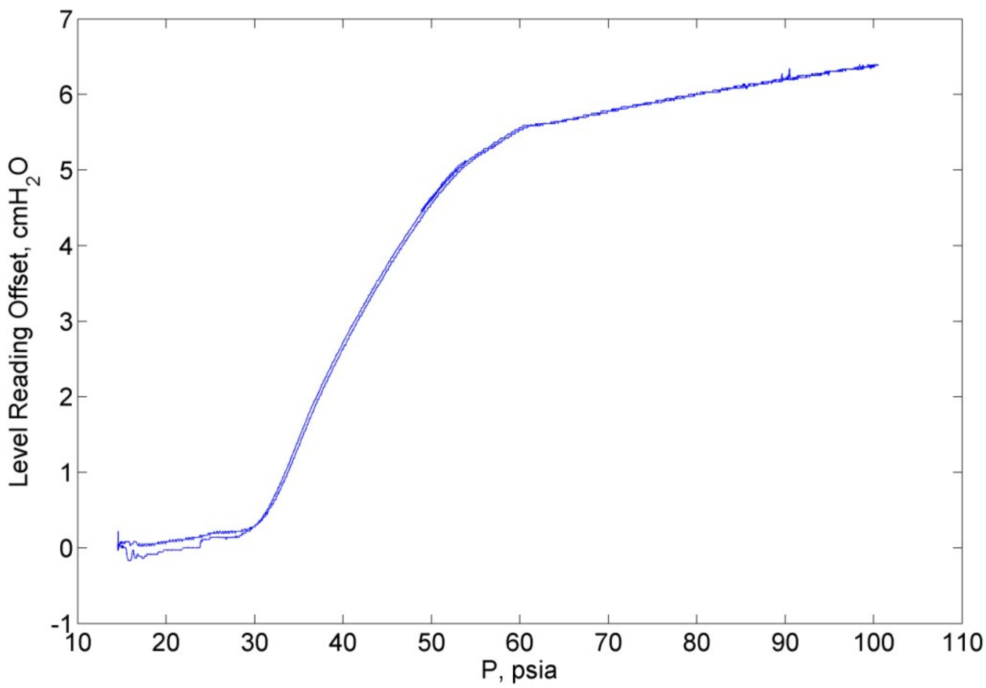

Figure 31: Common-Mode Pressure Level Reading Offset

Such an issue could be the result of bubbles in the instrument pressure reading lines. Indeed, if installed according to the manual, the particular transmitter model employed in this experimental facility may permanently trap air bubbles within the meter body without the ability to bleed them off. However, such bubbles are not expected to be large enough to account for the observed degree of pressure dependence.

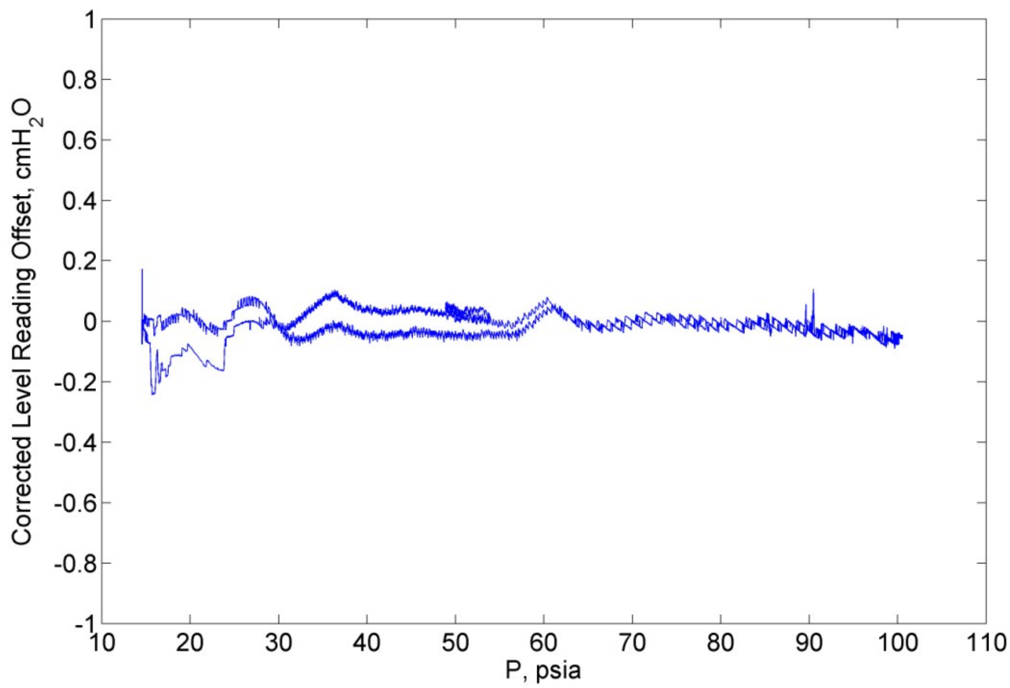

Figure 32: Level Offset after Correction

Fortunately, the common mode pressure dependencies were found to be consistently repeatable. While they did not match each other for the different transmitters (the Suppression Chamber level vs. the Steam Generator level), the profiles were found to have very little variation with time. Therefore, a correction profile for the level reading in the Suppression Chamber was developed and applied in the data processing script to correct the common mode pressure issue. It uses a polynomial (a function only of the Suppression Chamber's pressure) to compute an absolute offset (the shift was taken to be absolute rather than relative/fractional) and subtract it from the originally indicated reading. The offset in the level reading with the correction term applied is shown in Figure 32.

3.4 POST-SHAKEDOWN REPAIRS

Further shakedown testing revealed other latent issues in the experimental facility. Significantly, the low conductivity present in the water required large time constants ≥ 10 s to be set in the magnetic flowmeters to smooth out the resulting unrealistic fluctuations in the reported flow measurements. However, this also has the impact of reducing measurement responsiveness; high-speed flow transients will not appear correctly in the readings, if at all. Fortunately, the test conditions are not such that the water flowrates would be rapidly changing, and such time constants are therefore acceptable.

A more insidious and difficult to resolve issue revolved around the vortex flowmeter. Close attention to steam generator power levels and fluid flowrates (after the resolution of the steam generator's electrical problems) revealed discrepancies that were not constant in time. It appeared that the vortex flowmeter would sometimes transmit flow rates that were well in excess of 150% of their proper values. This was especially noticeable at lower flowrates/power levels with higher pressures in the steam generator.

After thorough investigation, it was determined that the likely culprit was excess noise in the steam flow; in the flowmeter employed, gas flows, especially at lower flowrates, produce a relatively weak acoustic signal at the transducer element, and noise at similar frequencies may be difficult or impossible for the electronics package to discriminate from the vortex shedding signal. The result is significant misreading.

The determination was done by connecting the sensor element to an oscilloscope and running various flows through the meter as installed in the system. Under the conditions that tended to produce the most severe misreading, the waveform read by the oscilloscope was severely distorted; the expected readout in a trouble-free system is a relatively pure sine wave at the vortex shedding frequency. This came as a bit of a surprise, as the flowmeter was installed with careful attention to its given requirements, and had L/D ratios both upstream and downstream well in excess of the minimum given values.

Further probing with a stethoscope revealed that the likely source of the noise was the main steam control valve. Under the most troublesome conditions, the valve is near closed. Such shallow valve angles are known to produce noise. In addition, the valve may encounter moisture. While the separator in the steam generator system can effectively remove the vast majority of entrained moisture, it is not perfect. As the system up to the valve is at saturation, any heat losses would work to condense small fractions of the steam. Such condensate would naturally flow to the valve. As it passes through the valve into the lower-pressure downstream piping, any moisture left in the steam would tend to flash; this can also be expected to add noise to the flow.

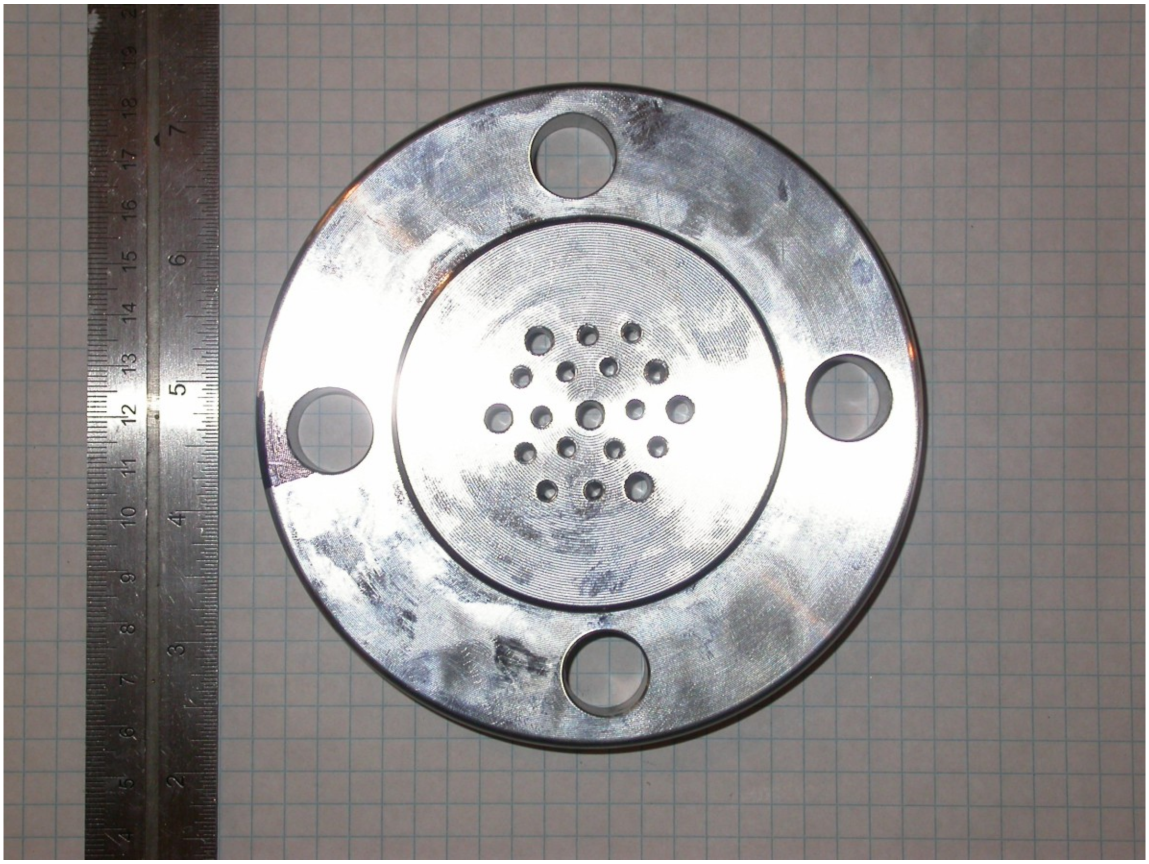

Figure 33: Silencer Plate

In order to limit the noise found in the flow to more tolerable levels, a thick multi-orifice plate was produced (Figure 33) and inserted into the steam line six inches downstream of the main steam control valve. It consists of a 1.5-inch NPS CL150 stainless steel flange blind with 19 holes bored through it in a hexagonal array. Of these holes, 5 have a diameter of 3/16”, while the remaining 14 have a diameter of 1/8”; all are chamfered on both sides of the plate. Once installed, this silencer plate appeared to function well; the distortions and fluctuations present before installation largely disappeared. While it adds a flow restriction/head loss to the system, it has the effect of staging the loss from the control valve and allows the valve to be opened further than it otherwise would have been. Not only does it limit the downstream propagation of valve noise, it also allows for less to be generated in the first place.

3.5 SYSTEM MODIFICATIONS AND ENHANCEMENTS

After the shakedown tests and repairs, some enhancements were made to the system as well as other modifications. The original orifice plate in the RCIC Turbine analog was found to be too small to allow full-power testing under reasonable conditions, and was therefore modified between Test #1 and Test #2. Its original 0.348” bore diameter was enlarged to 7/16”, and Test #1 was repeated with the new orifice as Test #2.

In addition to the adjustments to the orifice, modifications were made to the pump and connected equipment. A heat exchange system was added as well in order to reduce the cooldown period to reasonable timeframes as well as to conserve deionized water by reducing the demand for Suppression Chamber atmospheric blowdown operations.

3.5.1 Pump and Related Equipment

A further enhancement came after the second major failure of the original RCIC pump (between Test #4 and Test #5). A strainer was added upstream of the pump to prevent debris from accumulating in the impellors, which was discovered during post-failure examination of the first RCIC pump.

Based on the experimental system's performance through Test #10, it was determined that additional capacity on the RCIC Pump Recirculation Line was needed to prevent pump case overpressure during certain tests. To that end, the original recirculation line (with RCIC Pump Recirculation Valve V-67) was supplemented with a higher-capacity controllable recirculation line (containing recirculation globe valve V-66) before Test #11. This allowed the operator to shunt enough additional pump flow to direct pump outlet-inlet recirculation to shift the operating position on the pump curve (limiting boost pressure) without changing net system flow rates. This is especially important near the end of pre-pressurized tests, where the pump head in addition to the pressurized inlet conditions could easily exceed the pump's casing pressure limit.

Between Test #11 and Test #12, RCIC Pump-side instrumentation was upgraded. The original Dwyer 673-7 gauge pressure transmitter used for I-9, with a 0-100 psig range, was replaced with a Dwyer 682-3 with a 0-250 psig range. This allows for operators to electronically monitor the outlet pressure on the RCIC pump over its full range up to the casing pressure limit, rather than a subset of it. In addition, a Dwyer 673-7 gauge pressure transmitter was installed immediately before the pump inlet on the suction line as I-14. With the two new instruments, the data acquisition software was updated, and significant additional pump performance parameters could be inferred. Some of the updates to the data acquisition software were operational in nature – alarms were added to alert operators to conditions in the facility that approach design limits.

3.5.2 Heat Exchange System

While not a modification to the system during experimental runs, a heat exchange system added to the facility greatly enhanced the ability to run multiple tests in a week, as such was previously hindered by low cooldown rates. It provided sufficient cooling to allow for three tests per week.

Figure 34: Heat Exchanger Tubing

The centerpiece is an ad hoc heat exchanger. It was assembled from spare parts in the NHTS Laboratory, including 0.5” stainless steel tubing (many short lengths connected together as shown in Figure 34), a 55-gallon drum, and pumps. Due to the potential pressures in the Suppression Chamber as well as the flow restriction of the tubing, more than one pump was needed to provide adequate head for reasonable flow rates through the tubing (the hot liquid flows through the tubing and is cooled by the pool of cooler city water in the drum). The tubing sits inside the drum, below the waterline. The pool of water in the drum was rapidly circulated by a circulation pump as well as the flows of incoming (cold) and outgoing (heated) city water.

Figure 35 depicts the heat exchange system as aligned during cooldown operations. Hot water from the Suppression Chamber flows into the atmospheric hot water tank through the main water lines and V-10. From there, the hot water is pumped through a magnetic flowmeter and the heat exchange drum. It then flows into the repurposed Main Steam Line as cooled water through V-6, through V-5 and then back to the Suppression Chamber through the RCIC and SRV spargers.

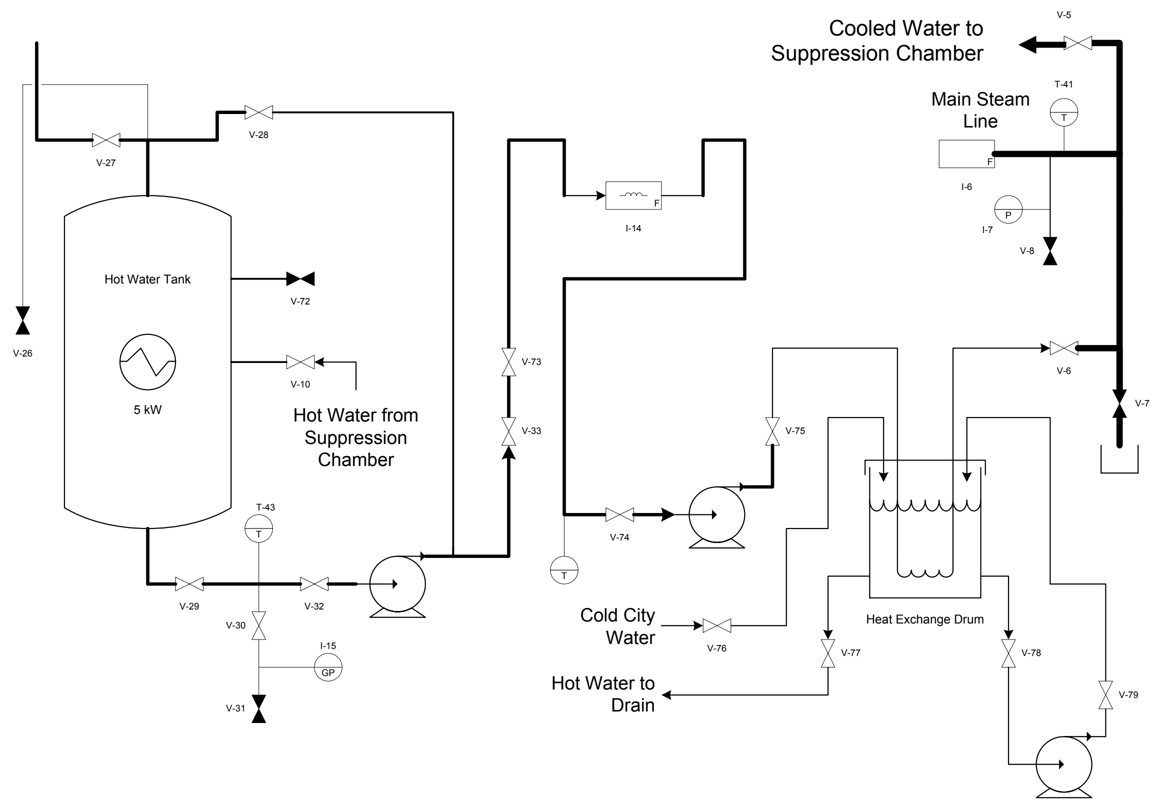

Figure 35: Heat Exchange System

4. EXPERIMENTAL FACILITY OPERATIONS

After shakedown testing and problem corrections, the experimental facility was operated in a data gathering mode. Given a set of testing objectives, a set of variable parameters was determined and procedures were developed to meet the objectives. Copious amounts of resultant data were collected, and general trends could then be identified.

4.1 TESTING PLAN

There are two primary alignments for system operation: steam discharge through the RCIC sparger analog, and discharge through the SRV analog. For each primary alignment, the steam can flow with or without active water injection that produces two-phase injection through the sparger. In addition, the flow rates are continuously variable, within reason. Furthermore, tests can be conducted to stay at low temperatures, or extended to go to higher temperatures, which could conceivably result in the premature failure of the pump. Therefore, there are a multitude of combinations of alignment, steam flow, and water injection rates. The variability of the water flow rate to the steam generator is lower, as it needs to balance the steam removal rate to ensure long-term steam supplies in the testing. Pre-pressurization and venting conditions can be added to the mix as well, very effectively increasing the potential number of unique combinations.

The overall testing plan focuses on examining the time-based thermal profiles developed in each test. These profiles will be compared across tests with different combinations of test parameters.

4.2 VARIED PARAMETERS

The experimental runs conducted varied several parameters. The parameters varied were steam generator heater power (steam flow rate), Suppression Chamber pressurization conditions, water injection rate into the steam line, and sparger type. Variations were considered not just on one parameter at a time, but also for the compounding effects of multiple parameters. While a very wide range of potential parameters can be tested, time constraints limited the total number of tests performed to 32. The parameters for each test are shown in Table 5.

Table 5: Test Parameters

Test #	Sparger/System	Power Level	Pressurization	Water Injection to Steam
1	RCIC*	57 kW	Standard	None
2	RCIC	57 kW	Standard	None
3	RCIC	157 kW	Standard	None
4	RCIC	107 kW	Standard	None
5	SRV	157 kW	Standard	None
6	RCIC	107 kW	Atmospheric	None
7	RCIC	107 kW	Atmospheric	0.4 gpm
8	RCIC	107 kW	Standard	0.4 gpm
9	RCIC	107 kW	14 psig Start	None
10	RCIC	157 kW	10 psig Start	None
11	RCIC	107 kW	15 psig Start	0.4 gpm
12	RCIC	107 kW	5 psig Start	None
13	RCIC	157 kW	Standard	0.6 gpm
14	RCIC	157 kW	Atmospheric	None
15	SRV	107 kW	Standard	None
16	SRV	107 kW	15 psig Start	None
17	SRV	107 kW	Standard	0.4 gpm
18	RCIC	107 kW	5 psig Start	0.4 gpm
19	RCIC	157 kW	10 psig Start	0.6 gpm
20	RCIC	57 kW	Atmospheric	None
21	RCIC	57 kW	Standard	0.2 gpm
22	RCIC	57 kW	5 psig Start	None
23	RCIC	57 kW	5 psig Start	0.2 gpm
24	RCIC	107 kW	15 psig Start, Vented	None
25	SRV	57 kW	Standard	None
26	RCIC	107 kW	Atmospheric, Vent Closed	None
27	RCIC	107 kW	Standard	0.8 gpm
28	RCIC	107 kW	Constant 2 atm	None
29	RCIC	107 kW	Constant 2 atm	0.4 gpm
30	RCIC	57 kW	Standard	0.8 gpm
31	RCIC	32 kW	Standard	None
32	RCIC	107 kW	Standard	None

*Used smaller orifice in RCIC Turbine analog

Steam generator power levels through each of the tests remained set at a constant value for the test duration. To limit the number of tests, only 3 primary power levels were examined: full power (157 kW), standard power (107 kW), and low power (57 kW). A special-case very low power test (32 kW) was performed as well. The 157, 107, and 57 kW power levels provided test-average steam mass flowrates near 66, 45, and 24 g/s, respectively. Without water injection to the steam line, these correspond to mass fluxes through the RCIC Sparger of 50, 34, and 18 kg/m^{2}s. Feedwater flowrates to the steam generator were kept as close to the steam flowrate as achievable to maintain a balance between the two as well as a constant inventory in the steam generator.

Tests used either single-phase or two-phase steam/water injection. For most of the two-phase tests, water injection into the steam line was selected based on the steam generator power level to target 55-60% quality in the steam line. At 157 kW, the standard injection rate was 0.6 gpm, while the flowrates were 0.4 gpm and 0.2 gpm for 107 kW and 57 kW, respectively. In addition, 0.8 gpm testing was done for two tests (power levels of 107 and 57 kW), producing lower steam qualities. The use of volumetric rather than mass flowrates or other derived quantities was due to operational simplicity: the control valve is next to the Badger magnetic flowmeter, which actively displays flow in GPM and can be read directly by operators while correcting the position of the control valve. Due to the thermal expansion of water, the mass flowrate of the water injected into the steam line will tend to slightly decrease in time with increasing pool temperatures; this is the opposite trend of the steam mass flow, which slightly increases over the test duration due to constant heater power and increasing feedwater temperatures. As a result, the expected trend is a slight increase in steam quality as the test progresses; this can, however, be complicated in tests where high initial steam superheat drops significantly over the test duration.

Pre-pressurization testing included a wider variety of conditions: the Suppression Chamber fully vented to the atmosphere through the test, a 2-atm constant pressure by pre-pressurizing with air and maintained by a backpressure regulator, the "Standard Alignment" in which the Suppression Chamber starts at atmospheric pressure and is isolated from the outside (builds up pressure as the pool heats up), and pre-pressurized variants of the Standard Alignment where the test starts with additional air pressures of 5, 10, or 14-15 psig and continues to pressurize as the pool warms. The pressurization tests were performed at numerous combinations of other parameters.

There were only two options for sparger type: SRV and RCIC Sparger analogs. More tests were performed with the RCIC than SRV sparger analogs, and no test was performed with both simultaneously or both alternated; each test was only performed with one sparger, and the same sparger, for the duration of the test.

4.3 PROCEDURES

Procedures were developed to safely operate the system and collect quality data. Here, they are divided into the relevant operational modes for the system (startup, shutdown, etc.). Each test will progress through several modes; some, such as pressurizing the Suppression Chamber with air, are not relevant for certain tests and are therefore omitted. The basic steps are:

1. Pre-Startup
2. Verify Suppression Chamber and Steam Generator Levels
3. Pressurize the Suppression Chamber
4. Agitate and Ensure Temperatures Meet Requirements
5. Start the Steam Generator
6. Warm the System
7. Maintain Stability for Data Operations
8. System Shutdown
9. System Cooldown
10. Securing at Cold Shutdown

More detailed procedures for each of the operational modes follow. The valve numbers are shown on the P&IDs in Appendix A. In addition, basic tables for primary valve alignments are included. The baseline valve alignment (used for Cold Shutdown) is given in Table 6; it is the starting point for valve realignments.

Table 6: Baseline/Cold Shutdown Valve Alignments

Valve	Position	Valve	Position	Valve	Position
V-1	CLOSED	V-28	OPEN	V-55	CLOSED
V-2	CLOSED	V-29	OPEN	V-56	OPEN
V-3	N/A	V-30	OPEN	V-57	CLOSED
V-4	N/A	V-31	CLOSED	V-58	CLOSED
V-5	OPEN	V-32	OPEN	V-59	OPEN
V-6	CLOSED	V-33	OPEN	V-60	CLOSED
V-7	CLOSED	V-34	OPEN	V-61	CRACKED
V-8	CLOSED	V-35	OPEN	V-62	150 PSIG
V-9	OPEN	V-36	OPEN	V-63	CRACKED
V-10	CLOSED	V-37	OPEN	V-64	OPEN
V-11	CLOSED	V-38	OPEN	V-65	CLOSED
V-12	N/A	V-39	OPEN	V-66	CLOSED
V-13	OPEN	V-40	CLOSED	V-67	OPEN
V-14	OPEN	V-41	CLOSED	V-68	CRACKED
V-15	CLOSED	V-42	CLOSED	V-69	OPEN
V-16	CLOSED	V-43	N/A	V-70	OPEN
V-17	CLOSED	V-44	N/A	V-71	CLOSED
V-18	CLOSED	V-45	N/A	V-72	CLOSED
V-19	CLOSED	V-46	CLOSED	V-73	OPEN
V-20	OPEN	V-47	CLOSED	V-74	OPEN
V-21	CLOSED	V-48	OPEN	V-75	OPEN
V-22	CLOSED	V-49	CLOSED	V-76	CLOSED
V-23	CLOSED	V-50	CLOSED	V-77	CLOSED
V-24	OPEN	V-51	CLOSED	V-78	OPEN
V-25	CLOSED	V-52	CLOSED	V-79	THROTTLE
V-26	CLOSED	V-53	CLOSED		
V-27	OPEN	V-54	CLOSED		

4.3.1 Pre-Startup

Cold Start - Everything powered off

1. Ensure all cables are appropriately connected

2. Plug in and power on the Data Acquisition Computer (including the speakers), SCXI chassis, 24V supply, and remaining instruments
3. Once startup has completed, log into the Data Acquisition Computer and load the appropriate LabVIEW program ('RCIC Facility v2.vi' for running a test, 'RCIC Facility Cooldown Alignment v1c.vi' for cooldown mode)
4. Enter the output datafile information, and begin running

Warm Start - Everything powered on

1. Power cycle instruments as necessary
2. Stop any programs using the data acquisition hardware
3. If necessary, reset the Data Acquisition Card driver. Necessary when the SCXI chassis has been power cycled, instruments are misreading, the system has been operating for long periods, significant noise has been injected into the electrical mains (i.e., thunderstorms), etc.
    a. Open the Windows Device Manager
    b. Under “Data Acquisition Devices”, disable the “PCIe-6341” adapter
    c. After a few moments, re-enable the adapter
    d. Close the Device Manager

4. Load the appropriate LabVIEW program (“RCIC Facility v2.vi” for running a test, “RCIC Facility Cooldown Alignment v1c.vi” for cooldown mode)
5. Enter the output datafile information, and begin running

Stopping:

1. Click the red “End Execution” button in the LabVIEW program, and give it a few moments to complete its end tasks
2. Close the LabVIEW program

If another test/data acquisition operation is forthcoming, the DAQ System can be left as-is for a warm start. Otherwise, power off the instruments, 24 V supply, SCXI chassis, and Data Acquisition PC (unless needed for other tasks).

4.3.2 Water Level Verification/Fill

Check the indicated water levels on both the Steam Generator and Suppression Chamber magnetic float indicators; verify against the transmitted values read by the DAQ

TO FILL THE HOT WATER TANK FROM THE DI WATER SOURCE:

1. Start the DAQ system in Cooldown Mode
2. Ensure that the outlet/drain valves V-10, V-31, V-33, and V-72 are closed
3. Open Culligan DI system valves V-24 and V-26 to begin filling

4. Close Culligan DI system valve V-26 when fill is completed

TO FILL THE HOT WATER TANK FROM THE SUPPRESSION CHAMBER

1. Start the DAQ in Cooldown Mode
2. Ensure the vapor space pressure in the suppression chamber is atmospheric and that the water is subcooled, and open the valves connecting them (V-9, V-10, and V-63)
3. Align the RCIC Pump to the hot water tank (Closed: V-1 and V-11; Open: V-9, V-10, and V-63)
4. Start the RCIC Pump and regulate flow to the hot water tank at a reasonable rate by throttling V-63
5. Once in range, stop the RCIC pump
6. Close the applicable valves (V-10)

TO FILL THE HOT WATER TANK FROM THE STEAM GENERATOR

This is the reverse of filling the steam generator from the hot water tank. The alignment is the same, but the water level in the steam generator needs to be greater than that of the hot water tank for reverse flow

TO FILL THE STEAM GENERATOR FROM THE SUPPRESSION CHAMBER

1. Start the DAQ in either Cooldown or Test Operation Mode
2. Ensure the vapor space pressures in the steam generator and suppression chamber are equal, and open the valves connecting them (V-9, V-11 and V-63; open V-16 if at atmospheric pressure)
3. Align the RCIC Pump to the steam generator (Closed: V-1 and V-10; Open: V-9, V-11, and V-63)
4. Start the RCIC Pump and regulate flow to the SG at a reasonable rate
5. Once in range, stop the RCIC pump
6. Close the applicable valves (V-11)

TO FILL THE STEAM GENERATOR FROM THE HOT WATER TANK

1. Start the DAQ in Cooldown Mode
2. Ensure that the Hot Water Tank has sufficient water. Concurrent filling of the hot water tank and steam generator is permissable.
3. Ensure that the steam generator is depressurized before filling. Open the blowdown valve (V-16)
4. Open the valves between the steam generator and hot water tank (V-10 and V-11; V-9 is nominally closed)
5. Close V-10 and V-11 when the steam generator is filled to the appropriate level, and open V-9

4.3.3 Suppression Chamber Pre-Test Pressurization

If pre-pressurization of the Suppression Chamber is needed, perform these steps.

1. Ensure that all atmospheric connections are closed
2. Open the Suppression Chamber Airspace Steam Line Connection Valve V-35
3. Open wide the Main Steam Line Control Valve V-1
4. Connect the air compressor hose to the air line quick connect on the steam generator, and power on the compressor
5. Open the steam generator air inlet valve V-17 and allow the system to begin pressurizing
6. Carefully monitor the Suppression Chamber pressure, and allow it to rise to the target pressure
7. Close the steam generator air inlet valve V-17
8. Shut down the compressor
9. Allow the system pressure to stabilize, and add more air via the inlet valve V-17 as necessary; close the valve when complete
10. Close the Suppression Chamber Airspace Steam Line Valve V-35, and ensure that the SRV Block Valve V-36 and RCIC Block Valve V-34 are closed
11. With all personnel safely clear of the vent area, open the steam generator blowdown valve V-16 to depressurize the steam generator

12. When fully depressurized, tightly close the steam generator blowdown valve V-16 and the Main Steam Control Valve V-1

4.3.4 Agitation

To ensure a uniform-temperature pool

1. Ensure that the vessel water levels and all electrical connections are suitable, and power cycle/turn on the instruments as necessary
2. Enter the test (especially the parameters/conditions) into the logbook, and make notes as milestones are reached
3. Start the RCIC Pump cooling fan on maximum speed
4. Start the data acquisition computer in test/experiment mode, and enter in the correct output file information – record everything
5. Set/ensure the following valve alignment: Open: V-53 or V-54 (alternate), throttle V-61; Closed: V-10, V-11
6. Start the RCIC pump and allow it to agitate the tank; continue agitation for several minutes after all submerged thermocouples come to uniform values
7. Close the recirculation block valves V-53 and V-54, then stop the RCIC Pump. Sufficient time needs to pass between the end of pumped agitation and the start of the data period after warmup to allow for the water motion to cease.

8. Ensure that the bulk pool temperatures are within range. If agitation is concurrent with subcooled Steam Generator warmup, it needs to be terminated before the Steam Generator is purged of air to allow for sufficient pool calming time.

4.3.5 Steam Generator Startup

Suppression Chamber agitation may continue into the early part of the Steam Generator warmup, while the Steam Generator temperatures are still below 100 °C.

STEAM GENERATOR STARTUP SEQUENCE

1. Close the vacuum breaker block valve V-13
2. Ensure that valves V-1 and V-11 are closed
3. Turn on the breaker and main power switch for the steam generator
4. Power on the applicable heaters. In warmup, all may be run.
5. If heaters do not power on, and the level is appropriate, bump the water level interlock reed switch with a magnet to unstick it
6. When the steam generator temperatures are above 105 °C, purge the air from the steam generator. SUPPRESSION CHAMBER AGITATION SHOULD HAVE CEASED BY THIS POINT.
7. Make sure no personnel are near the steam blowdown exhaust point
8. Open the Steam Generator blowdown line V-16, and wait until the sound changes to indicate steam rather than air flow

9. After a few moments of pure steam flow, close the blowdown valve V-16

10. Wait until the steam generator pressure rises above 40 psia, then set the power level to that of the test

4.3.6 System Warmup

Operators should exercise caution during system warmup procedures to maintain safety and to prevent damage to the system.

1. Close the steam line block valves V-34, V-35, and V-36, and open (with a partly-filled water bucket underneath) the main steam line condensate drain valve V-7. Be sure to catch any draining water with the bucket
2. SLOWLY open the main steam control valve V-1 until a VERY LOW steam flow passes through it
3. Condensate will begin draining out the open steam condensate drain line.
4. When the condensate draining out the condensate line becomes steam, CAREFULLY close the condensate drain valve V-7 and allow the steam line to pressurize and warm up. Adjustment of the steam flow rate may be necessary
5. If the steam generator pressurizes too fast, turning off some heaters may be necessary. The heaters should be re-energized before steam is

injected into the Suppression Chamber to ensure that the correct heater power level is maintained throughout the test period.

6. Once the steam line has pressurized, drain any new condensate from the line by slowly cracking open the valve V-7 until water slowly flows, and closing it when liquid flow becomes mostly steam. Do not open fully. Caution: HOT!
7. Adjust the main steam control valve V-1 to near the expected position to maintain the pressures and flows during the test
8. Open the appropriate (for the particular test) sparger valve (RCIC/SRV, V-34/V-36) carefully
9. Adjust the steam flow rate to near the target rate with the steam control valve V-1. Typically, steam generator pressures should be maintained to 70 - 90 psia, constant (and well above the steam line pressure) once full-circuit flow is established to ensure superheat through the vortex flowmeter
10. Barely crack open the feedwater control valve V-63
11. Start the RCIC Pump
12. Open the block valves V-9 and V-11 (V-10 closed) to permit feedwater flow to the steam generator, and adjust the control valve V-63 and pump recirculation valve V-68 to attain the correct flow to the steam generator. Note: V-53 and V-54 should both be closed

13. If water injection is directed to the steam line, carefully crack open the injection control valve V-68, and open the block valves V-49 and V-69

14. Adjust the Suppression Chamber Atmospheric block/regulator valve V-50 as determined for the particular test

15. Ensure that the basic valve alignment is appropriate for the current particular test

16. Adjust the control valves V-1, V-63, V-66, and V-68 to bring all the flows into their appropriate ranges for the test

17. Allow the system to heat up/approach the test begin condition, adjusting valves as appropriate and draining any collected steam condensate (through V-7)

4.3.7 Primary Data Operations

Ensure that the valves are correctly aligned for the test during the warmup period.

Once full injection conditions/alignments are met, make only minor adjustments to maintain the correct flowrates and pressure/temperature conditions (i.e., more than the minimum necessary superheat at the vortex flowmeter)

While temperatures are below the test begin condition in the Suppression Chamber, but near the temperature, fully drain any new condensate from the steam line by CAREFULLY cracking open the condensate drain valve V-7 until all the collected liquid is vented. Limit the flow rate to a slow drain and only open the valve slightly; DO NOT OPEN THE VALVE FULLY DURING TESTING.

Once the test period has begun, only make slight, slow changes to control valve positions to maintain flows/temperatures/pressures

For fine-tuning the flow rate from the RCIC pump back to the steam generator, multiple valves are employed. The main control valve, V-63, can be thought of as a ‘rough adjustment’; it is difficult with just that valve to make fine adjustments to the flow. Small adjustments can be made by varying the position of the pump recirculation globe valve V-66; such adjustments will result in a reverse effect as a similar adjustment would have for the main control valve (i.e., opening the control valve will increase flow to the steam generator, while opening the recirculation valve will tend to decrease flow to the steam generator. The gate valve V-67 should ALWAYS BE OPEN to ensure adequate minimum flow through the pump, and should not be used to regulate flow. In addition, the recirculation valve should be opened enough to limit the pump outlet pressure to below its case pressure limit (150 psig) and below the outlet relief valve's (V-62) set point. This can be a concern in the latter stages of a pre-pressurized test.

At the end of the test period, or if any equipment limits have been met/exceeded (or if something unspecified goes wrong), proceed immediately to the shutdown sequence. It should be noted that the data processing scripts look for the termination of steamflow as a flag that the test has been terminated, and define and endpoint as 60 seconds before detection of that signal to allow for beginning shutdown procedures.

A summary of the valve alignments for the data period is given in Table 7. Items in bold differ from their cold shutdown positions.

Table 7: Main Data Period Valve Alignments

Valve	Position	Valve	Position	Valve	Position
V-1	**THROTTLE**	V-28	OPEN	V-55	CLOSED
V-2	CLOSED	V-29	OPEN	V-56	OPEN
V-3	N/A	V-30	OPEN	V-57	CLOSED
V-4	N/A	V-31	CLOSED	V-58	CLOSED
V-5	OPEN	V-32	OPEN	V-59	OPEN
V-6	CLOSED	V-33	OPEN	V-60	CLOSED
V-7	CLOSED	**V-34**	**TEST**	V-61	CRACKED
V-8	CLOSED	**V-35**	**CLOSED**	V-62	150 PSIG
V-9	OPEN	**V-36**	**TEST**	**V-63**	**THROTTLE**
V-10	CLOSED	V-37	OPEN	V-64	OPEN
V-11	**OPEN**	V-38	OPEN	V-65	CLOSED
V-12	N/A	V-39	OPEN	**V-66**	**THROTTLE**
V-13	**CLOSED**	V-40	CLOSED	V-67	OPEN
V-14	OPEN	V-41	CLOSED	**V-68**	**THROTTLE**
V-15	CLOSED	V-42	CLOSED	V-69	OPEN
V-16	CLOSED	V-43	N/A	V-70	OPEN
V-17	CLOSED	V-44	N/A	V-71	CLOSED
V-18	CLOSED	V-45	N/A	V-72	CLOSED
V-19	CLOSED	V-46	CLOSED	V-73	OPEN
V-20	OPEN	V-47	CLOSED	V-74	OPEN
V-21	CLOSED	V-48	OPEN	V-75	OPEN
V-22	CLOSED	**V-49**	**TEST**	V-76	CLOSED
V-23	CLOSED	**V-50**	**TEST**	V-77	CLOSED
V-24	OPEN	V-51	CLOSED	V-78	OPEN
V-25	CLOSED	V-52	CLOSED	V-79	THROTTLE
V-26	CLOSED	V-53	CLOSED		
V-27	OPEN	V-54	CLOSED		

4.3.8 System Shutdown

IMPORTANT!

FIRST, **close the downstream water injection to steam line block valve V-49 to prevent water hammer and steam exposure to the Badger flowmeter**.

In rapid sequence, QUICKLY

1. close the main steam control valve V-1,
2. switch off the steam generator entirely,
3. close the feedwater block valve V-9, and
4. switch off the RCIC pump

Allow the system to sit for at least two minutes before proceeding. It is permissible to delay 3 and 4 above to give extra fill to the steam generator if the RCIC pump's limits are not at risk of being exceeded.

5. Open the SRV and RCIC sparger block valves V-36 and V-34
6. Open wide the main steam control valve V-1 to blow down the steam generator to the Suppression Chamber
7. Open the Suppression Chamber blowdown valve V-50 to dump the hot steam-air mixture into the Suppression Chamber Blowdown Drum.
8. Close the Suppression Chamber Blowdown valve V-50 once nearly all the available air from the Suppression Chamber has been vented (sounds of steam condensation rather than air bubbling in the drum's

water volume) or the Suppression Chamber reaches a sustainable atmospheric pressure. Do not allow the drum's water to reach saturation temperatures.

9. Once the steam generator finishes blowing down to the Suppression Chamber, close the main steam line control valve V-1 tightly
10. Ensure that all personnel are clear of the vent area, open the steam generator blowdown valve V-16, and bring the steam generator to atmospheric conditions
11. Operate the air compressor until it has sufficient pressure to fill the steam generator with sufficient pressure to blow air into the Suppression Chamber, and attach the quick connect hose to the air hose connection on the steam generator.
12. Close the steam generator blowdown valve V-16
13. Open the steam generator air inlet valve V-17 and fill it with air until it has sufficient air pressure to purge the steam line all the way to the Suppression Chamber – generally at least 15 psi above the Suppression Chamber's pressure.
14. Close the steam generator air inlet valve V-17
15. Open the main steam control valve V-1 to blow air through the steam line through the spargers until the steam generator pressure drops to that of the Suppression Chamber
16. Tightly close the main steam control valve V-1

17. Close the RCIC Sparger block valve V-34
18. With all personnel clear of the vent area, open the steam generator blowdown valve V-16, and allow the steam generator to come to atmospheric pressure
19. open the steam generator vacuum breaker block valve V-13
20. Close the steam generator blowdown valve V-16
21. End execution of the test-mode LabVIEW VI, and begin execution of the cooldown mode VI
22. Proceed with cooldown procedures. If the pool temperature is still pressurized or above 100 °C, it is in the Superheated Hot Shutdown condition

4.3.9 System Cooldown

Follow these steps to proceed through system cooldown. As a basic reference, the normal operating alignments of the valves are given in Table 8. Items in bold differ from their cold shutdown positions, and items in italics differed from their cold shutdown positions during the main data period.

Table 8: Primary Cooldown Valve Alignments

Valve	Position	Valve	Position	Valve	Position
V-1	*CLOSED*	V-28	OPEN	V-55	CLOSED
V-2	CLOSED	V-29	OPEN	V-56	OPEN
V-3	N/A	V-30	OPEN	V-57	CLOSED
V-4	N/A	V-31	CLOSED	V-58	CLOSED
V-5	OPEN	V-32	OPEN	V-59	OPEN
V-6	**OPEN**	V-33	OPEN	V-60	CLOSED
V-7	CLOSED	***V-34***	***OPERATE***	**V-61**	**THROTTLE**
V-8	CLOSED	***V-35***	***OPERATE***	V-62	150 PSIG
V-9	OPEN	***V-36***	***OPERATE***	***V-63***	***THROTTLE***
V-10	**OPEN**	V-37	OPEN	V-64	OPEN
V-11	*CLOSED*	V-38	OPEN	V-65	CLOSED
V-12	N/A	V-39	OPEN	***V-66***	***THROTTLE***
V-13	*OPEN*	V-40	CLOSED	V-67	OPEN
V-14	OPEN	V-41	CLOSED	*V-68*	*CRACKED*
V-15	CLOSED	V-42	CLOSED	V-69	OPEN
V-16	CLOSED	V-43	N/A	V-70	OPEN
V-17	CLOSED	V-44	N/A	V-71	CLOSED
V-18	CLOSED	V-45	N/A	V-72	CLOSED
V-19	CLOSED	V-46	CLOSED	V-73	OPEN
V-20	OPEN	V-47	CLOSED	V-74	OPEN
V-21	CLOSED	V-48	OPEN	V-75	OPEN
V-22	CLOSED	*V-49*	*CLOSED*	**V-76**	**THROTTLE**
V-23	CLOSED	***V-50***	***OPERATE***	**V-77**	**OPEN**
V-24	OPEN	V-51	CLOSED	V-78	OPEN
V-25	CLOSED	V-52	CLOSED	V-79	THROTTLE
V-26	CLOSED	**V-53**	**OPERATE**		
V-27	OPEN	**V-54**	**OPERATE**		

From SUPERHEATED HOT SHUTDOWN

1. Ensure that the heat exchange drum is filled with water and that there is sufficient water in the hot water tank to drain a substantial volume

without dropping below the minimum level for operation of the hot water pump

2. Start the heat exchange recirculation pump
3. Open the heat exchange drum outlet valve V-77 fully, and throttle open the cold water inlet valve V-76 to match the drain flowrate in the heat exchange drum. Maintain full levels.
4. Ensure that the Main Steam Control Valve V-1 is tightly closed, the SRV line (V-36) is open, the RCIC and Suppression Chamber Airspace valves V-34 and V-35 are closed, and that the main steam line has been purged with air
5. Ensure that the Cooldown Heat Exchange Auxiliary Pieces are properly connected to the system
6. Fully open hot water valves V-29, V-32, V-33, V-73, V-74, and V-75

In rapid succession, quickly

7. Turn on the hot water pump
8. Turn on the auxiliary hot water pump
9. Open the Cooldown System Block Valve V-6

If additional makeup water is needed in the system, the hot water tank can be simultaneously filled via the Culligan DI system (opening V-26)

Once a substantial amount of water has been added to the bottom of the Suppression Chamber, there should be sufficient thermal stratification that hot subcooled water can be extracted from the bottom and fed to the hot water tank without flashing issues

ALWAYS maintain a MINIMUM of 50 inches of water above the outlet of the hot water tank to ensure sufficient NPSH at the hot water pump

To send hot water to the hot water tank,

1. Close the steam generator feedwater block valve V-11
2. Open the hot water tank feedwater block valve V-10
3. Open the feedwater block valve V-9
4. Open the Suppression Chamber Recirculation Lower Block Valve V-54
5. Fully open the Suppression Chamber Recirculation Control Valve V-61
6. Throttle open the main feedwater control valve V-63 to refill the hot water tank (fill rate greater than water removal rate)

Optimum feedwater temperatures are between 95 and 98 °C to have a high enough ΔT across the heat exchanger to provide for effective heat removal.

Once temperatures at the outlet drop below around 90 °C, open the RCIC Sparger Block Valve V-34 to weaken the thermal stratification layers in the pool

When either the pool's pressure is insufficient to maintain necessary feedwater flow or the outlet temperatures stay below 90 °C, begin forced recirculation:

1. Throttle the main feedwater control valve V-63 and the Suppression Chamber Recirculation Valve V-61 to barely open
2. Start the RCIC Pump
3. Throttle the main feedwater control valve V-63 to provide sufficient feedwater flow to the hot water tank
4. Throttle the Suppression Chamber Recirculation Valve V-61 to provide a small mixing current in the lower regions of the vessel, to maintain outlet temperatures near 95 °C

Continue to maintain flows (all heat exchanger flow rates, balanced flows to the hot water tank, near-saturation water to the hot water tank) until the Suppression Chamber bulk pool temperatures drop several degrees below saturation. NOTE: THESE CONDITIONS MAY BE CONDUCIVE TO PUMP CAVITATION. Avoid cavitation in the pump, flashing in valves, lines, etc.

Once the bulk pool temperatures drop several degrees below saturation:

1. Provide additional recirculation flow (throttle open V-61) to achieve and maintain pool thermal uniformity.

2. Open the Suppression Chamber Vapor Space Steam Line Valve V-35 to discourage the formation of cool thermal layers on the bottom of the pool

Once the pool is below 100 °C, if operator fatigue becomes an issue, the system can be shut down, depressurized, and allowed to sit safely overnight (Hot Shutdown). To do so:

1. Close the Suppression Chamber Vapor Space Steam Line Valve V-35
2. Open the Suppression Chamber Blowdown Valve V-50 and vent the remaining pressure through the blowdown drum
3. Once the Suppression Chamber pressure reaches atmospheric pressure, close the Suppression Chamber Blowdown Valve V-50
4. Open the Suppression Chamber Vapor Space Steam Line Valve V-35
5. Shut off all pumps
6. Close the Feedwater Block Valve V-9
7. Close the cooling water supply valve V-76 and the heat exchange drum drain valve V-77
8. Switch off the RCIC Pump Cooling Fan

The Data Acquisition System may be allowed to continue collecting data while the system is left to perform a natural cooldown. To resume active cooldown from the Hot Shutdown state:

1. switch on the RCIC Pump Cooling Fan

2. ensure that the Lower Suppression Chamber Recirculation Block Valve V-54 is open (may alternate with Upper Suppression Chamber Recirculation Block Valve V-53)
3. Throttle open the Suppression Chamber Recirculation Control valve V-61
4. Start the RCIC Pump
5. Open the Heat Exchange Drum Drain Valve V-77
6. Throttle open the Heat Exchange Cold Water Valve V-76 to maintain level in the heat exchange drum
7. Start the Heat Exchange Drum Recirculation Pump
8. Ensure that valves V-6, V-29, V-32, V-33, V-73, V-74, and V-75 are full open and start the hot water pump
9. Start the auxiliary hot water pump
10. Throttle open the Feedwater Control Valve V-63
11. Open the Feedwater Block Valve V-9
12. Regulate feedwater flow with the Feedwater Control Valve V-63 to maintain level in the hot water tank

Maintain levels and flows with cooling until the bulk Suppression Chamber temperatures reach the appropriate cold shutdown temperatures (i.e., cold enough to run another test, typically at or below 37 °C)

If performing another test within the next few days, the overnight shutdown procedures (above) can be applied, and the next test started at some point afterward. Otherwise, follow the long-term Cold Shutdown sequence

4.3.10 Cold Shutdown

To reach Cold Shutdown, start from an appropriate (subcooled, unpressurized) Hot Shutdown at low temperature.

1. Perform an overnight shutdown sequence for Hot Shutdown
2. close the V-6 Cooldown System Block Valve
3. close the hot water tank feedwater block valve V-10 (V-11 still closed)
4. open the feedwater block valve V-9
5. end execution of the cooldown mode VI
6. shut down the instruments
7. switch off the 24V power supply
8. power off the SCXI chassis
9. Back up collected data from the Data Acquisition Computer
10. Shut down the data Acquisition Computer
11. Reached Cold Shutdown

At cold shutdown, all pressures should be atmospheric and all temperatures should be well below saturation. The primary valve alignment in Cold Shutdown should be that of Table 6.

4.4 RESULTS

A total of 32 tests were performed. Each of them will be briefly described in the order in which the tests were performed. Summaries of the tests are given in Table 9 and Table 10.

Test #4 has been used in the past as a baseline reference case. The typical progression of phenomena common in these tests is given in 4.4.4, which discusses Test #4. In addition, only a limited number of thermocouple positions are plotted in these results for simplicity. The typical plot includes the vessel front stratification set, consisting of an Upper (Thermocouple SP19), Middle (Thermocouple SP20), Lower (Thermocouple SP21), Left (Thermocouple SP22, at the same elevation as the Middle), Right (Thermocouple SP23, at the same elevation as the Middle), and a Bottom/Vessel Outlet temperature reading.

Table 9: Mean Measured Flow Conditions

Test #	Steam Flow, g/s	FW Flow, g/s	Water Injection Flow, g/s	Sparger Steam Quality	SC Start P, psia	SC End P, psia	Initial Water Level, in.	Final Water Level, in.
1	23.5	22.2	0.0	1.012	16.2	29.7	28.0	28.8
2	23.5	25.0	0.0	1.012	15.0	30.8	30.8	31.1
3	65.8	65.9	0.0	1.019	15.1	54.3	30.2	30.3
4	45.3	45.1	0.0	1.017	14.7	47.8	29.7	33.9
5	66.4	65.6	0.0	1.017	15.1	32.5	29.6	33.0
6	45.0	43.8	0.0	1.022	14.8	15.6	29.7	30.1
7	45.4	44.0	24.5	0.638	14.7	15.4	30.1	30.4
8	45.5	44.9	24.8	0.625	14.7	42.2	29.9	33.6
9	43.5	43.4	0.0	1.003	29.6	72.3	33.5	33.5
10	65.4	64.2	0.0	1.013	25.9	74.8	32.0	32.8
11	43.7	43.1	24.9	0.585	30.2	100.7	32.7	32.7
12	44.7	43.7	0.0	1.009	20.7	72.1	30.5	32.6
13	66.3	65.9	37.2	0.626	15.1	46.8	30.8	35.2
14	66.8	65.2	0.0	1.028	14.8	16.2	30.4	30.6
15	45.7	45.6	0.0	1.012	15.1	39.0	30.2	31.8
16	45.5	45.4	0.0	1.005	30.2	56.9	30.1	30.2
17	45.4	45.4	25.3	0.623	15.3	39.2	29.7	30.0
18	44.4	44.8	25.3	0.599	20.3	62.4	29.7	29.8
19	66.4	65.7	37.4	0.606	25.1	95.9	30.6	31.1
20	23.9	23.5	0.0	1.017	14.8	15.5	31.0	31.1
21	23.8	23.2	12.5	0.635	15.2	40.7	30.7	31.7
22	23.7	23.5	0.0	1.005	20.2	49.3	30.5	31.2
23	23.3	22.9	12.5	0.618	20.3	48.2	30.4	31.1
24	44.8	44.0	0.0	1.011	30.5	32.3	30.9	31.2
25	23.9	23.7	0.0	1.008	14.9	42.3	30.7	31.6
26	45.6	44.7	0.0	1.019	15.0	35.4	30.6	31.4
27	44.8	44.4	49.9	0.441	15.0	42.7	30.4	31.3
28	44.6	43.9	0.0	1.011	30.1	30.7	31.0	31.3
29	44.4	43.8	25.0	0.606	30.8	30.6	31.3	31.5
30	23.3	23.0	49.8	0.261	14.9	40.8	30.6	31.7
31	13.0	12.9	0.0	1.000	14.6	39.6	30.6	31.6
32	44.7	44.3	0.0	1.015	15.1	49.6	31.1	31.3

Qualities greater than unity are superheated steam

Table 10: Peak Stratification

Test #	Duration, s	Start Pool T	End Pool T	Strat. Period, s	Max Top-Mid DT	Max Mid-Low DT	Max Low-Outlet DT
1*	10368	40	95	6972	2.1	10.8	20.7
2	12878	40	100	8247	1.4	9.3	22.6
3	6678	40	127	3731	2.1	5.5	43.1
4	8917	40	122	5373	3.1	20.9	43.3
5	4710	40	104	0	2.6	2.3	5.0
6	6466	40	99	2846	2.4	5.9	21.0
7	5932	40	94	2809	1.9	3.4	13.2
8	8436	40	117	5206	2.3	11.7	36.8
9*	9336	40	128	8075	5.1	29.4	61.9
10*	6452	40	134	4506	4.0	29.0	55.0
11~	11407	40	146	10381	5.6	28.9	65.1
12~	10942	40	136	7521	4.1	26.9	55.9
13	6361	40	121	2372	2.2	1.9	15.4
14	4542	40	100	1127	2.2	1.5	9.1
15	8081	40	113	0	2.3	2.1	4.1
16	8120	41	112	3859	2.4	3.0	5.5
17	7977	40	113	0	2.2	2.1	4.2
18~	9795	40	129	7111	3.7	25.5	52.6
19~	8367	40	147	6235	2.7	12.0	44.4
20	12992	40	100	6260	1.6	5.8	14.0
21	15915	40	114	8952	1.5	10.6	23.9
22	16254	40	117	10082	1.7	13.2	30.7
23	16122	40	115	10733	1.8	14.4	32.9
24	8209	40	113	5575	5.1	14.6	36.6
25	16930	40	116	10297	1.9	2.3	4.4
26	8602	40	116	3683	2.2	5.8	27.7
27	8705	40	117	4709	1.7	3.7	15.7
28	10221	30	120	7568	4.5	21.0	39.6
29	9483	35	119	7233	4.5	22.9	40.5
30	17979	30	113	7817	1.3	10.1	24.2
31'	31398	35	112	22584	1.0	8.4	27.9
32	9675	41	123	5994	2.8	20.7	43.5

*Stopped before completion
~Destratification did not complete before termination
'Steam Flow Measurement Issues

4.4.1 Test #1

Test #1 was the only test to use the smaller-diameter orifice (0.348”) in the RCIC Turbine analog. It ran at 57 kW in the Standard Alignment – Suppression Chamber isolated with an initial near-atmospheric pressure and no water injection to the steam. This produced main steam line pressures on the order of 10 psi greater than those of Test #2, which was almost identical; the only difference was the use of the larger orifice. Procedurally, the test was terminated earlier than the others. The final pool lower-outlet destratification point was not found, but the others (upper-mid level, mid-lower level) were.

The test ran with steam flowrates of 23.5 ± 0.5 g/s, and feedwater flows were 22.2 ± 0.9 g/s. As with the other tests, chugging was evident and decreased in intensity as the test progressed. Thermal stratification was evident (and can be seen in Figure 36) for most of the test, appearing after about 56 minutes and enduring through the end near 173 minutes; the beginning and end of the stratification period as determined by the data processing script are identified by gray vertical lines, while the vertical dotted gold line indicates plume detection as defined in Section 5.2. The top-mid level stratification peaked at 2.1 °C at 124 minutes, followed by a peak 10.8 °C maximum mid-low level separation at 159 minutes. The low-outlet separation reached 20.7 °C at the very end, and was still growing. Over the test period, the pressure in the Suppression Chamber nearly doubled.

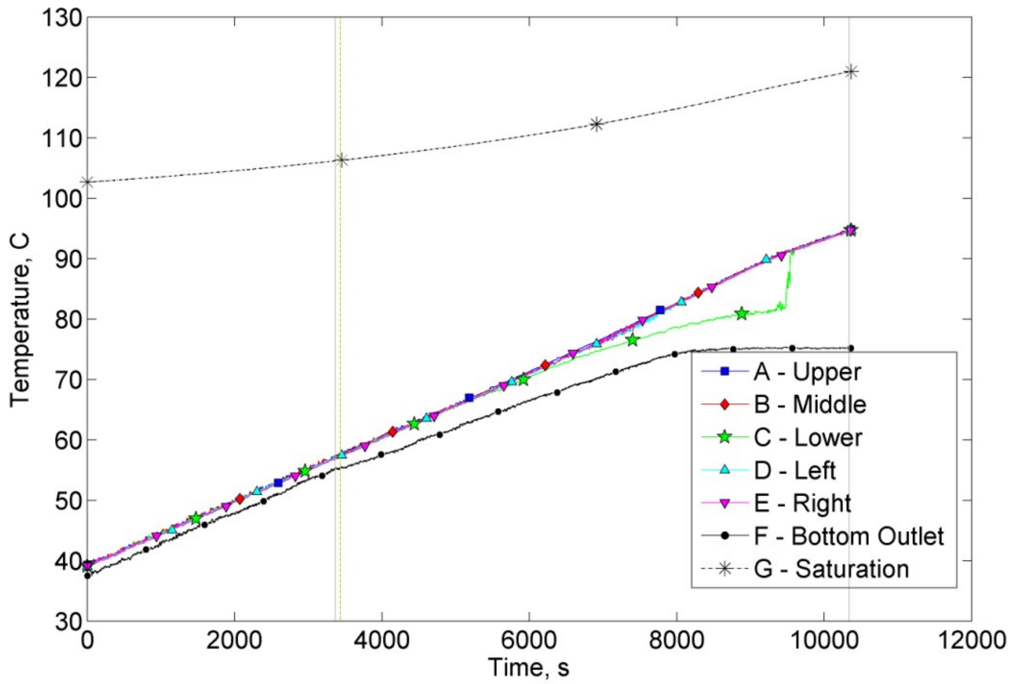

Figure 36: Test #1 Thermal Progression

4.4.2 Test #2

Test #2 was nearly identical to Test #1, with the exception of the larger orifice diameter being used. It too ran 57 kW of heater power in the steam generator with a standard alignment RCIC profile. Unlike Test #1, it was run to completion – the full destratification and reconvergence of all pool temperatures to essentially a uniform bulk temperature was observed. It was also reported in [50].

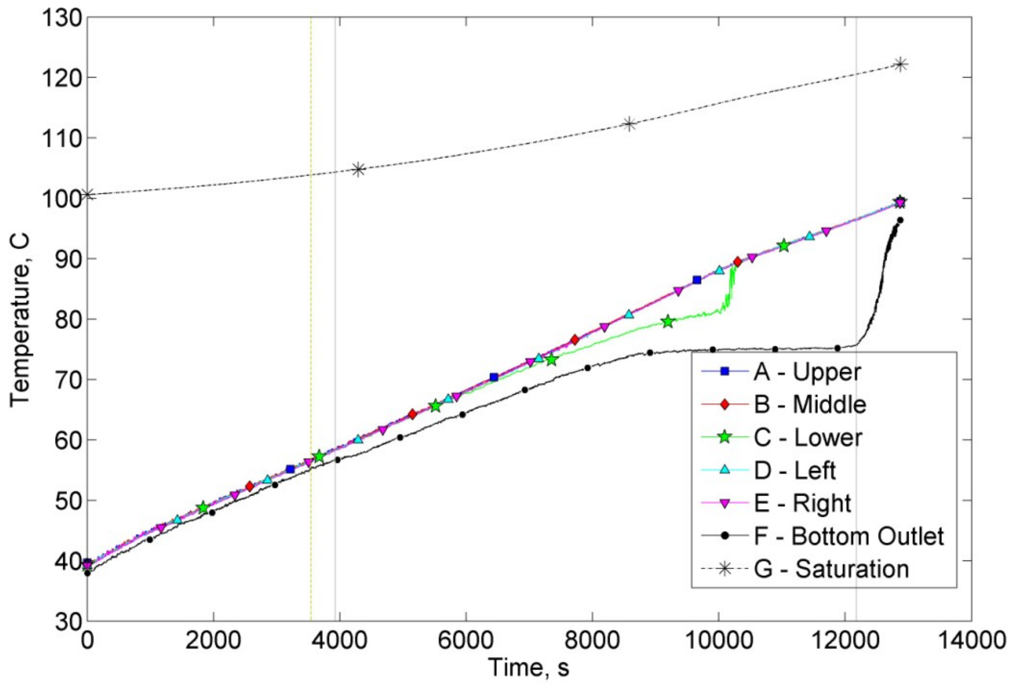

Figure 37: Test #2 Thermal Progression

While not identical, the results and thermal profiles for Test #2 were similar to those of Test #1. Steam and feedwater flowrates were 23.5 ± 1.1 and 25.0 ± 2.2 g/s, respectively. The initial water inventory was slightly greater, and the initial (post-warmup) pressures slightly less than Test #1. Thermal stratification appeared somewhat later, after 65 minutes (see Figure 37), and was slightly, but not significantly when compared to instrument tolerances, lower than Test #1 for the top-mid (1.4 °C) and mid-low regions (9.3 °C). Owing to the run through completion, the peak low-outlet stratification was greater, and measured 22.6 °C.

As was the case earlier, the period of major thermal stratification ran for the majority of the test – more than 2/3 of a nearly 203 minute period.

4.4.3 Test #3

Test #3 was a full-power (157 kW) standard alignment run. With its nearly triple the heater power of the previous tests, the water in the Suppression Chamber heated up at a much faster rate, and proved somewhat more difficult to control than lower-power tests. This test was also discussed in [50].

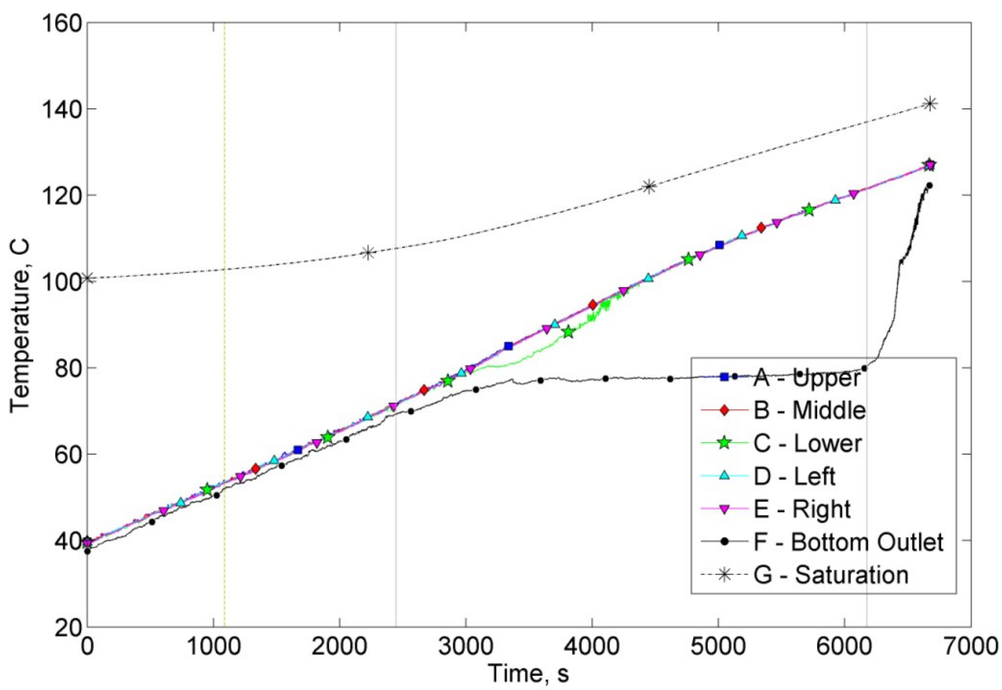

Figure 38: Test #3 Thermal Progression

With 65.8 ± 3.0 g/s of steam flow and 65.9 ± 9.2 g/s of feedwater, there proved to be more variation in steam and water flow rates. In order for the increased flowrate through the orifice, greater upstream pressures were needed in the main steam line. To maintain superheat through the vortex flowmeter, somewhat greater pressures were needed in the steam generator (~90 psia with a main steam line running ~70-80 psia). Not only were flows through the main steam control valve no longer choked (it would be choked through the orifice for most of the run), but the high differential pressure between the RCIC Pump and steam generator made it difficult for operators to maintain a stable, balanced flow back to the steam generator.

Thermal stratification (shown in Figure 38) in the upper levels of the pool were similar to those of the earlier low-power tests. The peak separation in the top-mid regions was 2.1 °C, and the mid-low difference peaked at 5.5 °C. The low-outlet stratification, however, was much larger. At 43.1 °C, the difference was more than 20 °C greater, and nearly twice that of Test #2. Destratification occurred later, and the final pool temperature was resultingly greater than earlier tests.

4.4.4 Test #4

Test #4 was a mid-power (107 kW) standard alignment test, and was considered the quintessential/base-case RCIC test in [50] and [51]. It produced some of the clearest stratification and chugging profiles in the basic tests.

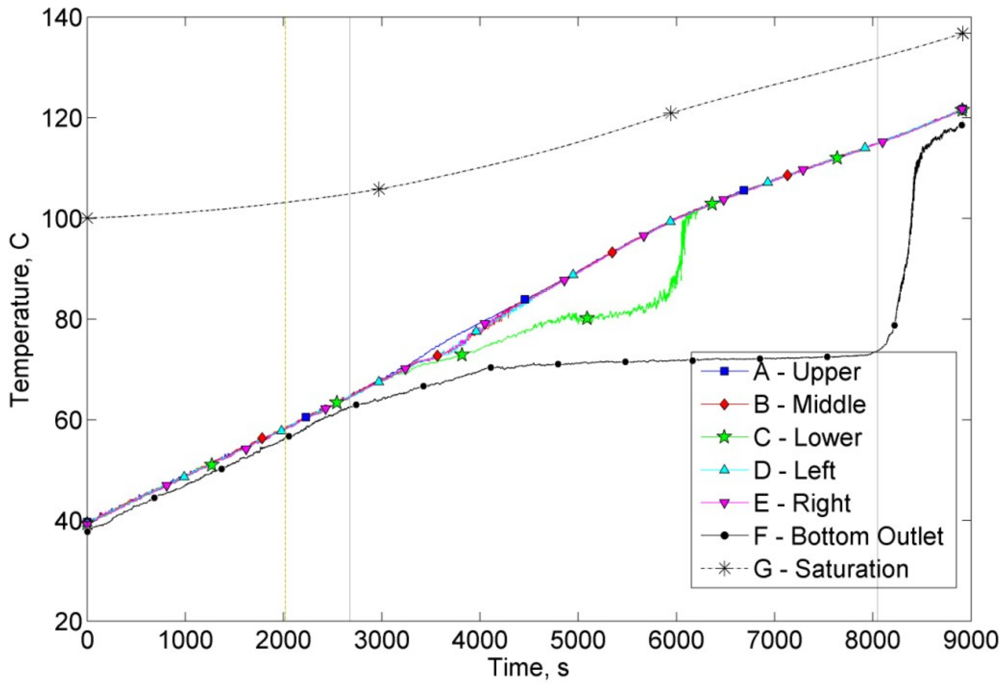

Figure 39: Test #4 Thermal Progression (Vessel Front)

With steam and feedwater flowrates of 45.3 ± 1.3 and 45.1 ± 3.8 g/s, respectively, a peak stratification of 3.1 °C top-mid was produced, only slightly more than the tests at higher and lower powers. The mid-low difference, however, was remarkable: 20.9 °C, the greatest of the standard alignment tests. The peak low-outlet stratification was the greatest of the standard alignment tests as well at 43.3 °C, although that is within instrument tolerance of the same value for Test #3. The thermal profiles can be seen in Figure 39 for the front of the vessel, which shows essentially the same profile as in the (axially) middle region of the pool (shown in Figure 40).

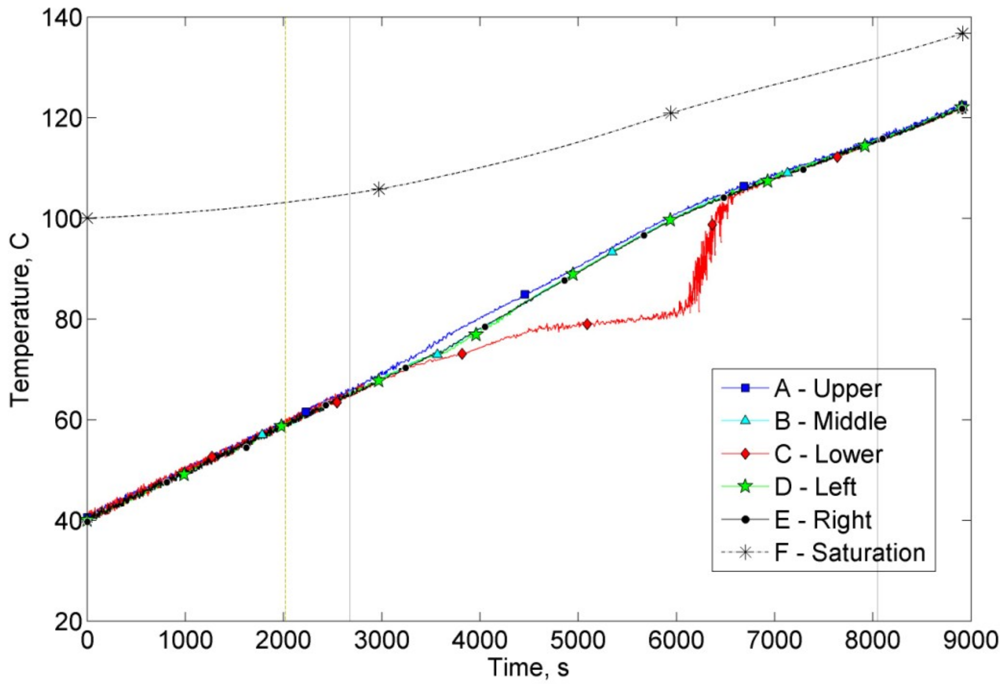

Figure 40: Test #4 Pool Thermal Progression, Mid-Pool

Axial temperatures were very consistent at similar elevations in the pool with one major exception: Thermocouple SP8. It is located very near the outlet for the RCIC Sparger, and displays behavior indicating a somewhat chaotic hot spot. Initially, it matches the others on its elevation, but eventually separates. The separation is an important part of the analysis of the data collected in these tests, and is taken to represent the formation of a thermal plume. The axial profile can be seen in Figure 41.

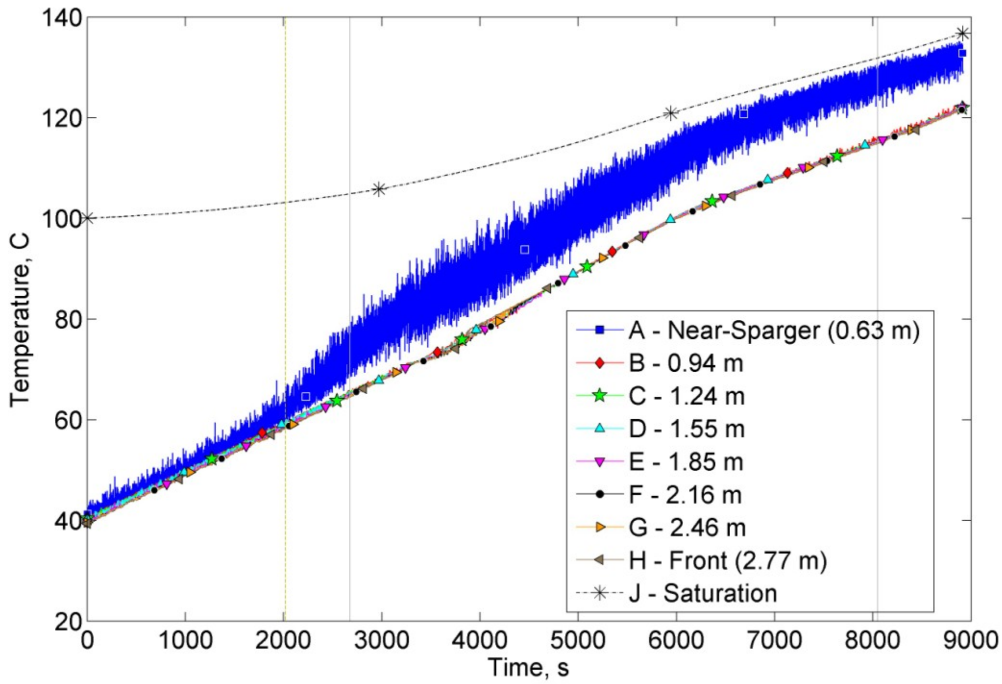

Figure 41: Test #4 Pool Mid-Level Axial Temperature Progression

By about 2780 seconds into the test, operators had noticed that the sounds of violent steam condensation in the Suppression Chamber had begun to die down, and that there had appeared noticeable hesitation in the chugging. This coincides with an apparent transition period starting at roughly 2000 seconds and appearing to end sometime before 3500 seconds in both the sparger DP and sparger outlet temperature data, and can be found in Figure 42. Qualitative reports from operator's notes (regarding the sounds that were being heard by operators) reveal that by 3080 seconds, the acoustic profile had changed significantly, with a longer time between pops. By 3680 seconds, pops were few, far between, and much quieter than before; by 4520 seconds, they had stopped almost entirely. The recorded data shows the largest pressure and temperature spikes in the sparger occurring approximately once every 7 seconds, with smaller spikes more frequent, similar to the shakedown tests. Similar responses are visible in data from other tests; the temperature and pressure spikes are clear in Test #2, as shown in Figure 43; its largest spikes in the instrument data seemed to occur more frequently, on the order of 1 per second. Test #3 had its largest spikes, appearing somewhat lesser in magnitude than the lower-power tests, occurring on roughly 2-7 second intervals.

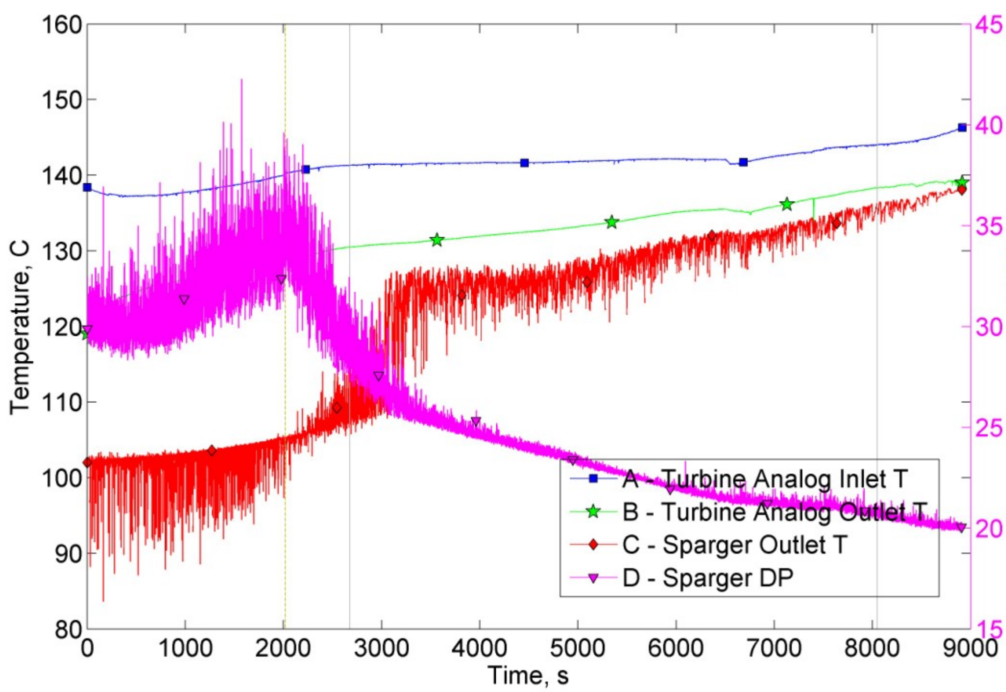

Figure 42: Test #4 Sparger Performance

Long after this test completed, near the end of cooldown operations in preparation for Test #5, the pump motor experienced a catastrophic failure of the centrifugal switch which necessitated replacement of the whole motor. Due to the relatively small cost difference between a new motor and a completely new pump, a complete replacement pump was procured. In the process of replacement, a Y-strainer was added to the pump inlet to reduce the debris ingestion by the pump.

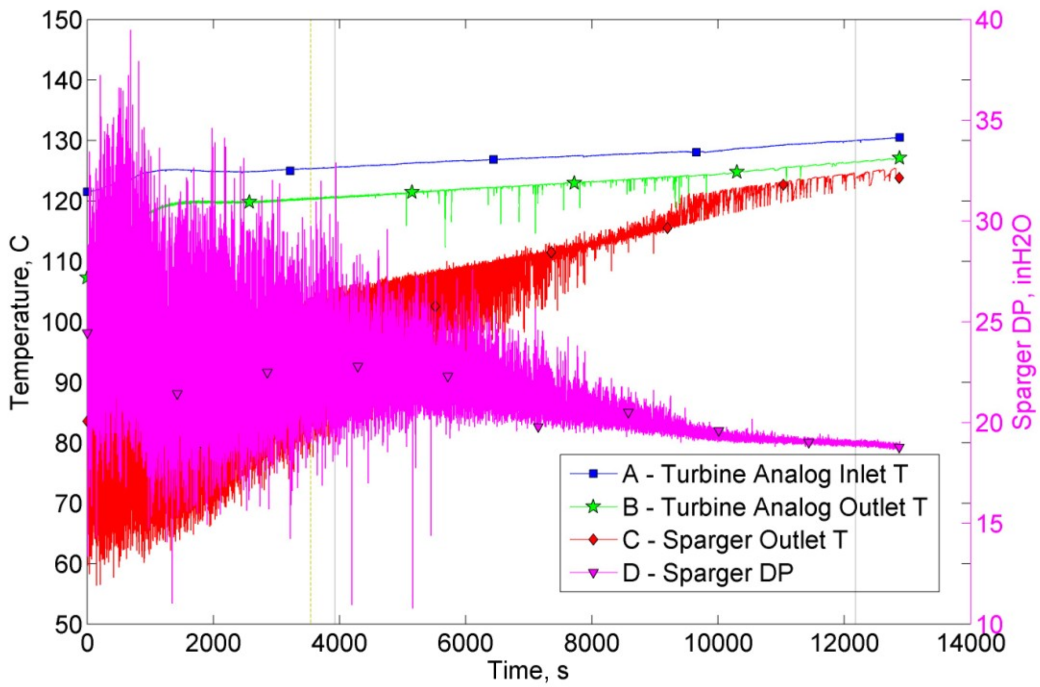

Figure 43: Test #2 Sparger Performance

4.4.5   Test #5

Test #5 was the first of the SRV alignment tests, and has been presented previously in [50]. It was conducted at full power (157 kW), and was like the standard alignment in terms of water injection to the steam line (none) and pressurization conditions (Suppression Chamber isolated from the lab, beginning at atmospheric pressure); the main difference was that instead of the RCIC Turbine analog and sparger, steam flow was aligned to the SRV sparger. This resulted in reduced main steam line pressures (no orifice to obstruct the steam flow) and a lack of data for DP across the sparger as well as temperatures at the outlet – neither instrument exists on the SRV sparger analog.

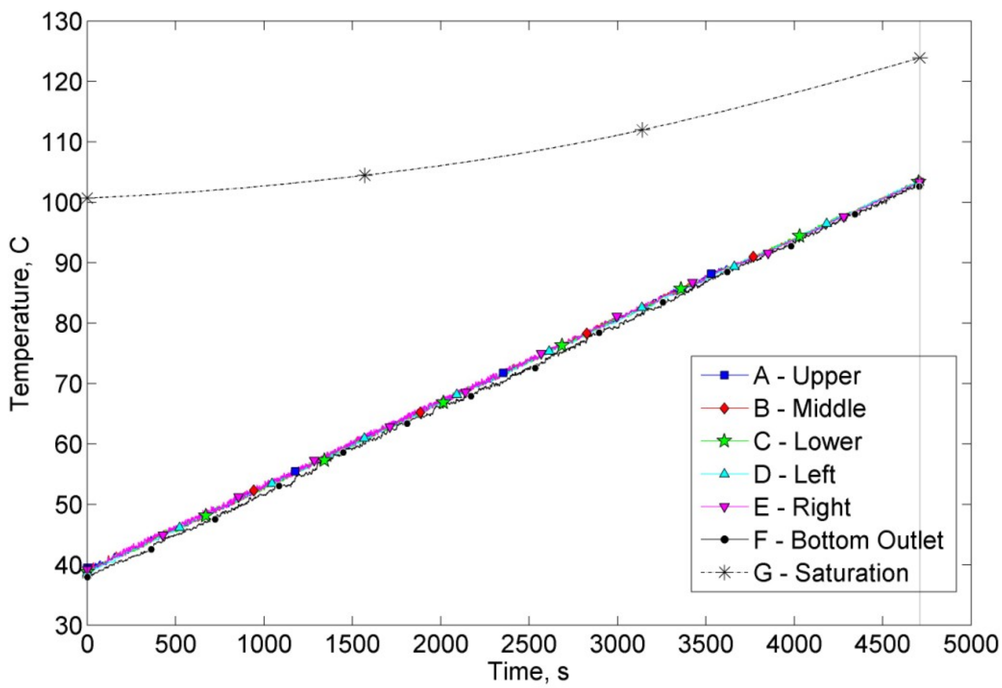

Figure 44: Test #5 Thermal Progression

The test ran with 66.4 ± 2.1 g/s of steam and 65.6 ± 3.5 g/s of feedwater. While it did not run for quite as long as the high power standard alignment test, it ran long enough to go to completion. There were measureable differences in temperature between different locations – a peak of 2.6 °C top-mid, 2.3 °C mid-low, and 5.0 °C low-outlet (see Figure 44), but that appears to be the result of fluctuating currents within the vessel; no consistent bulk stratification was detected to develop.

Operators did hear what sounded like the violent ‘pops’ and ‘bangs’ of condensation events characteristic of chugging in the RCIC sparger; at the beginning of the test, they were loud, violent, and fast. They lost much intensity by around 3700 seconds, and were quiet and non-violent by the end of the test.

4.4.6 Test #6

Test #6 was a fully-vented medium power (107 kW) RCIC test with no water injection to the steam line. Instead of isolating from the atmosphere, a valve (V-50) to the airspace in the Suppression Chamber was left open for the entire duration of the test, maintaining near-atmospheric pressures in the vessel. This test was discussed previously in [51].

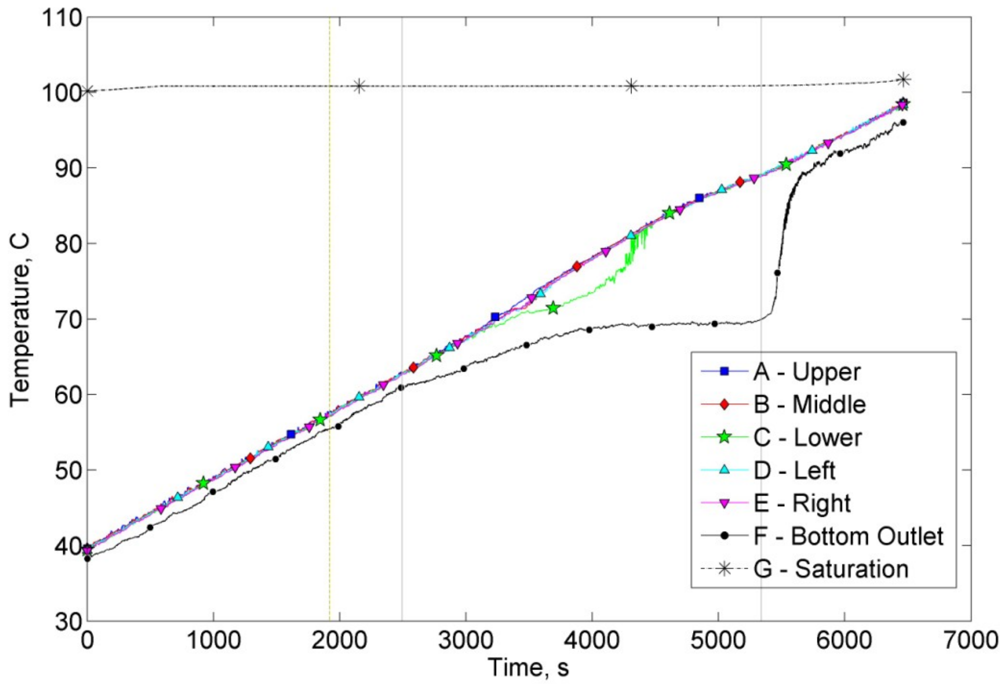

Figure 45: Test #6 Thermal Progression

Steam flow registered at 45.0 ± 1.4 g/s, and feedwater was 43.8 ± 1.9 g/s. This test finished faster than some of the others. The stratification period, at 2846 seconds in duration, was less than half of the test period shown in Figure 45. It also produced weaker gradients than the standard alignment test of the same power (Test #4); the greatest top-mid stratification was 2.4 °C, the mid-low differences were limited to 5.9 °C, and the low-outlet differences peaked at 21.0 °C – a little less than half of the standard alignment value.

The early parts of the test tended to resemble the standard alignment. Pressurization in the standard alignment tends to happen in the latter parts of the test, while the early increases are much smaller. The detected onset of thermal stratification in the pool only happens about 3 minutes earlier (out of a nearly 108-minute run) in the atmospheric case and has similar bulk pool temperatures. However, in the atmospheric case, the stratification terminates much sooner.

4.4.7 Test #7

Test #7 was a RCIC atmospheric test at medium power with water injection (targeting 0.4 GPM) into the steam line. It was the first of the water injection tests, and was essentially Test #6 run with water injection.

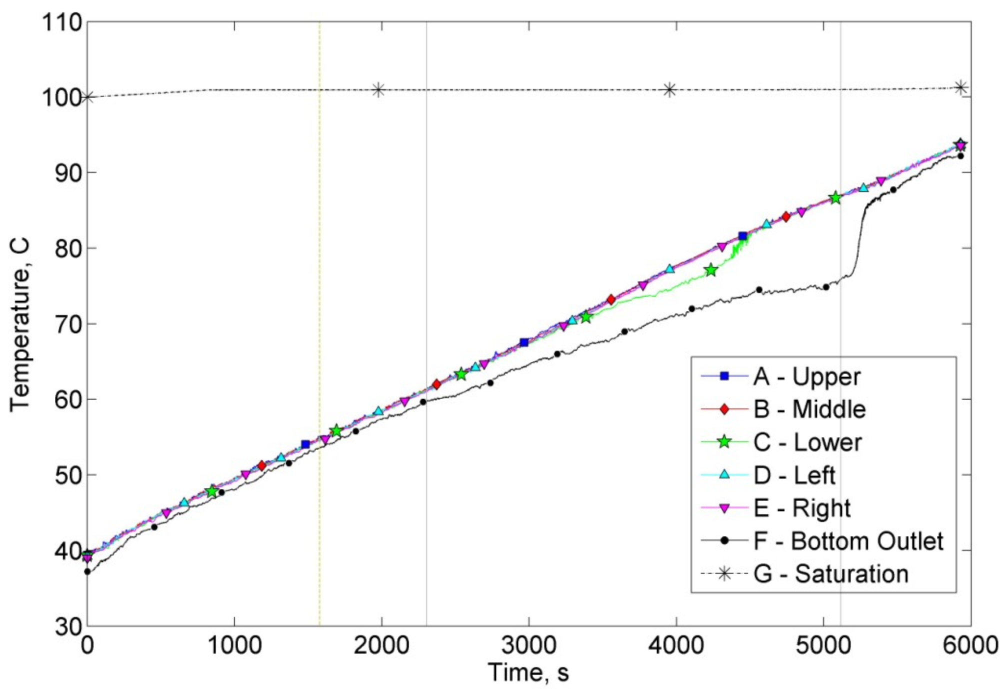

Figure 46: Test #7 Thermal Progression

Steam flow was measured at 45.4 ± 2.3 g/s over the test. Feedwater was 44.0 ± 6.5 g/s, and water injection to the steam line was 24.5 ± 1.9 g/s. The resulting main steam line steam quality was 0.59 ± 0.03, while post-orifice it was 0.64 ± 0.03.

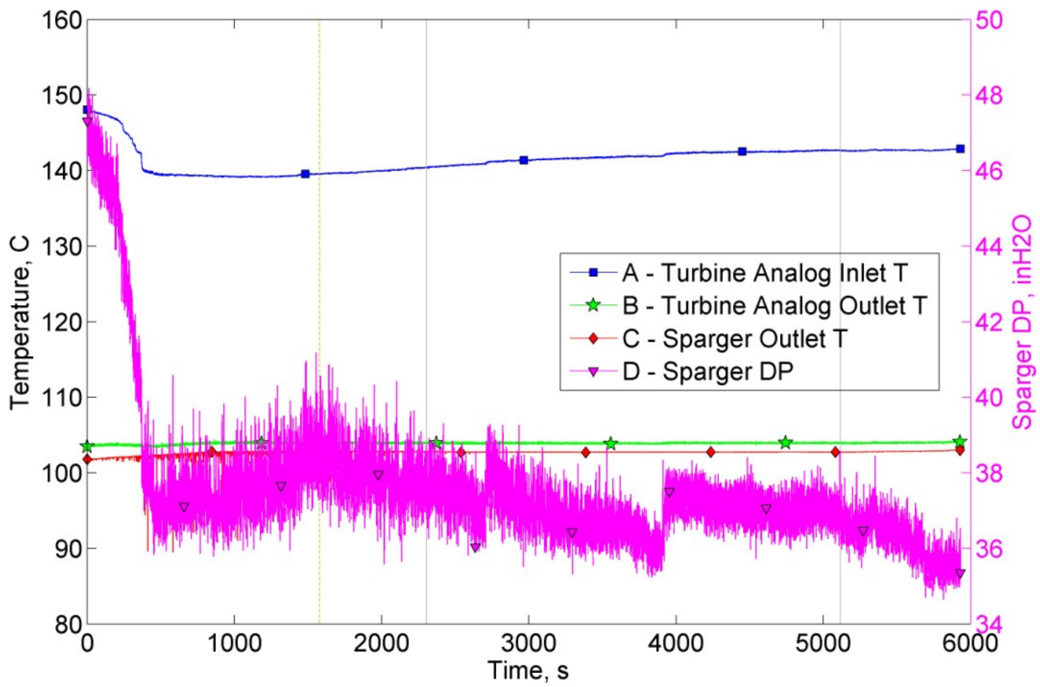

Figure 47: Test #7 Sparger Behavior

The thermal stratification in the Suppression Chamber (shown in Figure 46) was very limited in this test. The top-mid difference peaked at 1.9 °C, while the mid-lower stratification was limited to just 3.4 °C. The low-outlet stratification was less than 2/3 that of Test #6 at only 13.2 °C. The stratification period was similar in duration to that of Test #6, being less than one minute shorter for a nearly 47 minute period. The temperature curves, when compared to Test #4, appear smaller and somewhat distorted.

Even the chugging signatures in the data become much harder to discern; the operator's observations do not line up nearly as well with the sparger outlet temperatures and DP readings (Figure 47) as in other tests.

4.4.8 Test #8

Test #8 was a mid-power (107 kW) RCIC test under standard pressurization with 0.4 GPM of water injection into the main steam line – essentially a standard alignment test with water injection. The results show a somewhat diminished amount of thermal stratification in the Suppression Chamber when compared to the mid-power standard alignment test (Test #4).

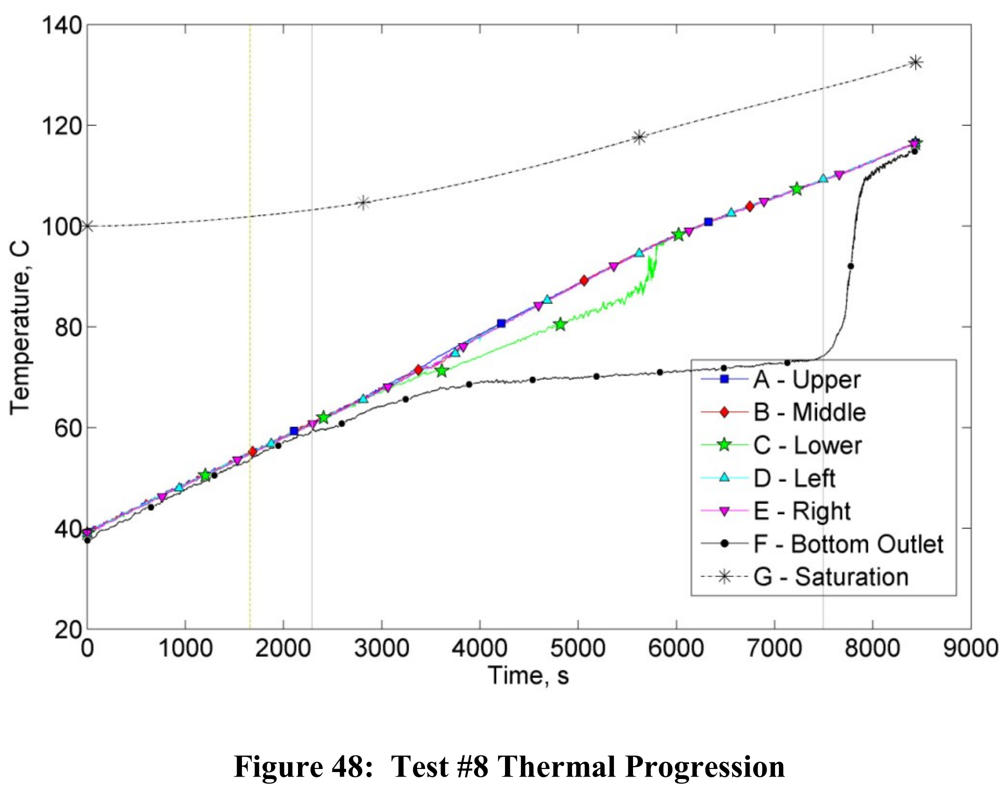

Figure 48: Test #8 Thermal Progression

Steam was injected at a rate of 45.5 ± 1.0 g/s. Feedwater was 44.9 ± 1.3 g/s, and water was injected into the steam line at 24.8 ± 1.1 g/s. This produced a steam quality of 0.59 ± 0.02, rising to 0.63 ± 0.02 past the orifice.

The resulting thermal stratification in the Suppression Chamber (Figure 48) was below that of Test #4, but was not orders of magnitude less. The top-mid difference peaked at 2.3 °C, while the low-outlet separation was limited to 36.8 °C. The mid-low stratification was the biggest change, both in absolute and relative terms, with a maximum of 11.7 °C (compare to 20.9 °C in Test #4). As with Test #7, the chugging regime was more difficult to distinguish in the recorded data than in the earlier tests. It should also be noted that the pool mid-level thermal profile, while stratified, did not have the same flattening out as displayed in Test #4 ca. 5000 seconds, but instead continued to trend upwards.

4.4.9 Test #9

Test #9 was the first of the pre-pressurized tests conducted, and was previously presented in [51]. It was a mid-power (107 kW) RCIC test, and other than the initial 14 psig of air pressure in the Suppression Chamber it was the same as the standard alignment. It proved challenging on the then-installed equipment, and even had to be terminated early due to reaching the casing pressure limit on the RCIC pump.

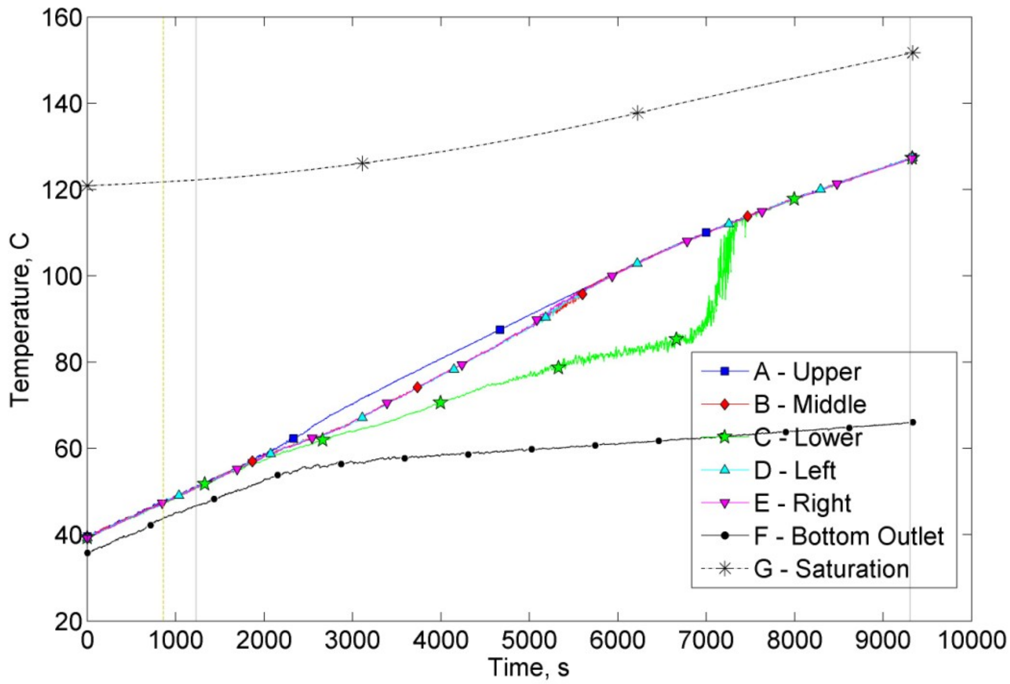

Figure 49: Test #9 Thermal Progression

Steam flow was maintained at 43.5 ± 1.1 g/s, and feedwater flowed at 43.4 ± 1.7 g/s. Over the course of nearly 156 minutes, the pool displayed a remarkable amount of thermal stratification; this is shown in Figure 49. The top-mid stratification peaked at a difference of 5.1 °C, and maintained a clear separation for approximately an hour. The mid-low stratification reached a 29.4 °C difference, the greatest at that location in the entire test series. The low-outlet separation, which was still growing at the termination of the test, reached 61.9 °C.

Not only did the pump outlet pressure limit the test, but it is likely that the relief valve on the line experienced some chattering. The relief's outlet line was observed to be warm to the touch several minutes before the termination of the test. However, the receiving blowdown drum's temperatures were not observed to be rising significantly; therefore, it is not believed much system inventory was lost through that route.

4.4.10 Test #10

Test #10 was a high-power (157 kW) pre-pressurized RCIC test. With 10 psig of initial air pressure, it behaved in manners similar to both Test #3 and Test #9. As with Test #9, high pump discharge pressures required early test termination.

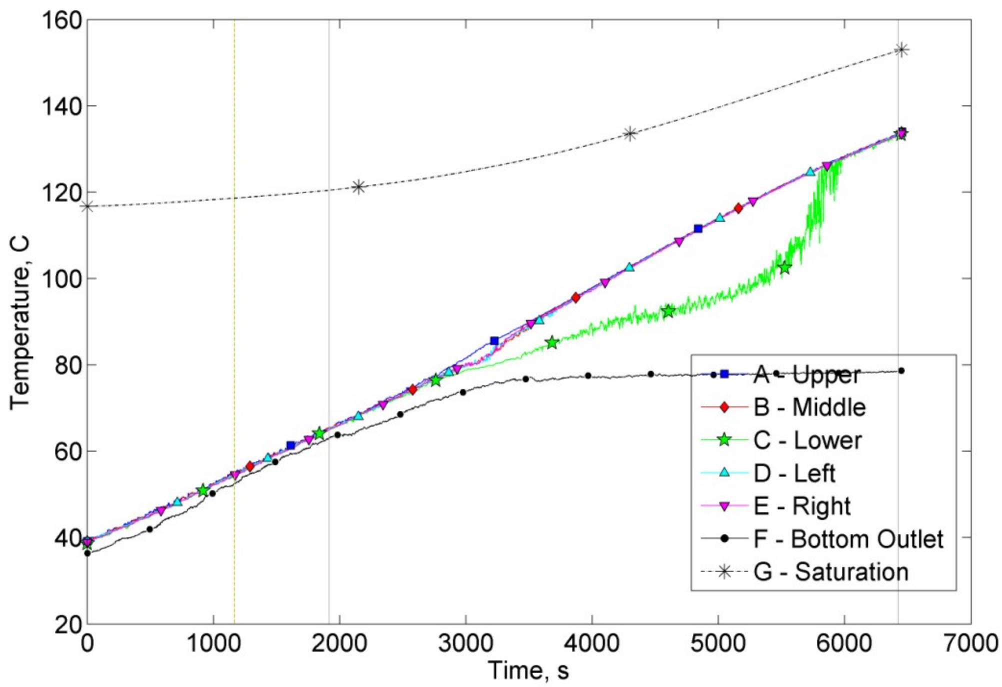

Figure 50: Test #10 Thermal Progression

The steam flowrate was 65.4 ± 3.2 g/s, and feedwater flowed at 64.2 ± 8.5 g/s. Unlike Test #9, which maintained steam generator pressures in the mid to upper 70s psia until late in the test when it was necessary to allow it to rise to provide adequate flow and superheat in the vortex flowmeter, the steam generator pressure was maintained above 100 psia for most of the test. In addition, early steam flowrates tended to be slightly low as operators slowly worked towards a stable pressure and flow envelope for the entire loop.

The thermal stratification limits in the Suppression Chamber (see Figure 50) were similar to that seen in Test #9. The top-mid difference had a maximum of 4.0 °C, and the mid-low separation reached 29.0 °C. Unlike Test #9, the top-mid profiles did not have such a clear lengthy separation. Similar to Test #9, the low-out stratification was still increasing in intensity at the end of the test, at which point it has reached a difference of 55.0 °C.

4.4.11 Test #11

Test #11 was a mid-power (107 kW) pre-pressurized (15 psig) RCIC test with 0.4 GPM of water injection to the steam line. It was an operationally challenging test, and the first to use the enhanced pump recirculation flow lines (allowing greater flow through the pump to limit the discharge pressure). By the end of the test, much of the equipment was at or fast approaching limiting operational conditions (steam generator, Suppression Chamber, pump discharge). As a result, while the limits of thermal stratification were found, full destratification in the Suppression Chamber was not complete at test termination.

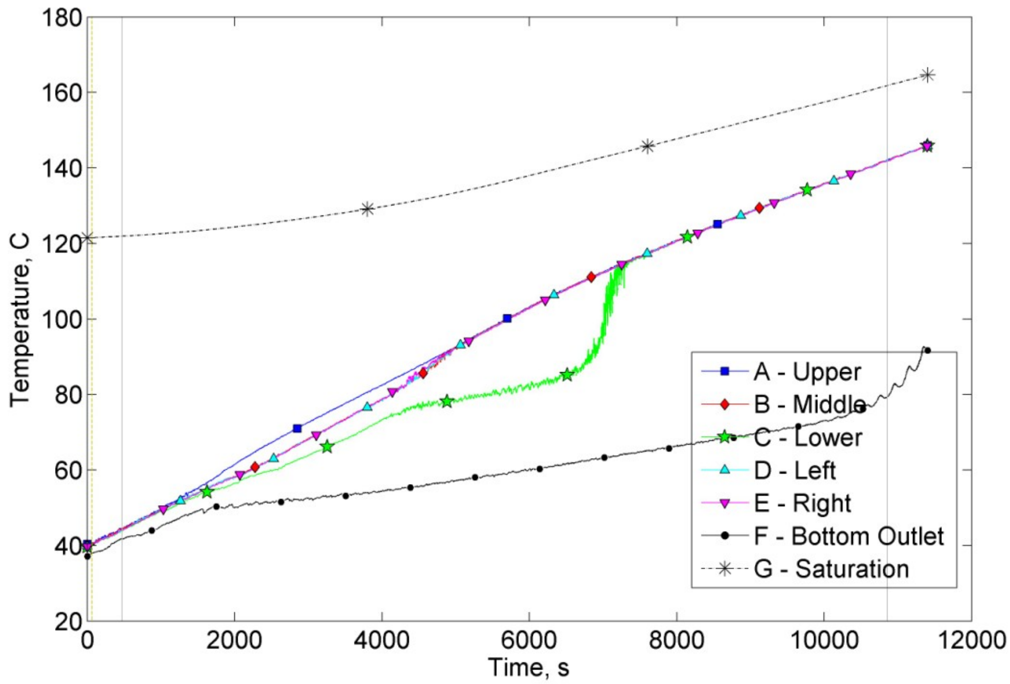

Figure 51: Test #11 Thermal Progression

Steam generator pressures were kept well above 100 psia for the test duration, rising above 120 psia at the very end as needed. For comparison, the Suppression Chamber rose to 100.7 psia at the end – barely 2 psi below the relief valve set point, and its greatest pressure in these tests. This maintained steamflows of 43.7 ± 1.0 g/s while feedwater was 43.1 ± 1.9 g/s. The water injection to the steam line was 24.9 ± 1.5 g/s. The resulting steam quality was 0.57 ± 0.02, rising to 0.59 ± 0.02 post-orifice.

As with the other pre-pressurized RCIC tests, the thermal stratification in this test was severe; this is revealed in Figure 51. The top-mid differences peaked at 5.6 °C, the greatest in these tests at that location. The mid-low stratification reached 28.9 °C, also one of the highest values recorded at its location. The low-outlet stratification hit its maximum with a difference of 65.1 °C – not only the maximum recorded for this location, but the maximum one-level separation overall in the entire collection of these tests.

4.4.12 Test #12

Test #12 was a mid-power, moderately pre-pressurized (5 psig) RCIC test – essentially Test #9 with lower start pressurization and abilities to operate the pump longer. It was also documented previously in [51]. In addition, due to the significant fraction of time that the pump discharge pressure monitor was out-of-range high in previous tests, it was upgraded to a higher pressure monitor and the original was instead moved to the pump inlet. This allowed operators better monitoring at the DAQ station of a parameter that had been shown to be limiting for system operation without traveling to the readout gauge.

Flowrates were 44.7 ± 0.8 g/s for steam and 43.7 ± 1.8 g/s for feedwater. As with other pre-pressurized tests, equipment limitations played a major role in the test termination. While it did run to completion, and the destratification was mostly complete, it was not fully complete. The test was terminated when the pump suction temperature approached the thermal limit for the upgraded Viton seal.

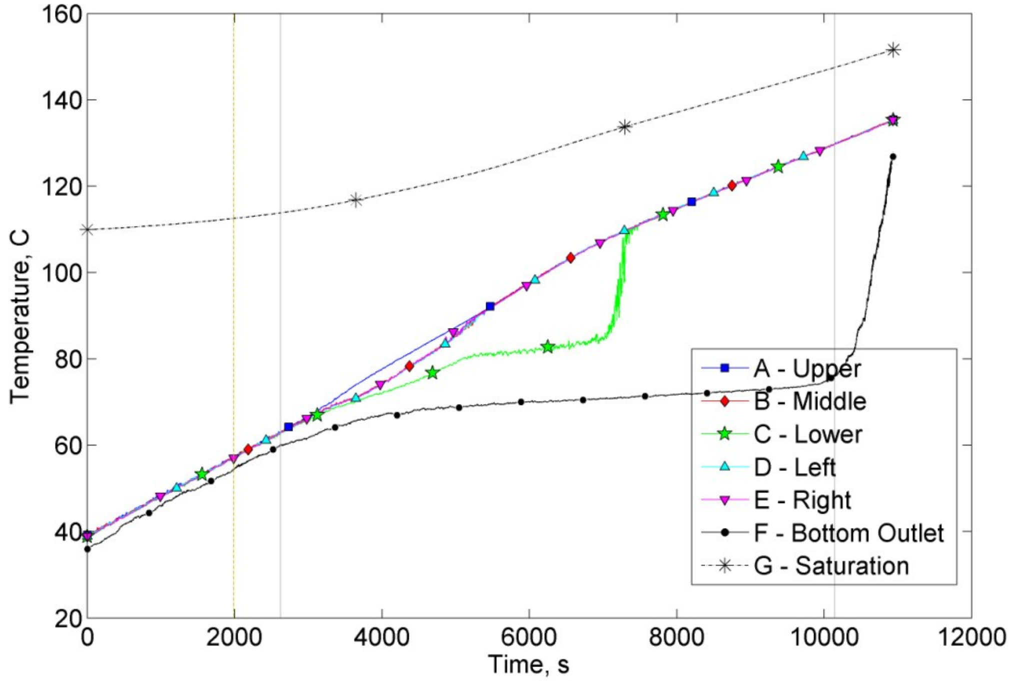

Figure 52: Test #12 Thermal Progression

Thermal stratification in the Suppression Chamber was severe (shown in Figure 52), although not as severe as in other pre-pressurized tests. The top-mid separation reached 4.1 °C, and the mid-low difference peaked at 26.9 °C. At 55.9 °C, the low-outlet stratification limit was well above most other tests.

4.4.13 Test #13

Test #13 was a high-power (157 kW) RCIC test with 0.6 GPM of water injection and standard pressurization – a version of Test #3 with water injection into the steam line. As tended to be the case with other high-power tests with atmospheric pressure in the Suppression Chamber at some point during operation, control was difficult for operators to maintain. In fact, the first attempt at this test went unstable (unable to balance steamflow with feedwater) and the test had to be aborted at the beginning. The second attempt, however, was successful in collecting data. As a result of the operational demands, superheat in the vortex flowmeter was more limited than in other tests.

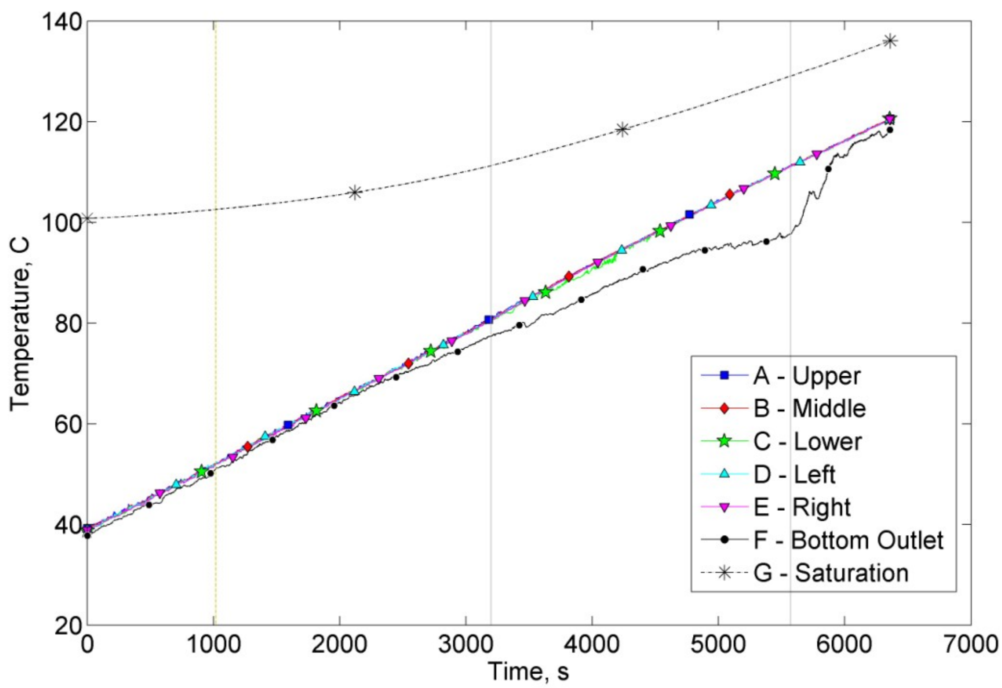

Figure 53: Test #13 Thermal Progression

Steam flow was 66.3 ± 2.9 g/s, and feedwater was maintained at 65.9 ± 5.1 g/s. Water injection to the steam line was was 37.2 ± 2.6 g/s. This produced steam qualities of 0.58 ± 0.03, increasing to 0.63 ± 0.02 downstream of the orifice.

Thermal stratification in this test, depicted in Figure 53, was more limited than in a number of other RCIC tests. The peak top-mid difference was 2.2 °C, while the maximum mid-low separation was only 1.9 °C. The low-outlet stratification was limited to 15.4 °C, a far cry from the 65.1 °C seen in Test #11.

4.4.14 Test #14

Test #14 was a full-power (157 kW) atmospheric RCIC test with no water injection into the steam line. Due to the number of tests terminated early by equipment limitations, revisions were made to the data acquisition software for this and subsequent tests to notify operators when certain limits are close, and to sound an alarm if conditions get too close to said limits.

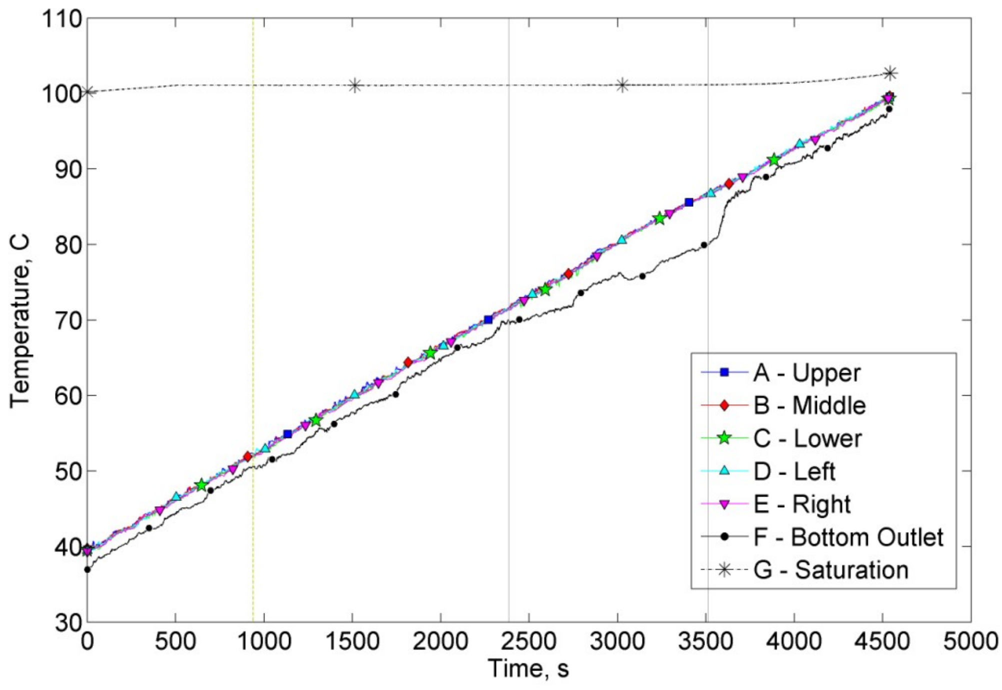

Figure 54: Test #14 Thermal Progression

Steam flow ran at 66.8 ± 2.0 g/s. Feedwater was 65.2 ± 10.6 g/s; as with the other high-power tests, this test was more difficult to keep stable than the mid-power ones. Over the course of this (more than 75-minute) test, pressures in the Suppression Chamber were nearly constant at atmospheric.

The thermal stratification developed in this test, shown in Figure 54, was some of the weakest developed in all of the RCIC tests. Top-mid separation was limited to 2.2 °C, and the mid-low numbers were even less at just 1.5 °C. Even the low-outlet values had a relatively small peak separation, being just 9.1 °C. The profiles themselves were not only weak, the outlet temperature meandered more so than in other tests. It did not develop the clean flattening profile seen in the standard alignment runs.

4.4.15 Test #15

Test #15 was a mid-power (107 kW) standard pressurization SRV test. Over the course of its nearly 135 minute run, no major consistent thermal stratification profile was detected.

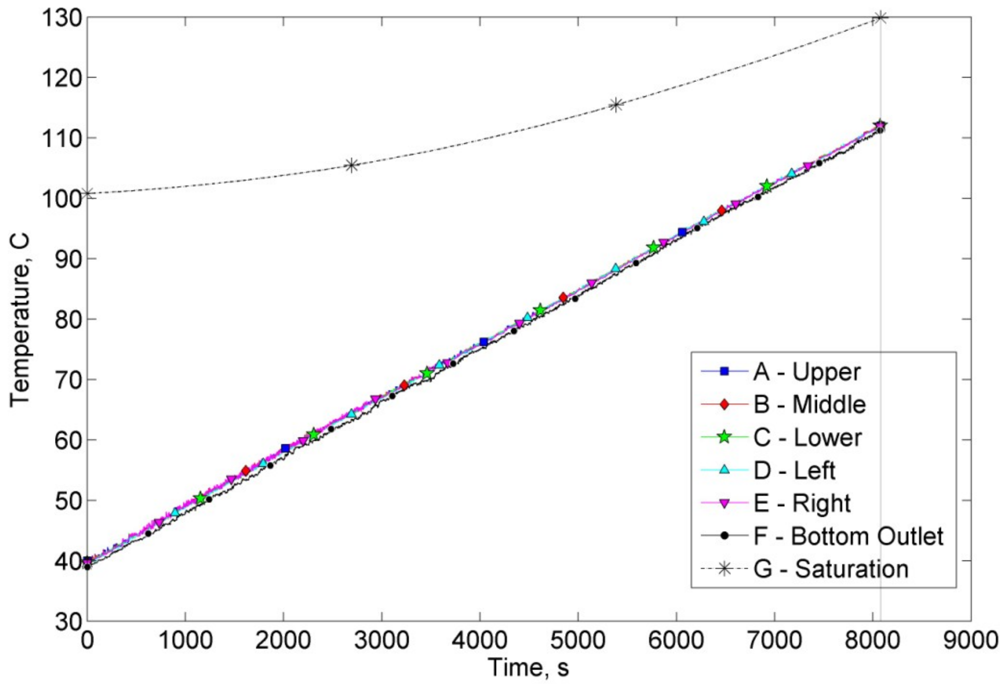

Figure 55: Test #15 Thermal Progression

Steam flowrates were 45.7 ± 1.6 g/s. Feedwater was maintained at 45.6 ± 1.7 g/s.

While a major stratification profile was not detected (see Figure 55), there were still detectable differences in the measured temperatures at different pool elevations. The top-mid difference was limited to 2.3 °C, and the mid-low differences peaked at 2.1 °C. This test had the weakest low-outlet temperature separation at that level for the entire test series, with a maximum of only 4.1 °C.

4.4.16 Test #16

Test #16 was a pre-pressurized SRV test at mid-power (107 kW). It was much the same as Test #15, with the notable exception of starting at 15 psig. An operational error in the first attempt to run this test resulted in termination at the beginning of the first attempt; after cooling, a second attempt was able to complete successfully.

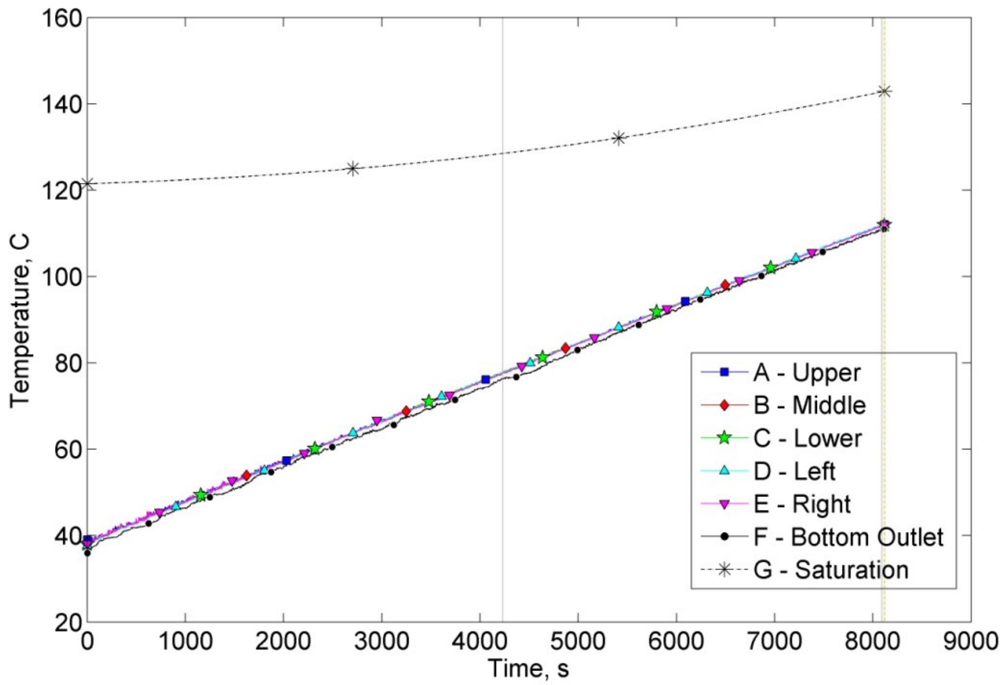

Figure 56: Test #16 Thermal Progression

The test ran for a period of more than 135 minutes. The steam flowrate was 45.5 ± 1.2 g/s, and the feedwater flowrate was 45.4 ± 1.8 g/s.

The stratification detection routines report a stratification period for nearly half the test. Indeed, the outlet temperatures do appear to be measurably lower than those of the higher elevations as depicted in Figure 56. However, they also fluctuate more and are not far below the higher elevation temperatures, making detection problematic. The detected stratification here may be more of an issue with heat loss at the vessel outlet than inhomogeneous thermal deposition. The top-mid and mid-low differences peaked at 2.4 and 3 °C, respectively; the low-outlet difference reached a maximum of 5.5 °C.

4.4.17 Test #17

Test #17, much like Test #15, was a mid-power (107 kW) standard pressurization SRV test. Unlike #15, this test included water injection into the steam line at a target rate of 0.4 GPM. It remained well mixed, as demonstrated by Figure 57.

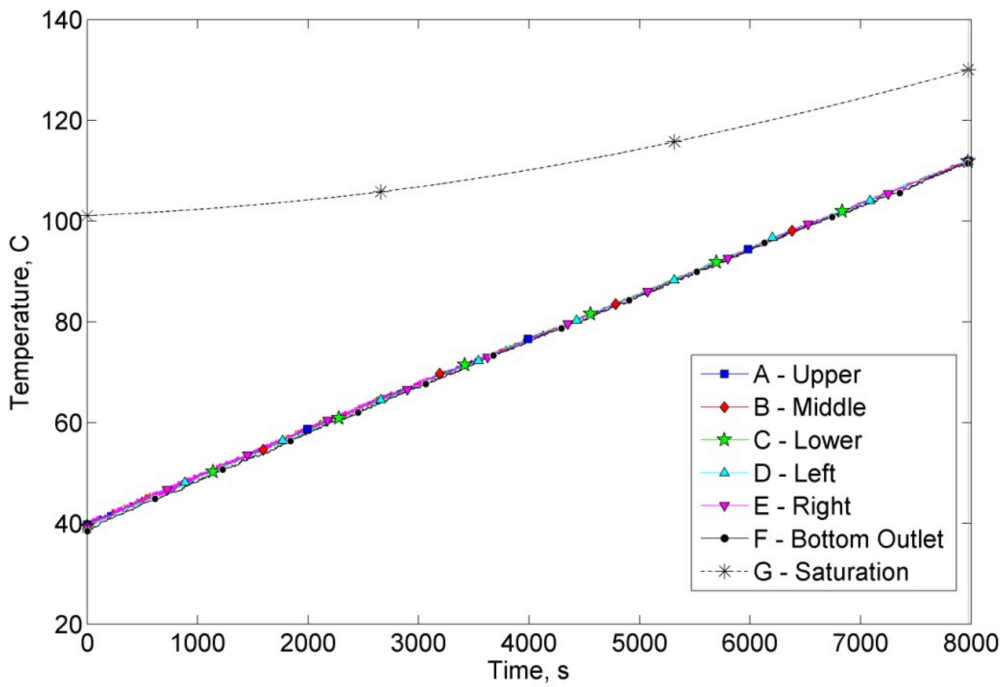

Figure 57: Test #17 Thermal Progression

This test was less than two minutes shorter than Test #15, finishing just short of 133 minutes. It had a steam flowrate of 45.4 ± 1.6 g/s, and feedwater flowed at 45.4 ±

1.9 g/s. Water was injected into the steamline at 25.3 ± 1.4 g/s, producing a quality of 0.62 ± 0.02.

The peak thermal differences in this test were almost identical to those of Test #15, although their times in the test were different. The top-mid and mid-low differences were 2.2 and 2.1 °C (compare to 2.3 and 2.1 °C in Test #15), respectively. The peak low-outlet difference was 4.2 °C (Test #15 showed 4.1 °C).

4.4.18 Test #18

Test #18 a bit of a cross between Test #8 and Test #12. It was a mid-power (107 kW), somewhat pre-pressurized (5 psig) RCIC test with 0.4 GPM water injection into the steam line. As was the case for several other tests, this test was terminated before full destratification was complete to keep the pump's seal within its thermal limits.

Steam flowed at 44.4 ± 0.8 g/s, and feedwater ran at 44.8 ± 1.6 g/s. The water injection rate was 25.3 ± 1.0 g/s, producing qualities of 0.58 ± 0.01 (0.60 ± 0.02 past the orifice). As with other water-injected RCIC tests, the whole chugging period is difficult to identify from instrument data alone.

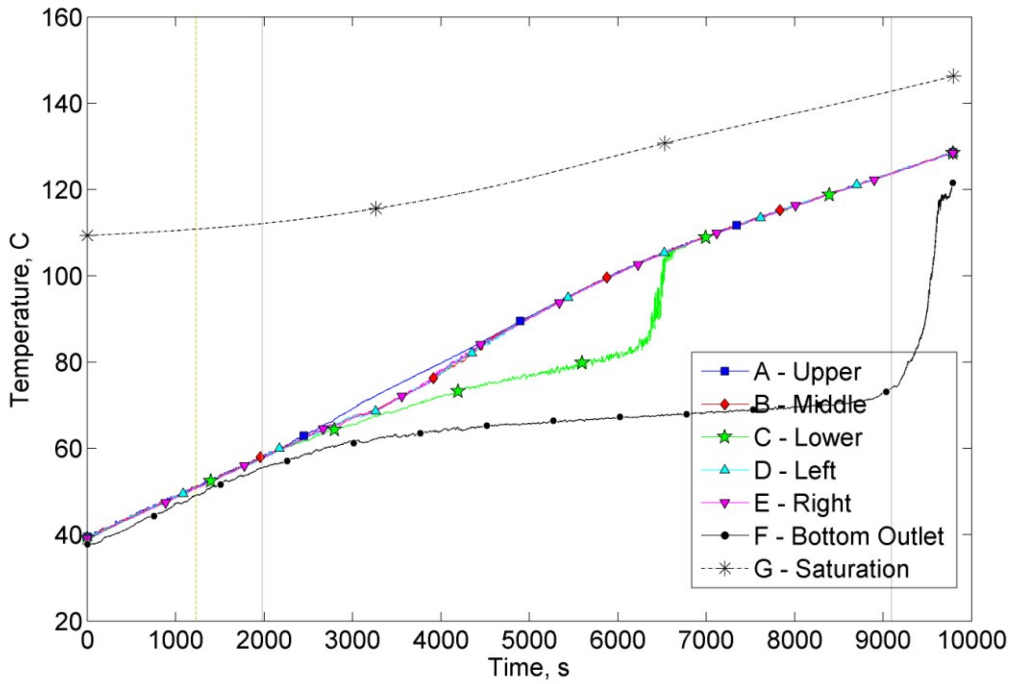

Figure 58: Test #18 Thermal Progression

The thermal profile for this test (Figure 58) followed that of Test #12 more than that of Test #8. The top-mid difference was limited to 3.7 °C. The mid-low and low-outlet separations peaked at 25.5 and 52.6 °C, respectively; these were much closer to Test #12's 26.9 and 55.9 °C than to Test #8's 11.7 and 36.8 °C.

4.4.19 Test #19

Test #19 was another pre-pressurized RCIC test with water injection. In this case, the test ran at full power (157 kW) with 0.6 GPM of water injection into the steam, and had the Suppression Chamber pre-pressurized to 10 psig. Similar in nature to Test #11, the necessary pressures in the steam generator were relatively high; they ran above 100 psia for most of the test, and finished well above 120 psia – at which point the reliefs on the steam generator, while not lifted, were noticeably leaking steam. Destratification, while detected, once again could not go through to completion in order to protect the pump seal.

Over the course of this nearly 140-minute test, the Suppression Chamber pressure rose to 95.6 psia – the second highest termination pressure in these tests. Steam flowed at 66.4 ± 2.8 g/s, and feedwater fed the steam generator at 65.7 ± 3.3 g/s. Water injection into the steam at 37.4 ± 1.2 g/s produced a quality of 0.58 ± 0.02, which rises to 0.61 ± 0.02 past the orifice.

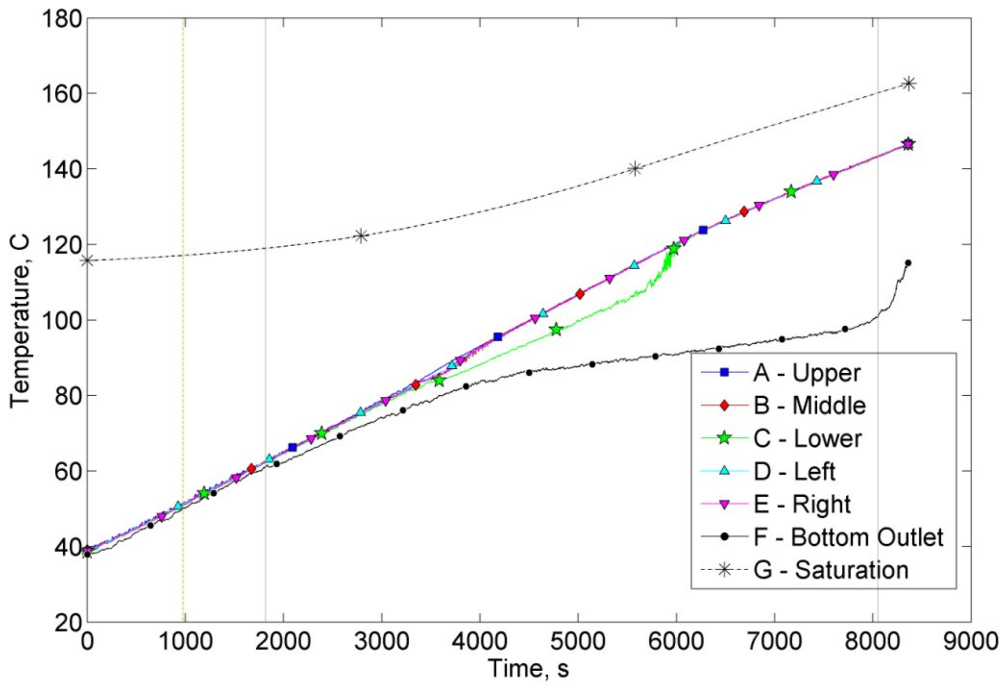

Figure 59: Test #19 Thermal Progression

The stratification profile (Figure 59) did not flatten out as much as in other tests; rather, temperatures separated but kept increasing (albeit at slower rates) as was seen in other water injection tests. The degree of stratification was also lower than seen in other pre-pressurized tests. The top-mid difference was limited to 2.7 °C, and the mid-low values peaked at 12.0 °C. While not small, the maximum low-outlet separation of 44.4 °C here was still only around 2/3 the largest value in these tests.

4.4.20 Test #20

Test #20 was a low-power (57 kW) atmospheric RCIC test with no water injection to the steam line. It ran for nearly 217 minutes.

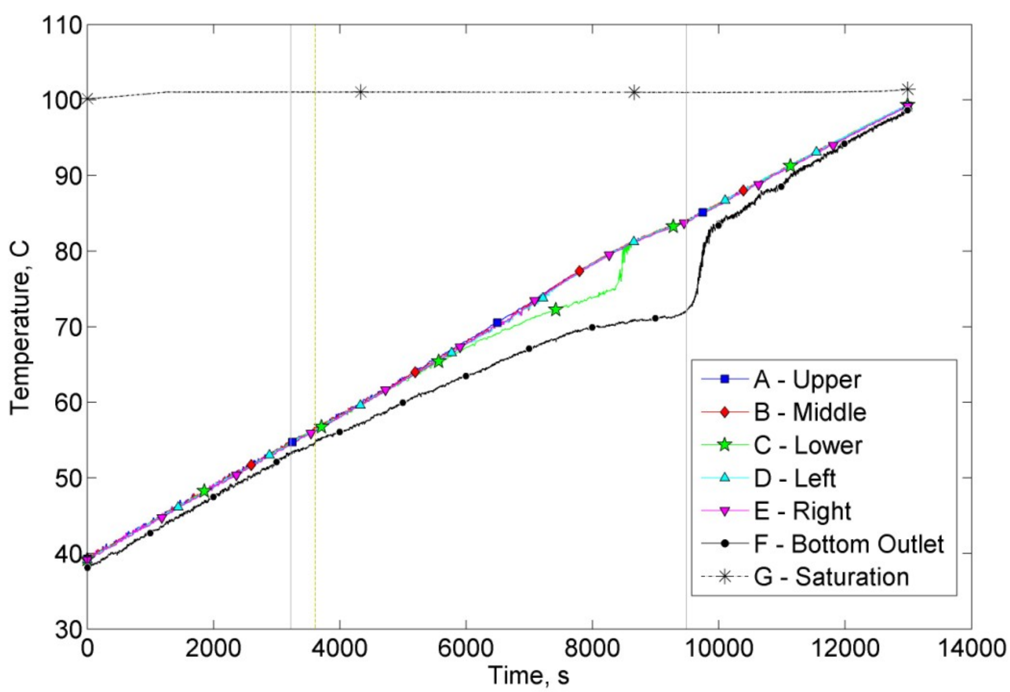

Figure 60: Test #20 Thermal Progression

Steam flowed at 23.9 ± 0.8 g/s, and feedwater to the steam generator ran at 23.5 ± 1.1 g/s. The resulting stratification, shown in Figure 60, was weaker than in many other tests, consistent with the low power and atmospheric conditions. The top-mid profile only saw a peak separation of 1.6 °C, and the mid-low stratification was limited to 5.8 °C. The low-outlet stratification reached a maximum of only 14.0 °C, one of the smaller values in the RCIC tests.

4.4.21 Test #21

Test #21 was a low-power (57 kW) RCIC test with standard pressurization and 0.2 GPM water injection into the steam line. This test was akin to Test #2 with the addition of water injection to the steam. The test ran for more than 265 minutes, well beyond the point of full thermal destratification in the Suppression Chamber.

Steam flowed at 23.8 ± 0.8 g/s, and feedwater sent 23.2 ± 0.9 g/s back to the steam generator. With 12.5 ± 0.4 g/s of water injection into the steam line, the quality was maintained at 0.62 ± 0.02. This rose to 0.63 ± 0.01 downstream of the orifice.

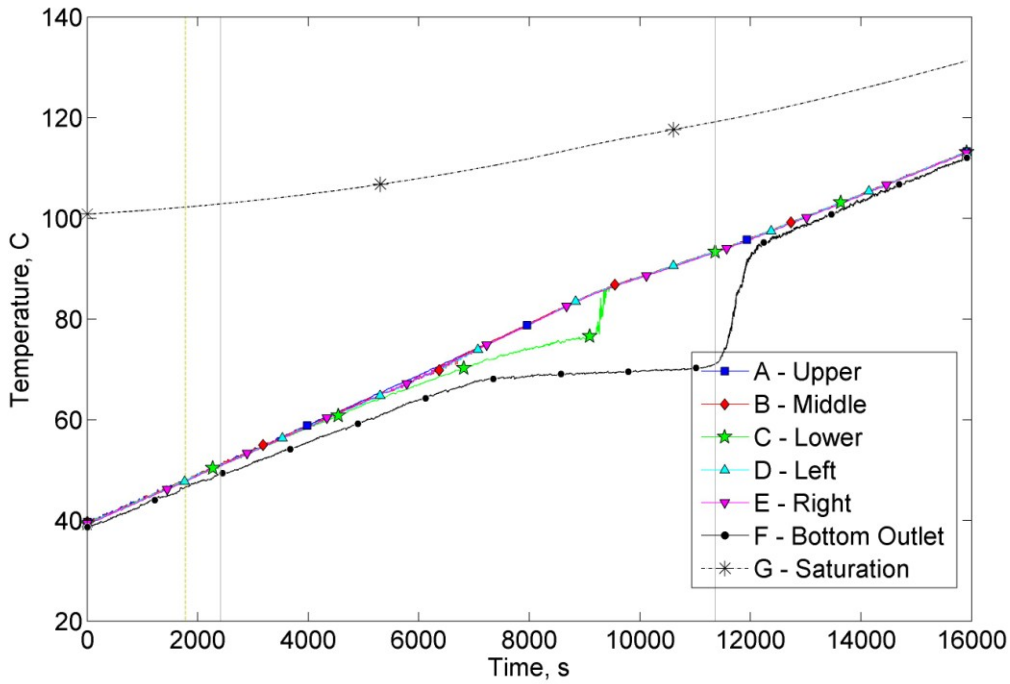

Figure 61: Test #21 Thermal Progression

Interestingly, the resulting thermal stratification in the Suppression Chamber (see Figure 61) tended to be greater than that of Test #2 (although not much greater, and was similar to the results from Test #1). The top-mid separation was 1.5 °C. The mid-low difference peaked at 10.6 °C, on par with the 10.8 °C of Test #1 and more than the 9.3 °C of Test #2. The peak low-outlet stratification was 23.9 °C, more than the 22.6 °C of Test #2; Test #1 terminated before a fully comparable limit was found (terminated at 20.7 °C).

4.4.22 Test #22

Test #22 was a low-power (57 kW) pre-pressurized (5 psig) RCIC test with no water injection to the steam line. At nearly 271 minutes, it was one of the longest tests performed; the thermal profile is shown in Figure 62.

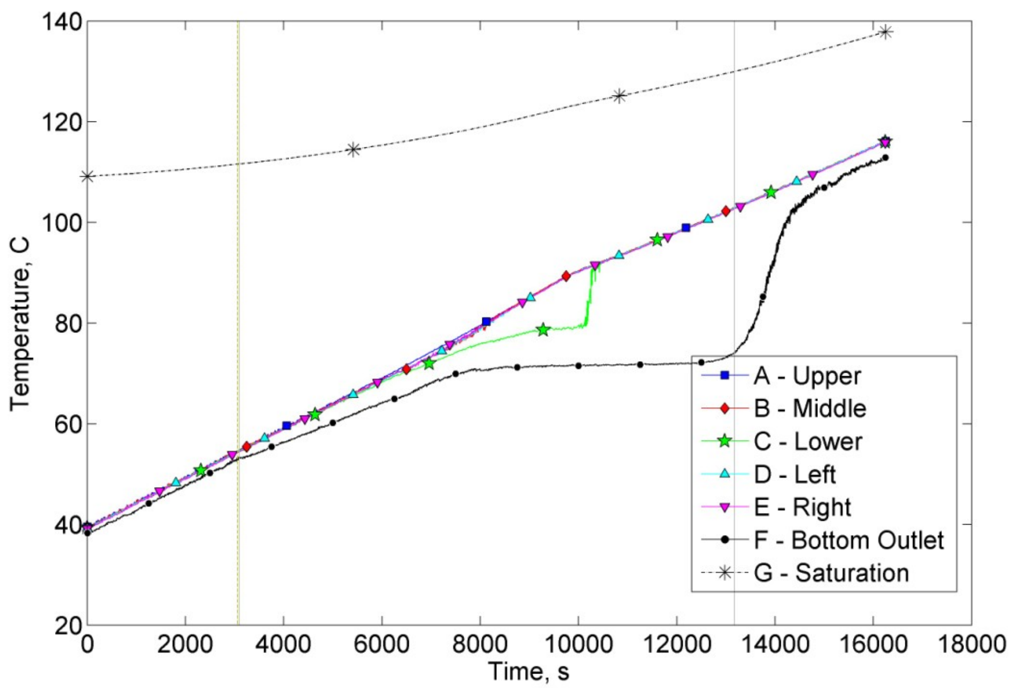

Figure 62: Test #22 Thermal Progression

Steam flowed through the RCIC Sparger at 23.7 ± 0.6 g/s, and feedwater flowed back to the steam generator at 23.5 ± 0.9 g/s. As was the case with other pre-pressurized tests, the resulting thermal stratification in the Suppression Chamber was greater than in the comparable test without pre-pressurization (here, Test #2).

While the stratification limit for the top-mid region had an insignificant difference between this test and Test #2 (1.7 °C here vs. 1.4 °C in Test #2), the lower regions did show greater stratification. The mid-low difference peaked at 13.2 °C, measurably more than the 9.3 °C of Test #2, and the low-outlet separation reached 30.7 °C (more than 8 °C greater than the 22.6 °C of Test #2).

4.4.23 Test #23

Test #23 (profiled in Figure 63) was a low-power (57 kW) pre-pressurized (5 psig) RCIC test with 0.2 GPM water injection into the steam line. It was essentially Test #22 with the addition of water injection, and ran for almost the same amount of time; it was just two minutes shorter.

The steam flowrate was 23.3 ± 0.5 g/s, and feedwater flowed at 22.9 ± 1.2 g/s. The water injection rate to the steam line was 12.5 ± 0.4 g/s, resulting in a steam quality of 0.61 ± 0.01. Downstream of the orifice, this became 0.62 ± 0.01.

As was the case with Test #21, the addition of water injection into the steam line seemed to increase the degree of thermal stratification in the Suppression Chamber when compared to a similar water-injection free test (here, Test #22). This appears to be limited to low power tests; higher power levels appeared to experience the opposite.

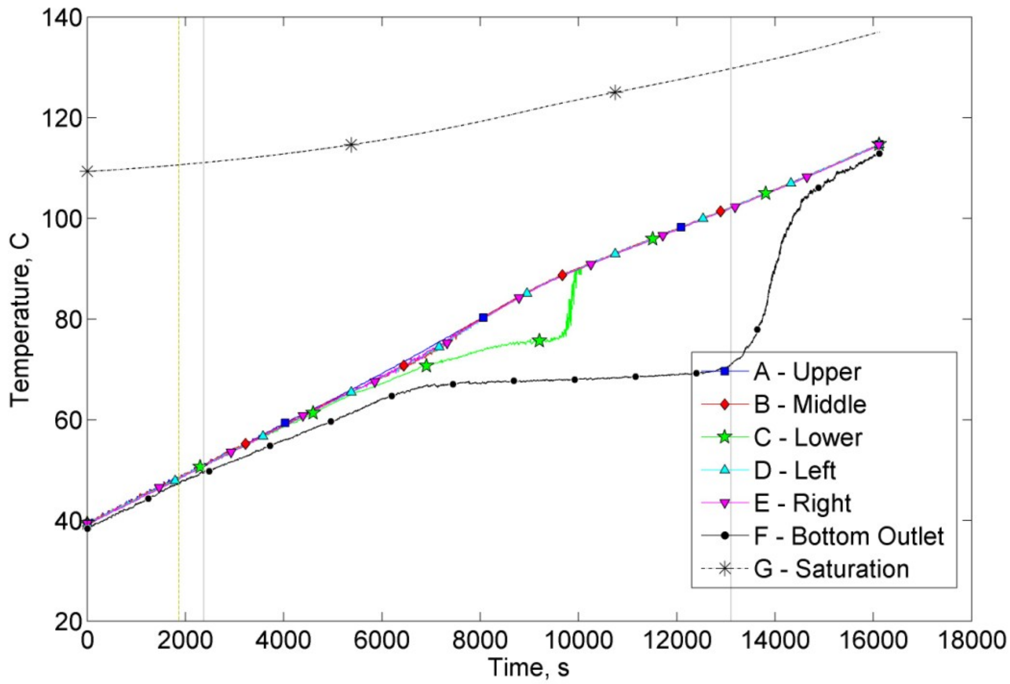

Figure 63: Test #23 Thermal Progression

The peak difference for the top-mid levels was 1.8 °C, not significantly greater than the 1.7 °C of Test #22. The 14.4 °C separation at the mid-lower level was greater than the 13.2 °C at that level in Test #22, but not by much. The greatest increase was seen in the low-outlet region, which experienced up to 32.9 °C of separation; this was a 2.2 °C (~7%) increase from the 30.7 °C of Test #22.

4.4.24 Test #24

Test #24 was the first of two tests (the other being Test #26) which investigated the effects of a simple venting operation. In this test, a mid-power (107 kW) RCIC test with no water injection to the steam line started out with the Suppression Chamber pre-pressurized to 15 psig. Then, when temperatures in the upper middle of the pool (SP 11) were greater than 86 °C, operators opened a vent line from the vapor space and let the Suppression Chamber blow down to near atmospheric pressure. At that point (Thermocouple SP11 ~ 89 °C), the vent line was closed and the Suppression Chamber re-isolated from the outside atmosphere; pressure once again began to rise through the final end of the test.

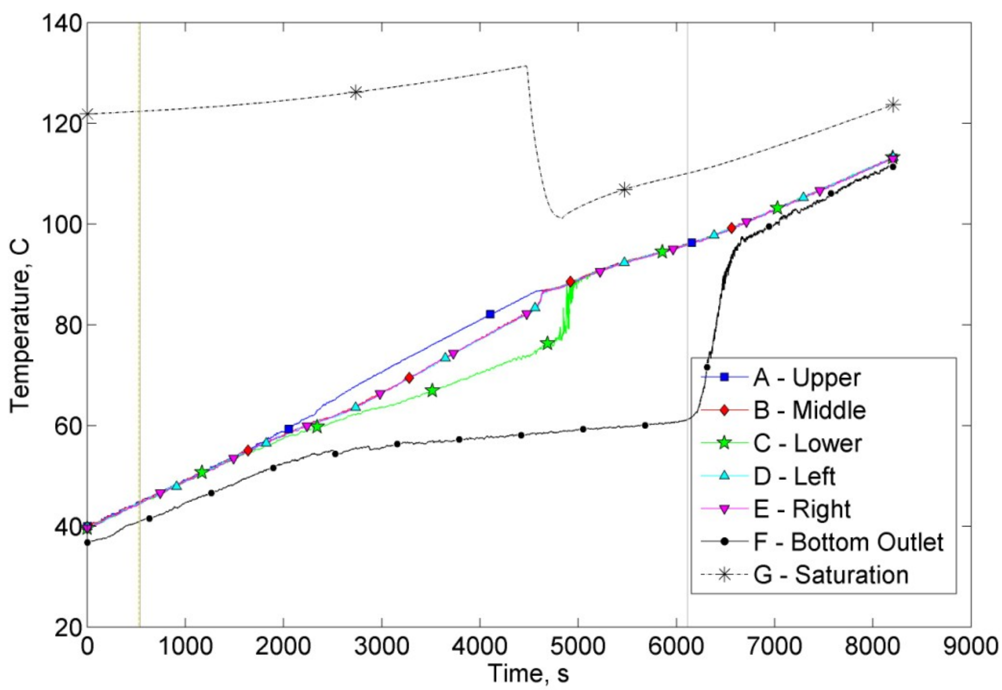

Figure 64: Test #24 Thermal Progression

The steam flow was maintained at 44.8 ± 1.3 g/s, and feedwater was 44.0 ± 1.8 g/s. The initial stratification profile developed as it had in the pre-pressurization case of Test #9. The peak top-mid level stratification was found to be 5.1 °C, the same as in Test #9. It was not impacted by the venting, as venting did not occur until about 21 minutes after the peak had passed. However, there was still significant stratifcation at that level when the venting occurred, and during venting (the sudden drop in saturation temperature in Figure 64) the difference suddenly and rapidly disappeared.

Similarly, the mid-low thermal stratification appears to have been strongly impacted by the venting procedure. Shortly after the end of the operation, the lower level temperatures jumped up to those of the upper levels. The peak stratification was then 14.6 °C, falling between the fully vented case (Test #6, 5.9 °C) and the standard alignment (Test #4, 20.9 °C). This was reflected in the low-outlet profiles as well, which produced a maximum difference of 36.6 °C, closer to Test #4's 43.3 °C than to Test #6's 21.0 °C.

4.4.25 Test #25

Test #25 ws a low-power (57 kW) standard pressurization SRV test. It was also the last SRV test performed, and ran for more than 282 minutes.

The test had a steam flowrate of 23.9 ± 0.9 g/s, and feedwater was at 23.7 ± 1.1 g/s. The thermal profile in the Suppression Chamber was, as with the other SRV tests, largely well-mixed as depicted in Figure 65. The top-mid levels showed a peak separation of 1.9 °C, and the mid-low levels kept within 2.3 °C. The outlet temperatures did tend to lag behind the rest of the Suppression Chamber; the maximum difference was 4.4 °C, but the profile itself triggered the stratification detection algorithm.

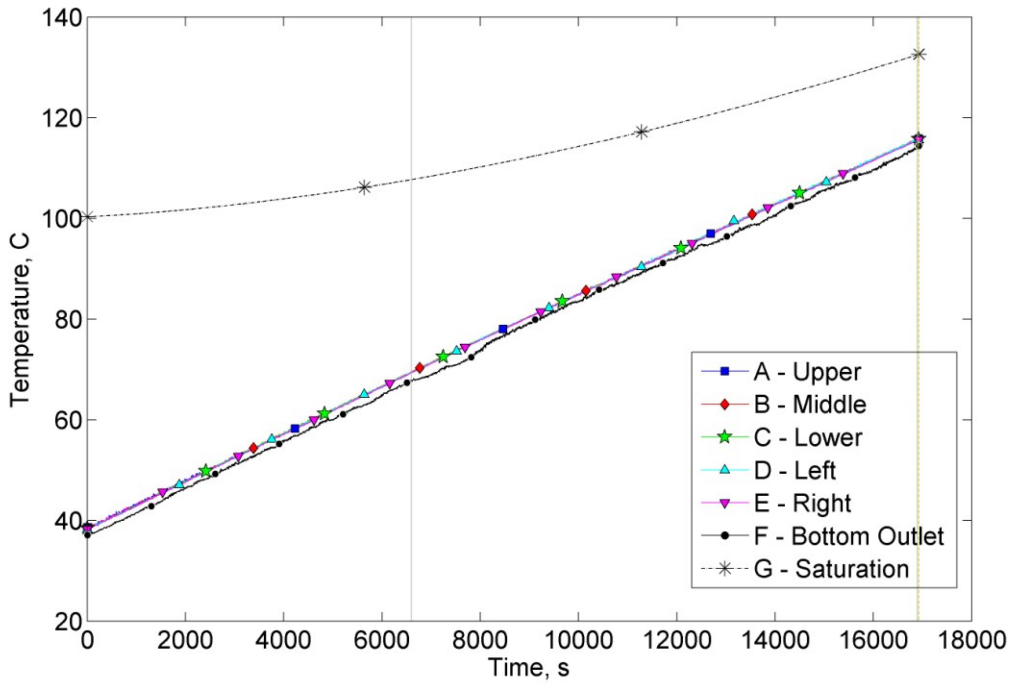

Figure 65: Test #25 Thermal Progression

4.4.26 Test #26

Test #26 was, in a manner not completely unlike Test #24, a venting procedure RCIC test. However, in this test the vent was initially open, and then closed partway through the test. As a result, the early portion of the test was essentially identical to the fully-vented mid-power case (Test #6). When the temperature from SP 11 registered 82 °C, however, the vent was closed and the Suppression Chamber subsequently began to pressurize (note the change in behavior for the saturation temperature in Figure 66); this was maintained through the end of the test. This test ran at mid-power (107 kW) for more than 143 minutes, and had no water injection into the steam line.

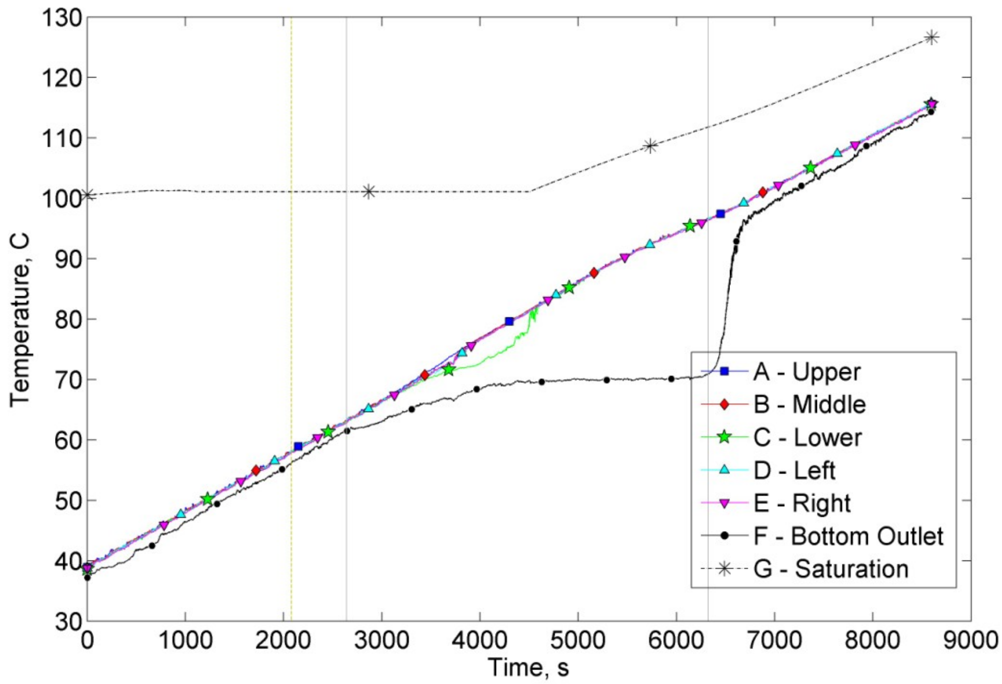

Figure 66: Test #26 Thermal Progression

The steam flowrate was 45.6 ± 1.3 g/s, and the feedwater flowed at 44.7 ± 1.6 g/s. Up to the vent closure, this test produced results in line with those of Test #6, and the timings were within a few short minutes for the major features. Here, both the top-mid and mid-low peak thermal stratification occurred before vent closure, producing separations of 2.2 °C and 5.8 °C, respectively. The values, in order, from Test # 6 were 2.4 °C and 5.9 °C.

The low-outlet stratification limit, however, occurred in Test #6 after more than 87 minutes; the vent closure in this test occurred near the 75-minute mark, and all subsequent data should reflect the influence of the vent closure. The low-outlet stratification reached a greater limit at 27.7 °C here vs. the 21.0 °C seen in Test #6, and occurred at the 105 minute mark.

4.4.27 Test #27

Test #27 was a mid-power (107 kW) standard pressurization RCIC test with extra water injection to the steam line (0.8 GPM). It was similar to Test #8, except with a greater water injection to steam flowrate (0.8 vs 0.4 GPM). It was also the final test performed in the NRC testing program.

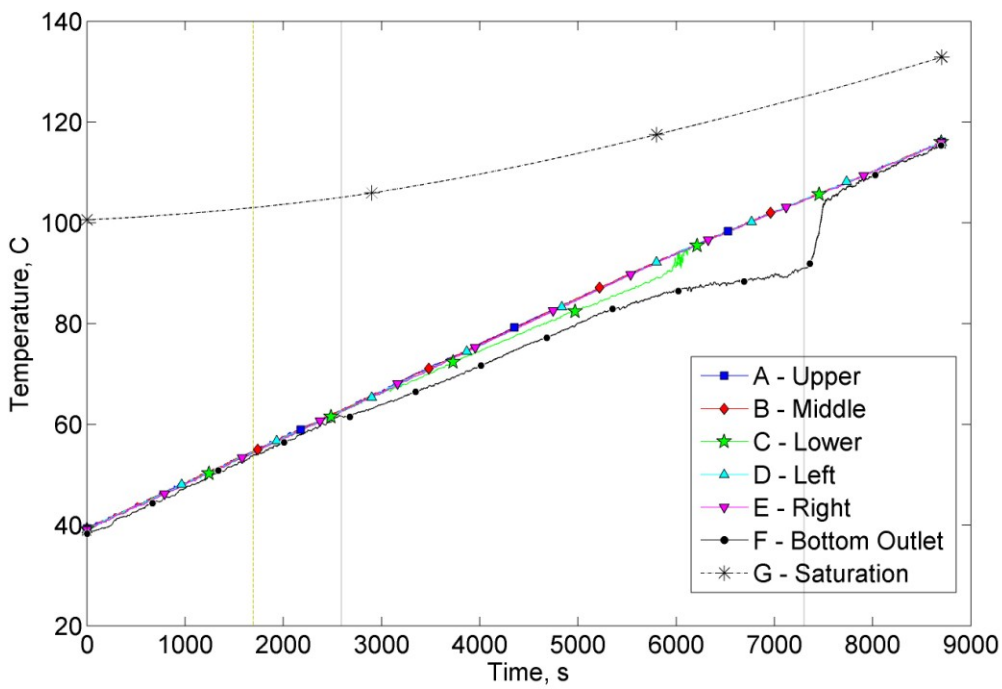

Figure 67: Test #27 Thermal Progression

Steam was kept to a flowrate of 44.8 ± 1.5 g/s, and feedwater flowed at 44.4 ± 1.6 g/s. With water injected to the steam line at 49.9 ± 1.6 g/s, the steam quality was lower than most other tests at 0.40 ± 0.03 (0.44 ± 0.02 past the orifice).

As was the case with other water-injected tests, the resulting thermal stratification profiles (Figure 67) did not flatten out as much as in the non-injected cases. In this test, the thermal stratification was more limited than the less-injected case (Test #8), and much more so than in the non-injected case (Test #4). The top-mid separation peaked at 1.7 °C here, reduced from the 2.3 °C in Test #8 and the 3.1 °C from Test #4. Similarly, the mid-low difference was 3.7 °C vs. the 11.7 °C and 20.9 °C of Tests #8 and #4, respectively. The diminished peak separation for the low-outlet temperatures was similarly significant, dropping to 15.7 °C from 36.8 °C in Test #8 and 43.3 °C in Test #4.

4.4.28 Test #28

Test #28 was the first of two constant 2-atm pre-pressurized RCIC tests performed. For this test, the vent line on the Suppression Chamber normally connected from the block valve to the blowdown drum was instead reconnected from the block valve to a backpressure regulator; after charging the Suppression Chamber with 15 psig of air, the regulator was carefully adjusted as necessary to maintain as constant as achievable the pressure in the Suppression Chamber.

This test was notable for starting at a much lower temperature than the earlier tests, and the test period began at 30 °C rather than the normal 40 °C (significant extra cooldown time permitted a cooler start temperature); this permitted the mid-power (107 kW) test to run for more than 170 minutes until temperatures approached saturation (demonstrated in Figure 68). There was no water injection into the steam line.

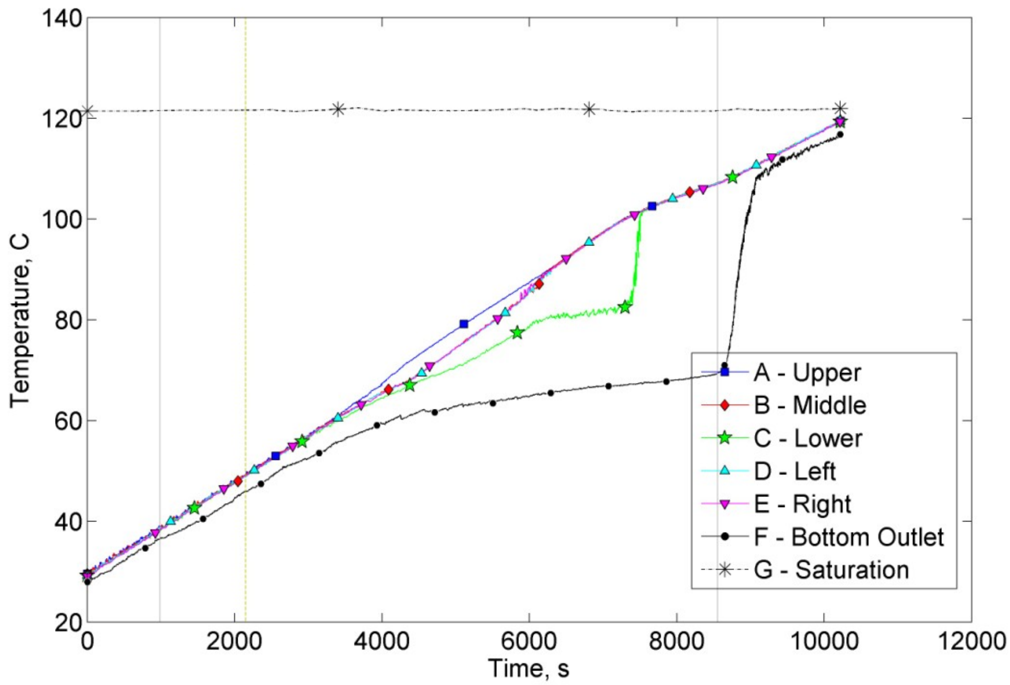

Figure 68: Test #28 Thermal Progression

The steam flow was maintained at 44.6 ± 1.5 g/s, and feedwater was sent to the steam generator at 43.9 ± 1.6 g/s. This produced a peak top-mid stratification of 4.5 °C, and a mid-low separation of 21.0 °C. The peak low-outlet difference was 39.6 °C.

4.4.29 Test #29

Test #29 was the second of two constant-pressure (2 atm) pre-pressurized RCIC tests. The vent line was arranged as in Test #28. The primary difference between this test and Test #28 was that this test used 0.4 GPM of water injection into the steam line.

In addition, early stages of work on another experimental facility at the lab (where the steam generator is a common component) may have slightly increased heat losses from the steam generator's steam piping. The start point was also lower than that of the standard tests, being 35 °C (40 °C in a standard test, 30 °C in Test #28).

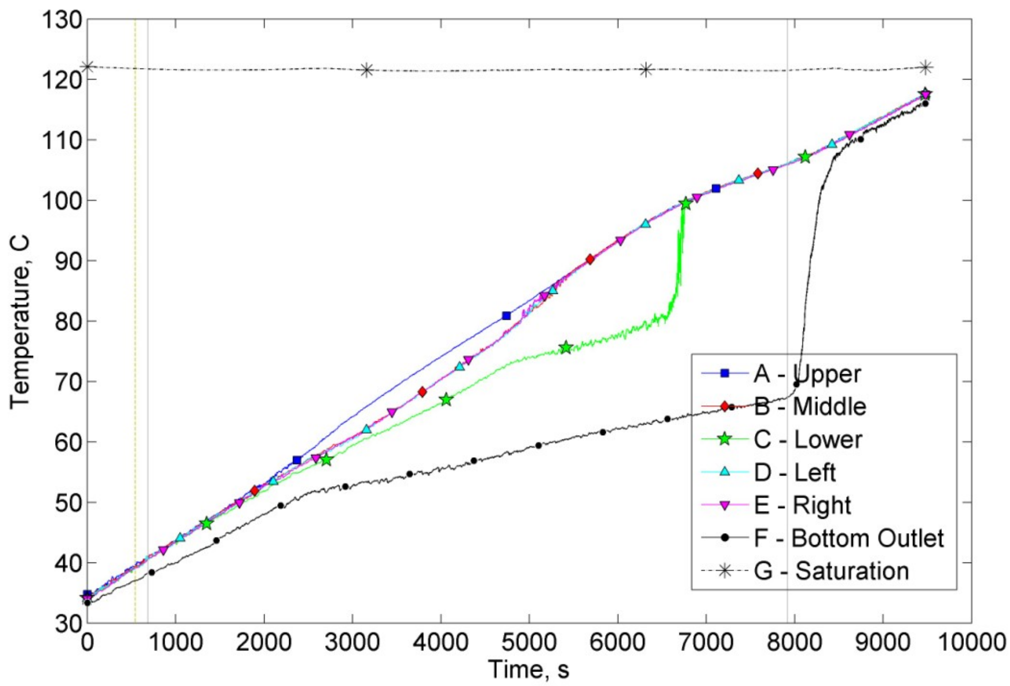

Figure 69: Test #29 Thermal Progression

This test was conducted at mid-power (107 kW), which produced a steam flow of 44.4 ± 1.3 g/s. Feedwater to the steam generator ran at 43.8 ± 1.4 g/s, and water injection to the steam line flowed at 25.0 ± 1.0 g/s. This produced a steam quality of 0.58 ± 0.02, which rose to 0.61 ± 0.03 downstream of the orifice.

Thermal stratification (see Figure 69) was largely comparable to that of Test #28, but measured to be very slightly larger. The top-mid limit was essentially identical at 4.5 °C. The mid-low and low-outlet differences, however, were greater at 22.9 °C and 40.5 °C, compared to Test #28's 21.0 °C and 39.6 °C, respectively.

4.4.30 Test #30

Test #30 was another test that started at below-standard temperatures; it ran for almost 300 minutes with a nominal beginning temperature of 30 °C. It was the test with the most severe two-phase conditions sent to the RCIC turbine analog and sparger. It was a low-power (57 kW) RCIC test with standard pressurization conditions and 0.8 GPM of water injection into the steam line.

Steam flowed at 23.3 ± 0.8 g/s, and feedwater was sent to the steam generator at 23.0 ± 0.8 g/s. The water injection to the steam line, at 49.8 ± 0.9 g/s, produced the lowest steam quality in these tests at 0.24 ± 0.03, which rose to 0.26 ± 0.03 downstream of the orifice.

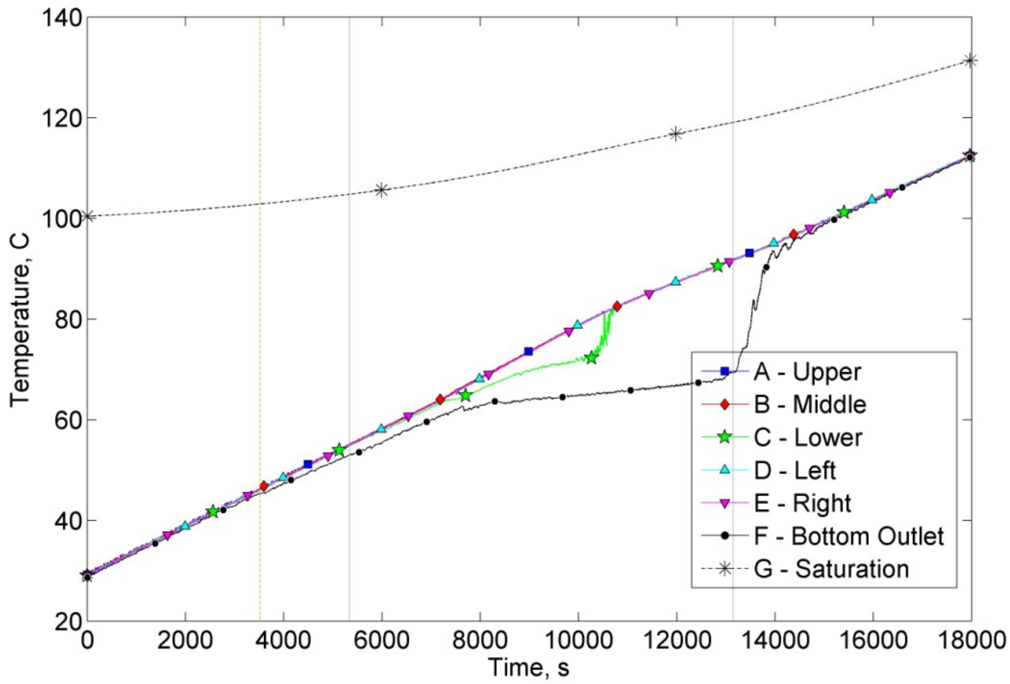

Figure 70: Test #30 Thermal Progression

Stratification (seen in Figure 70) was similar to both Test #2 and Test #21. The peak top-mid separation was only 1.3 °C (vs. 1.4 °C and 1.5 °C in Test #2 and Test #21, respectively). There was a limit of 10.1 °C difference for the mid-low region, between the 9.3 °C of Test #2 and the 10.6 °C of Test #21. The 24.2 °C maximum separation for the low-outlet region was greater than that of either of Test #2 or Test #21 (22.6 °C and 23.9 °C, respectively). One note of interest is that the thermal profile showed a flattening off not seen in higher-power water injection tests, and more closely resembled the non-injected cases.

4.4.31 Test #31

Test #31 was the lowest-power test conducted (32 kW). It ran for more than 523 minutes, the longest test on record by far, and started nominally at 35 °C (lower than the 40 °C in standard tests). Unfortunately, late in the test, the vortex flowmeter displayed symptoms of excessive acoustic noise in the steam flow. With low vapor velocities, the signal generated by the sensor in the vortex flowmeter can be relatively weak and may be susceptible to noise (especially valve hiss or water droplets flashing in the valve). The silencer installed after the shakedown tests proved adequate at higher velocities, but the threshold appears to have been reached late in this test.

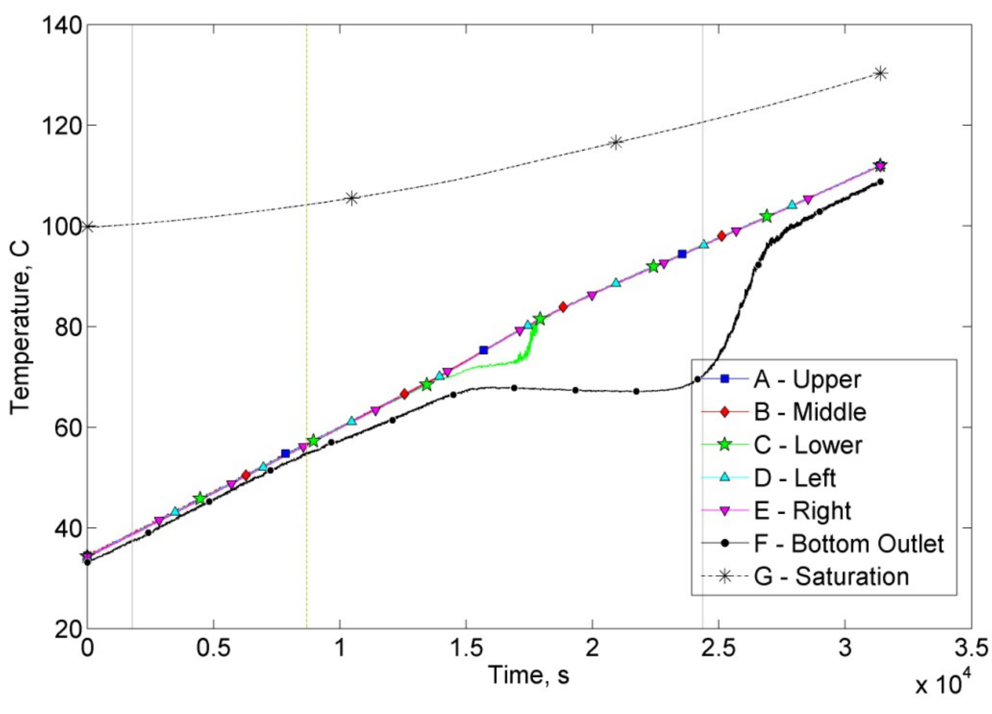

Figure 71: Test #31 Thermal Progression

Sometime after 400 minutes, the recorded flow rate showed spikes and trending increases in the flowrate that were unrealistic, and for this period can not be considered fully accurate. It should be noted that as the test progressed, pressure in the steam line rose in line with the Suppression Chamber's pressure, and was low compared to the steam generator. With a constant heater power and only lightly changing feedwater and pressure conditions in the steam generator, the actual flow through the main choke point (the main steam control valve, which should have experienced critical flow for most if not all of the test) should have remained fairly consistent during the excursions and inaccurate readings. However, with the greater pressures, the density of the steam would have been increasing; therefore, for the same massflow, the velocity through the vortex flowmeter would be lower. With the low velocities at the end of the test, it is estimated that the flowmeter would have been operating in the vicinity of 5% of its full scale range, relatively close to its lower limits.

This test was a standard alignment RCIC test at very low power. In the period up to the 400 minute mark, the steam and feedwater flowrates were 12.7 ± 0.4 g/s and 12.5 ± 0.6 g/s, respectively. For the entire test duration, including the period of inaccuracy for the vortex flowmeter, feedwater flowed at 12.9 ± 1.1 g/s. The measured value of the steam flowrate for the whole test was 13.0 ± 1.7 g/s; however, a more realistic value is estimated to be 12.8 ± 0.4 g/s.

Thermal stratification (profiled in Figure 71) in the topmost levels of the pool was more limited than in most of the other tests, and peaked at 1.0 °C. The mid-low separation, however, was not as remarkably low at 8.4 °C. Both are below the 1.4 °C and 9.3 °C, respectively, recorded in Test #2, the closest comparison. The low-outlet difference reached a maximum of 27.9 °C, a value greater than the 22.6 °C of Test #2.

4.4.32 Test #32

Test #32 was a repeatability test for Test #4. It was a standard alignment RCIC test at mid-power (107 kW). It was intended to be the first of two repeatability tests, but a magnetic flowmeter failed during the first attempt to run this test. Diagnosis and replacement with a similar model took enough time to limit the repeatability series to this test. As a result, this was the final test performed.

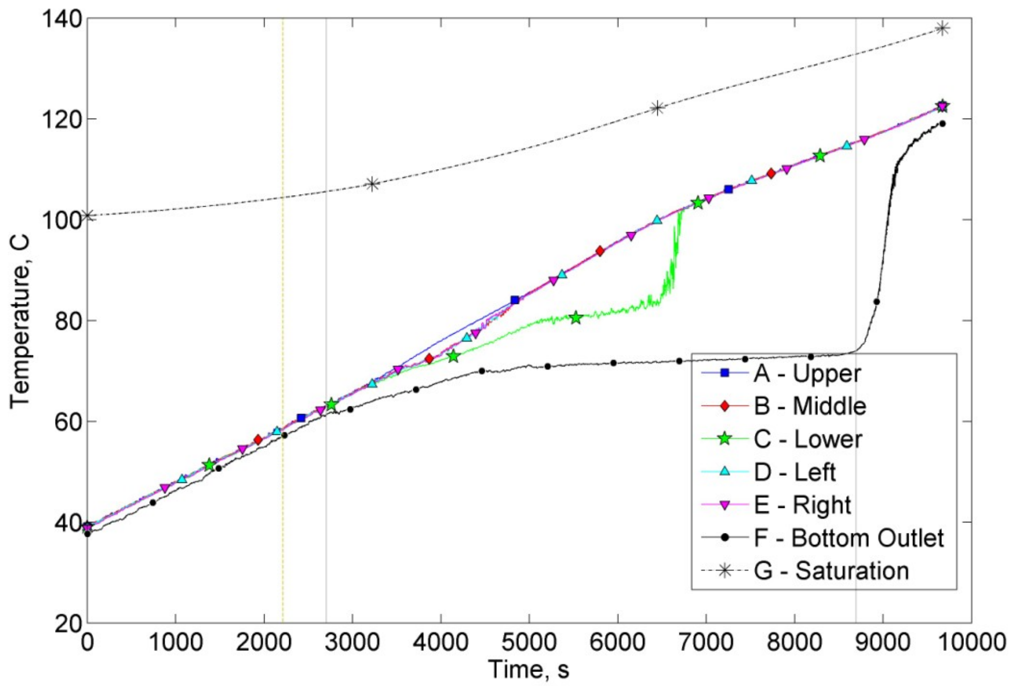

Figure 72: Test #32 Thermal Progression

Steam flowed at 44.7 ± 1.0 g/s. Feedwater to the steam generator had a flowrate of 44.3 ± 1.4 g/s.

The limits of thermal stratification and temperature profiles (shown in Figure 72) were very close to those of Test #4, and were all within one half of one degree of the Test #4 values. The top-mid peak difference was 2.8 °C (3.1 °C in Test #4). The mid-low and low-outlet separations were 20.7 °C and 43.5 °C, respectively; the comparable values for Test #4 were 20.9 °C and 43.3 °C, respectively.

4.5 OBSERVATIONS

Of the 32 tests performed, a minority (5) used the SRV-analog sparger. Even in the most severe case (Test #16), the thermal stratification was almost non-existent; these tests demonstrate the ability of the pool to be well-mixed by steam-condensing action. In the case where the pool would be much larger in comparison to the sparger and the mixing rate slower than the heatup rate, the development of a significant hot spot might still be possible with such a sparger design; however, these tests have provided little evidence to support it. The pool was essentially uniform.

The 27 RCIC-sparger tests, on the other hand, produced results demonstrating significant thermal stratification. While some tests produced limited and short-lived stratification, EVERY RCIC-ALIGNMENT TEST PRODUCED THERMAL STRATIFICATION in the Suppression Pool. Some tests produced very large gradients; Test #11, for example, had a peak thermal separation of 65.1 °C. The stratification, it should be noted, was entirely vertical; a characteristic horizontal profile (end-to-end and side-to-side within the Suppression Chamber) did not develop. That does not mean there were no differences whatsoever; in fact, it would appear that the vessel-front thermocouple group (SP19-SP23) tended to reveal destratification somewhat earlier than the middle and rear sets. This could be the result of imprecision in placement of the thermocouples; the sensitive end has several (sometimes more than 6) inches of lead to its nearest anchor point, allowing for a fair degree of movement if any force is applied. As the vessel was not opened after testing, the current positions of the thermocouples are unclear. In addition, the vessel-font group is relatively close to the vessel outlet; it is not beyond the realm of possibility that the pump suction produces a local distortion in the thermal profile.

A second deviation from lateral uniformity comes from Thermocouple SP8, the thermocouple in the immediate vicinity of the RCIC Sparger outlet. It is unsurprising that a very local and chaotic hot spot develops there; it may in the condensing region once steam bubbles can grow beyond the sparger outlet, and likely represents a thermal plume. It is unclear if the rapid swings in temperature it sees result from very chaotic hot-cold water turbulence, or if it comes into contact with two-phase steam/water mixtures. The installation of additional instrumentation would clarify this and enable comparison to point-source plumes modeled in [52] or later adaptations of plume theory [53]. Before that point, the thermocouple's readings are in line with the other thermocouples at that level. The appearance of the hot spot at that location is a key feature of these tests, and is taken to represent a significant weakening of the mixing currents in the pool along with the weakening of the condensation.

While there are significant variations between the RCIC tests, a characteristic thermal profile can be defined. Test #4 produced a relatively prototypic profile, which has a number of features common to the tests. It is a convenient test to use in comparisons, and has therefore been labeled the 'baseline' test. Early on, the pool is almost uniform; operators in this period observed loud metallic 'pops' and 'bangs' not unlike the popping sounds of popcorn coming from the Suppression Chamber. Coincident with them were spikes in the differential pressure reading across the sparger as well as in Thermocouple SP1 (inserted into the sparger line near the outlet). These sounds and spikes revealed the presence of violent steam condensation events; the thermocouple readings even dipped (for very short periods) into well-subcooled values, indicating the presences of subcooled water being drawn into the steam line. These sounds and spikes are clear evidence for chugging oscillations, whose presence is expected with sufficient subcooling in the pool. The largest spikes in standard alignment tests occurred roughly once every 1 to 7 seconds; smaller pulsations seemed to be at greater frequencies. However, it should be noted that due to the data logging frequency of 10 points/second, events with frequencies greater than about 1 Hz would not be preserved well, and those greater than 5 Hz cannot be resolved at all. Although similar sounds come from SRV-alignment testing, that alignment lacks the differential pressure and sparger temperature instruments that can clearly resolve the events in the data.

As the pool warms up, the violence of the condensation events weakens. The spikes in the sparger temperature and differential pressure trend toward decreasing severity, suggesting that the chugging oscillations are of decreasing intensity.

Eventually, the spikes disappear altogether and the chugging transitions through less violent condensation regimes. Meanwhile, as the oscillations weaken, the thermal plume around the sparger begins to establish itself. Subsequently, the pool begins to thermally stratify; it would appear that the chugging oscillations are the primary driver of pool circulation in the early parts of the tests. There are chaotic, transient flows in and near the sparger in the chugging regime, and they are effective at distributing energy and maintaining bulk pool uniformity. With the diminished chugging oscillations, the pool stratifies with some residual mixing; the temperatures all continue to rise, but at different rates at different vertical positions. The lower levels of the pool have thermal profiles that begin to flatten out, and may stop rising entirely.

The pool upper and middle readings continue to rise, and typically display some slight divergence in their trends. Such divergence is limited; the greatest separation (seen in Test #11) was 5.6 °C, while the other tests tended to be well below that. At that peak, the active pool mixing from concurrent condensation is thought to be at its lowest point, although total mixing from residual earlier action may continue to decay away. Afterward, the upper and middle temperature readings reconverge to common values while continuing to rise. The sounds coming from the sparger tend to be, at this point, notably calmer than at the beginning of the test; the chugging oscillations have given way to less violent condensation, and bubbling from the sparger outlet begins. At first, this seems to agitate only the portion of the pool above the sparger outlet; the buoyancy drives flows in the upper parts of the pool, but only limited momentum seems to penetrate into the lower regions.

As the upper parts of the pool continue to absorb energy and heat up, the penetration depth from the bubbling-based agitation increases. As the test continues, the lower parts of the pool intermix with the above areas, and eventually the whole pool from top to bottom joins the agitated part; the entirety of the pool once again becomes well-mixed and essentially uniform. This destratification front can show steep thermal profiles; as the front creeps past a thermocouple, even several dozen degrees of thermal separation can be seen to vanish in just a few minutes.

After full destratification, effectively no re-stratification of the pool has been observed. The degree of stratification, as well as distortions to the prototypical profile, depend on the major independent variables in these tests: the steam flowrate/steam generator heater power, the pressurization condition, and the steam quality.

In addition to the characteristic thermal profile these tests generated, operators noticed one important piece of information (more accurately, the lack thereof): *during none of the tests was the pump observed to cavitate*. While this cannot be guaranteed to be the case for a full-scale system with a much different impellor design, it is important to note here. To ensure that operators were not missing it, during a cooldown period the pump was deliberately driven into a cavitating state; such a state was obvious to the operators.

With the number of different independent variables explored, it is useful to divide them into groups. For example, "Power Series" groups standard RCIC-alignment tests for comparison. Likewise, a "Pressurization Series" exists for constant power levels, and a "Two-Phase Series" similarly considers the effects of injecting water into the steam line. Combinations of parameters can then more conveniently be compared to determine the greatest effects, and a special set of venting actions can be explored.

4.5.1 Steam Generator Power / Steam Flowrate

Part of the “Power Series” has been previously presented [50]. Tests #1, #2, #3, #4, #31, and #32 can be considered its primary constituents with some repetition for repeatability. The greatest stratification was seen at moderate power levels, while high and low power tests had much of their thermal profiles in common. While the upper-middle level separation for the high and low powers were closer to each other than to the moderate power cases (1.4 – 2.1 vs. 2.8 – 3.1 °C), even when the extra-low power test is added to the mix the spread, in actual numbers, is not great (between 1.0 and 3.1 °C). The middle-lower differences, greater in numerical value, again showed a clear difference between the moderate-power tests and the others (20.7 – 20.9 °C at mid-power vs. 5.5 – 10.8 °C). The peak separation was (in sheer numbers) very clear in the lower-outlet profile, ranging from 20.7 – 43.5 °C.

The moderate-power tests, which appear to be repeatable, seem to have found a sort of “sweet spot” for enhanced thermal stratification. Interestingly, the extra-low power test showed a greater separation in the lower-outlet profile than the low power tests (27.9 vs 20.7 – 22.6 °C). The mid and high power tests were nearly identical, ranging from 43.1 to 43.5 °C. This suggests a complicated set of phenomena contribute to the overall stratification relating to the steam flowrate; this would include the size/shape of any jet forming at the outlet (likely to be larger/deeper and more stable at greater flow rates), the ability to resist water ingress during chugging (greater steam flowrates would better resist ingress), and the scale of buoyant flows (greater steam flows likely produce larger buoyant flows to distribute the thermal energy).

4.5.2 Pressurization Conditions

Some of the standard "Pressurization Series" has been presented previously [51]. The pressurization condition of the Suppression Chamber turned out to be the most important of the variables considered, and had a clear effect: greater pre-pressurization leads to greater bulk thermal stratification in the pool. If the pool is fully vented (atmospheric), the resulting stratification will be reduced below that of the standard alignment; it is enough to severely distort the prototypic thermal profile; at high power (Test #14), the distortion is so severe that the prototypic profile is unrecognizable. With increased pre-pressurization, the stratification is not only more pronounced, but even the characteristic thermal profile becomes clearer. The stratification is also longer-lived.

The primary tests in this series are mid-power Tests #4, #6, #9, #12, #28, and #32. Test #6 and Test #28 were at constant pressure (1 and 2 atm, respectively), while the rest isolated the Suppression Chamber from the atmosphere and accumulated pressure beginning with their starting points (1, 2, 4/3, and 1 atm, respectively). A smaller low-power pressurization series can be assembled from Tests #1 (standard), #2 (standard), #20 (atmospheric), and #22 (building up from 5 psig); a similar set of high power tests consists of Tests #3 (standard), #10 (building up from 5 psig), and #14 (atmospheric).

The low-power tests showed significantly more stratified lower regions with increasing pressure; the standard alignment temperature differences were on the order of 40% greater than those of the atmospheric test, and the 5 psig pre-pressurization was more than double that of the atmospheric test. At mid-power, similar effects are seen: the constant 2-atm test has maximum temperature differences on the order of twice those of the atmospheric test (more than triple for the mid-low level separation). Test #12 (4/3 atm start point) had stratification that was almost 1/3 greater than the standard alignment, and Test #9 (starting from 2 atm) was roughly 1/2 greater than the standard alignment (and was still increasing for the lowest levels when equipment limitations forced cessation of the test).

Full power testing showed equally pronounced pressure effects. The atmospheric test was almost uniform from the top to lower thermocouple, and only saw 9.1 °C separation from the lower region to the outlet. While the pool upper levels were just as mixed as in the standard alignment, the lower and outlet stratification in the standard alignment were quadruple the values of the atmospheric test. Comparing the standard-alignment high power test to its pre-pressurized variant revealed an enormous fractional increase in the mid-low stratification: the peak separation increased by more than a factor of five. The low-outlet region did not see nearly as much of an effect (increasing less than 30%), but that in part could be due to the test ending (due to equipment limitations) long before its destratification point was reached.

Intuitively, the pressure effect can be connected to the differences in steam density. As the water in the pool is essentially incompressible, and the steam is introduced to the pool at similar pressures, the largest difference would relate to the fact that, without a phase change, the steam density at twice the absolute pressure would be approximately double that of the lower pressure. Similar-volume bubbles at greater pressure would have more mass, and would then tend to take longer to condense as the latent heat from the bubble is distributed to greater liquid volumes, decreasing the violence of the condensation. For a given mass flowrate, the volumetric flowrate at higher pressures would be reduced; in latter stages of tests, the reduced bubble flow at the sparger outlet would result in less overall agitation

4.5.3 Two-Phase Steam/Water Testing

Injection of a two-phase steam/water mixture through the RCIC Sparger rather than single-phase steam appears to have a complicated set of effects. The mid-power "Two-Phase Series" consists of Tests #4 (standard), #8 (0.4 GPM injection), #27 (0.8 GPM injection), and #32 (standard). The high-power series consists of Tests #3 (standard) and #13 (0.6 GPM); at low power, the series contains Tests #1 (standard), #2 (standard), #21 (0.2 GPM), and #30 (0.8 GPM). In many, but not all, cases two-phase injection reduced the amount of stratification that developed. It tended to distort the characteristic thermal profile, and added some slight mixing to the lower pool levels throughout the test period. Instead of heat being deposited solely in the upper parts of the pool, the two-phase tests indicate some energy being deposited at lower levels in the pool; the "flattening out" part of the thermal profiles does not get as flat as in single-phase testing. Some of this is likely the result of condensed water in the steam penetrating further down into the lower regions of the pool than the injected vapor phase, well below the condensation interface.

High-power testing saw reductions on the order of 2/3 for the peak temperature differences in both the mid-low and low-outlet regions when water was injected, reducing the sparger outlet quality to ~63%. A similar quality at mid-power resulted in smaller but still significant reductions in stratification severity; the peak mid-low stratification dropped by more than 40% and the low-outlet numbers decreased by 15%. Decreasing the steam quality further, to ~44%, resulted in decreases (compared to the standard alignment) revealing a much more mixed pool; the peak mid-low region temperature difference dropped by more than 80%, while the low-outlet region saw nearly 2/3 of the difference vanish.

At low power, an interesting trend reversal appears. Two-phase testing revealed an INCREASE in thermal stratification at the 63% steam quality level (only a small one; the low-outlet region saw an increase in the peak temperature difference of less than 6%). Further increase in water injection (decreasing the test-average steam quality to about 32%) further increased the ultimate degree of stratification (still by small amounts, on the order of 10% from the standard alignment). It would appear that the water injection interferes with the chugging oscillations, which seem to be suppressed at correspondingly lower pool temperatures with decreased steam quality. At the same time, in the low-power tests, the slower flow rates would give the condensed water in the steam line less penetrative power and a resultantly lower ability to agitate the pool.

It should be noted that the dry steam supply is consistent with the standard alignment case; in these two-phase tests, additional (liquid) flow is sent through the sparger, increasing the mass flux for essentially the same heat addition rate to the pool. The necessary changes in mass flux or heat addition makes separating the effects (mass flux and steam quality) more challenging.

4.5.4 Combined Parameters

When combinations of parameters were applied (i.e., pressurization with two-phase injection), the pressurization condition was the dominant factor in the overall stratification profile. The power levels and steam quality did play their roles, but they were of less significance than the pressure. Combined parameter testing was performed in Tests #7, #11, #18, #19, #23, and #29.

4.5.5 Active Venting Operations

Two tests were performed in which operators actively changed the venting condition mid-test: Test #24, in which a pre-pressurized Suppression Chamber was decompressed mid-test, and Test #26, which was maintained at atmospheric until a mid-test isolation. Test #26 performed as the atmospheric single-phase mid-power test (Test #6) until it was isolated as the pool bulk temperature crossed 82 °C; after that, it behaved as something of a cross between the atmospheric and standard alignment tests

The pre-pressurized depressurization test (Test #24) provides additional insight into the mixing behavior of the pool. Upon depressurization, the mid-low elevation stratification disappeared almost immediately. This effectively reveals that the mixing state of the pool is largely determined by current conditions rather than the heatup history in a test. While the temperatures of the unmixed portions are a function of the pool history, the active mixing state is not.

4.5.6 Comparison with Results from Other Facilities

The characteristic thermal profile found in these tests shows similar trends to those from both the University of Tokyo as well as the SIET tests. Remarkably, this applies not only to the open-ended pipe sparger design but the multiple-side-hole design as well as depicted in Figure 73 [40] (notably, the pool was open to the atmosphere in the SIET tests).

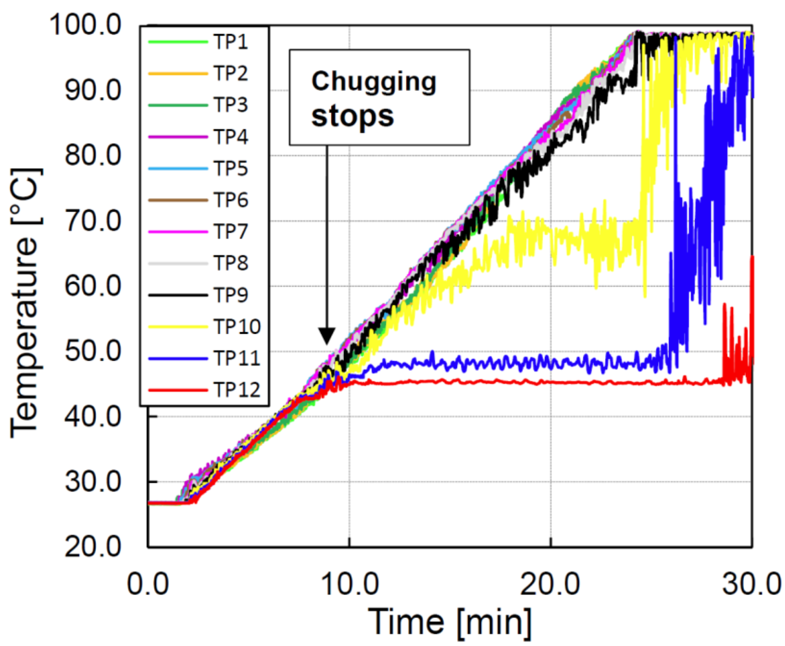

Figure 73: SIET Multi-Hole Sparger Pool Thermal Progression [40]

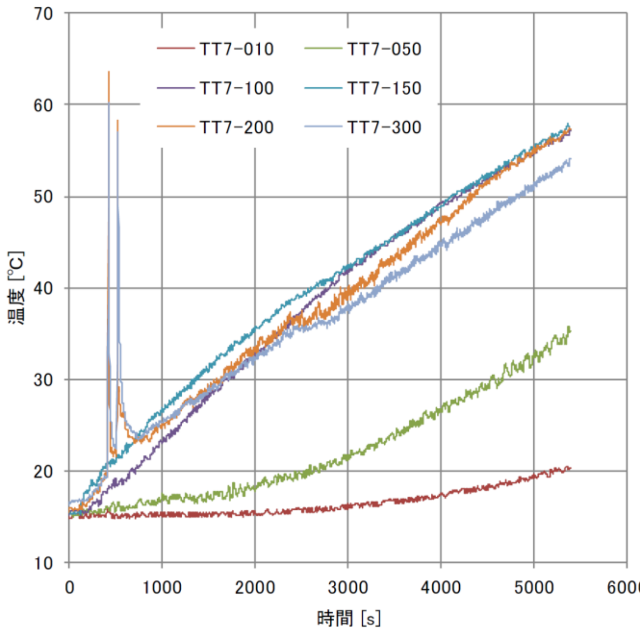

Figure 74: Atmospheric Thermal Progression, Reprinted with Permission from [54]

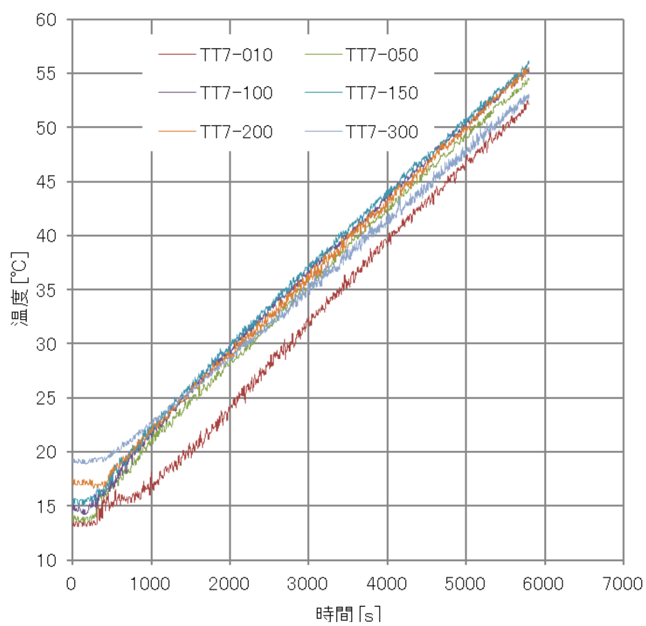

Figure 75: Vacuum Thermal Progression, Reprinted with Permission from [54]

Of particular relevance here, the effects of the pressurization conditions can be seen in the University of Tokyo tests. An interesting characteristic of them was that instead of above atmospheric pressures, testing was performed under atmospheric as well as vacuum conditions. In a manner not unlike the profiles seen for the NHTS tests, lower pressure in the test facility resulted in decreased thermal stratification. Vertical thermal profiles are shown for the atmospheric case in Figure 74 and for a vacuum (starting at -84 kPa gauge) case in Figure 75 [54].

A degree of similarity to the thermal progression in these NHTS tests was seen in POOLEX testing. As seen in Figure 76 [35], during the stratified period, the lower levels of the pool stayed at a relatively uniform, constant temperature. There was some separation in the upper portions of the pool, but the temperatures appear to move in concert with each other. It is important to note that steam injection was not constant, and the flowrate was dramatically increased at 4200 s to effect additional pool mixing; it was reduced over the succeeding hour until only small adjustments were needed to maintain the condensation position [35]. Even with the very different facility design and operation in the POOLEX tests, there remains a striking resemblance to the stratification data seen in the NHTS tests.

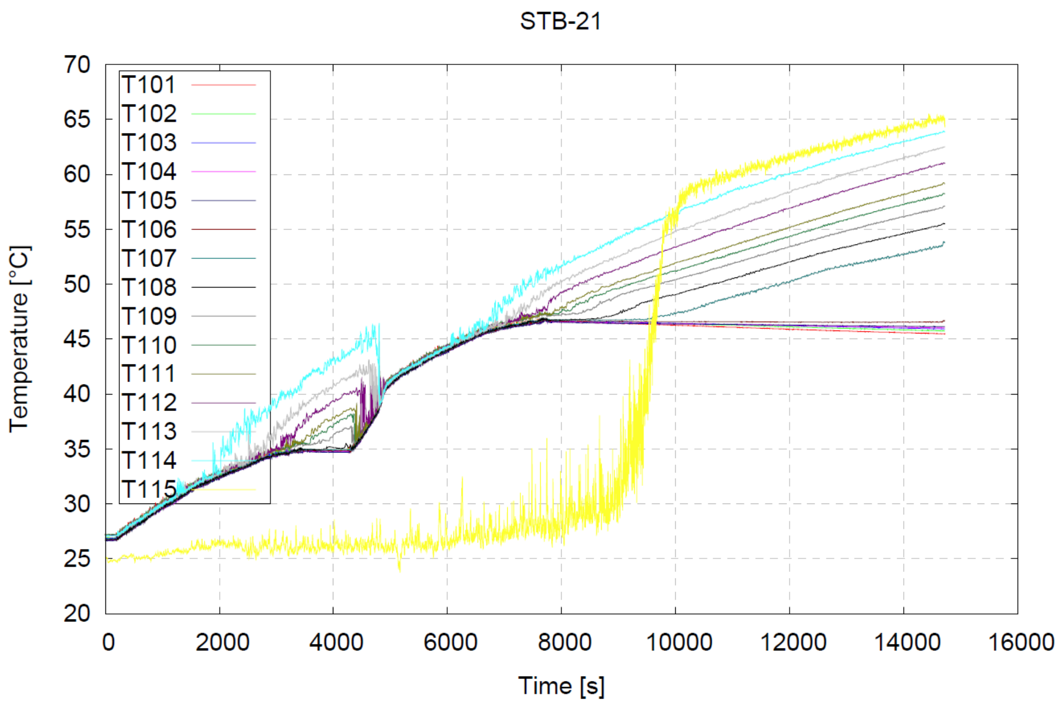

Figure 76: POOLEX STB-21 Test Thermal Progression [35]

5. ANALYSIS

The meaning and consequences of the data collected in this experimental program are presented here. The analysis attempts to produce a correlation that describes the aggregate mixing state of the Suppression Pool.

5.1 GOALS OF THE ANALYSIS

The characteristic thermal profiles seen developing through the test suite in this experimental program are the product of multiple phenomena occurring throughout each test. As direct contact condensation is a fundamental part of the experiment, relevant condensing regimes can be expected to play roles in the progression of each test. The notable, qualitatively observable, decrease in chugging intensity in the course of the RCIC tests in particular seems to be an important transition, as it appears to correspond well with the onset of bulk thermal stratification in the pool. While chugging appears to dominate the circulation patterns early in the tests, it is not the sole driver of pool circulation. Buoyancy-driven flows near the sparger outlet, especially late in the tests where steam bubbles may be able to reverse their initial direction and flow upward before condensing, become increasingly influential.

The transitions observed in the tests may be abrupt (as noted by operator observation in some tests, like Test #3, where the loud pops associated with strong chugging rapidly ceased) and easily noted by observant operators, or they may be smooth as one phenomenon gradually gives way to another (as in Test #21). The destratification profiles seen in the tests, in particular, would be near-impossible to identify without the direct temperature measurements. The multiplicity of phenomena involved in this experiment, especially when two-phase injection is considered, can make the use of existing correlations problematic as the phenomena may interfere with each other or interact in unexpected ways. Furthermore, the bulk effects measured may not be due largely to one phenomenon at a time.

For the purposes of this endeavor, the phenomena that may appear in the tests shall be considered in aggregate rather than separately; the goal is a single expression at any given time to describe the system state rather than the effective summation of several independent relationships. As chugging features so prominently in these tests, the result is expected to appear in the form of a chugging-like formula. Instead of strictly establishing the chugging conditions, however, it will reveal an aggregate bulk mixing state in the pool; i.e., whether the heat from the injected steam is distributed into just a small portion of the pool or is dispersed into the entire pool at large.

The bulk thermal mixing state of the Suppression Pool is an important part of whether or not the Suppression Pool RCIC System will be able to perform their safety functions in extended operations. When the RCIC Pump draws suction at sufficiently low elevations in the pool, thermal stratification will tend to provide it protection; the cooler inlet water would be less of a cavitation risk and would provide better cooling for the system's lubrication oil. However, limiting the heat injection to just the upper portion of the pool would tend to increase containment pressurization as that is the driving interface between the pool and containment airspace. The model developed herein should provide a framework to address these concerns.

5.2 DEFINITION OF THERMAL STRATIFICATION KEY POINTS

The broadly similar thermal profiles found in the RCIC-alignment tests, and the distinctive features of those profiles, allow for the identification of specific “key points” in the data. Aside from certain operational points (e.g., the beginning and ending points of a test), these key points identify features of the tests that should share common phenomenologies. These include the beginning and ending of identified bulk pool thermal stratification, the first formation of an identifiable thermal plume near the RCIC sparger outlet, the peak thermal separation between vertical levels, and the subsequent disappearance/reconvergence of said thermal separation. Presumably, the similar features in the thermal profiles of the tests that identify specific key points relate to phenomenological similarity across the suite of RCIC tests at those points. The key points identified are as follows:

1. Beginning of test
2. First appearance of identifiable thermal plume at the RCIC sparger outlet
3. Onset of detectable bulk thermal stratification
4. Peak thermal separation between the upper and middle vertical levels of the pool
5. Disappearance of the thermal separation between the upper and middle pool levels
6. Peak thermal separation between the middle and lower vertical levels of the pool

7. Disappearance of the thermal separation between the middle and lower pool levels
8. Peak thermal separation between the lower vertical level of the pool and the outlet at the bottom
9. Beginning of reconvergence for the lower vertical pool level and the outlet at the bottom
10. Disappearance of the thermal separation between the lower vertical level of the pool and the outlet at the bottom
11. End of test
12. Minimum recorded value for the proposed correlation (as defined for KP2-4
13. Maximum recorded value for the proposed correlation (as defined for KP2-4)
14. Peak thermal difference between the condensing/lower plume region and the bulk pool middle regions (unclear phenomena)

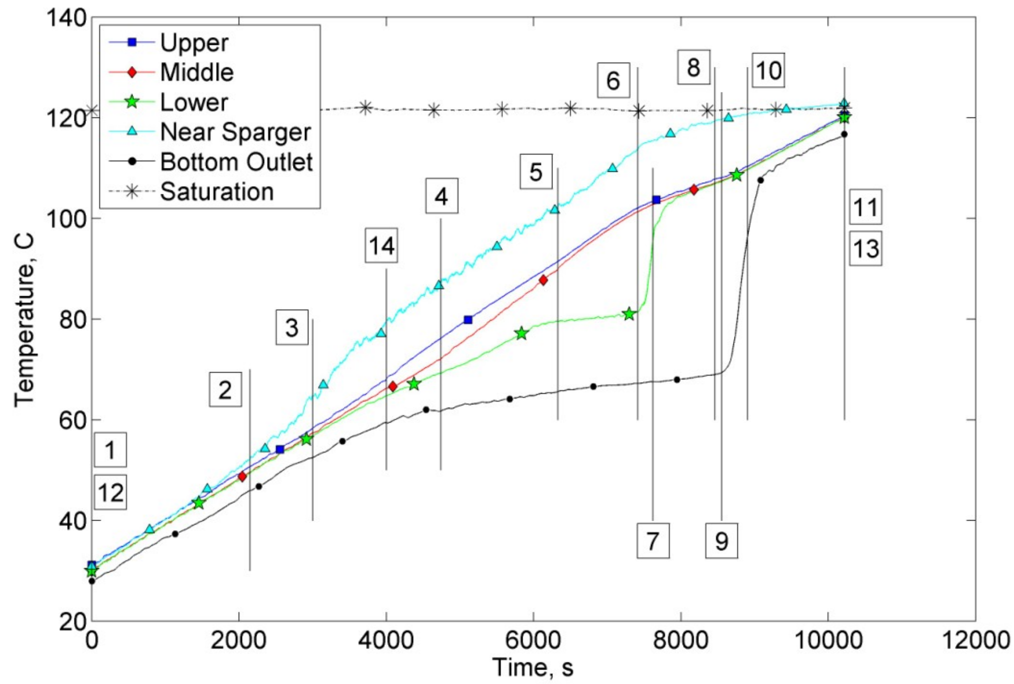

Figure 77: Key Point Progression in a Test

The descriptions of several of the above key points would benefit from further discussion, and are placed in their test progression in Figure 77. The thermal plume, central to Key Points 2 and 14, is only defined for RCIC tests (SRV runs are insufficiently instrumented). It is identified by comparison of the values for Thermocouples SP8 and SP9; SP8 is adjacent to the outlet of the RCIC sparger at the middle-level of the pool (approximately one inch away along the vessel axis) and SP9 is at the same vertical level, 12 inches further away axially from the sparger outlet. Due to the wild fluctuations in temperatures resulting from the nearby chaotic condensation, a smoothing algorithm is applied to these specific readings to determine the average local conditions. After the pool warms up sufficiently (this varies on test conditions), the average SP8 readings rise significantly above the SP9 readings (which maintain bulk middle-level readings). Once the average difference between SP8 and SP9 rises above 2 °C and remains so for the following 60 seconds, a thermal plume is considered to have formed; this indicates the test has progressed through Key Point #2. Key Point #14 is where the average difference is at its maximum. However, due to the poor spatial resolution of the thermal profile and indeterminate flow patterns, the phenomena relating to this are largely unclear and unresolved.

The bulk thermal stratification, defined primarily through Key Points 3 and 9, uses more smoothing than was used for the plume detection. Bulk pool temperatures are taken as averages of thermocouples SP11, SP12, and SP13, and compared to the temperatures read at the bottom outlet of the pool. To trigger the detection of the onset of bulk thermal stratification (Key Point #3), three main conditions must be met. First, the difference between smoothed bulk and outlet temperatures must be greater than 2 °C at the onset and for a full minute after. Second, the rate of temperature increase for the smoothed bulk and outlet temperatures must be different; at the onset and for a full minute afterward, the outlet temperature can be increasing at a rate no more than 75% of that of the bulk. Third, for the subsequent three minutes (to four minutes after the onset), the smoothed outlet temperature can be increasing at no more than 95% of the rate of increase for the bulk temperatures.

Detection of the onset of full destratification (Key Point #9) has fewer requirements: the rate of increase of the smoothed temperature at the pool outlet must be at least twice that of the smoothed bulk temperatures at the detection point and for the subsequent 60 seconds. Typically, the detection of Key Point #3 is well after that of Key Point #2. However, slowly-evolving temperature fluctuations can overcome the smoothing algorithms and lead to premature or inaccurate detection of the actual divergent trends; this appears to be the case, for example, in Test #21 as well as SRV Tests #16 and #25.

For Key Points 4, 6, and 8, the peak temperature differences are instantaneous (unsmoothed) values. The temperature differences are those within a vertical set (SP3-SP4-SP5-Outlet, SP11-SP12-SP13-Outlet, and SP19-SP20-SP21-Outlet), and the vertical set displaying the greatest difference is selected. However, due to the increasingly erratic behavior of Thermocouple SP4, Thermocouple SP4 was declared defective; this effectively limits that entire vertical set to consideration of lower to outlet region temperature differences (SP5-Outlet). The disappearances of the differences, as defined in Key Points 5, 7, and 10, use the same vertical thermocouple set as was found to have the maximum respective difference. This reconvergence is defined to be between the time of the maximum difference and the end of the test, and to be the point where the difference (with a smoothing algorithm applied) first drops below 1/3 of its peak value and stays below it for the subsequent 60 seconds. If the peak difference is less than 3 °C, the difference only needs to drop and stay below 1 °C. It should be noted that some tests did not proceed all the way through full destratification. For those tests, the relevant Key Points (generally Key Points 8, 9, and 10) are placed at the very end of the test.

5.3 CORRELATION DEVELOPMENT

Correlation development was based on the Key Points extracted from the RCIC-alignment tests. While five SRV runs were performed, their consistent full mixing in the Suppression Pool provides little impetus for more detailed mathematical modeling. Of the 27 RCIC-alignment tests, only those with clear and well defined Key Points in the early stages (Key Point #3 in particular, which should follow Key Point #2) were used in the development of the relationship; several tests had their bulk thermal stratification onset detection by the detection algorithm apparently go awry. To simplify things, only tests with steam qualities greater than 50% and steam mass flowrates greater than 20 g/s were considered in the development. This excludes Tests #27, #30, and #31. The primary Key Points used for development are Key Points 2, 3, 4, 5, 7, and 10; these cover the plume formation and initial stratification through the full destratification of the pool. Some skew is expected to result in the Key Point #10 results, as full destratification had not been achieved in some cases (Tests #1, #9, #10, #11, and #19); in such cases, Key Point #10 is placed at the very end of the test in the assumption that full destratification would have been forthcoming had the test proceeded.

For the correlation to be useful, it was essential to have a set of features. The values at the differing Key Points needed to be clear, consistent, and well-separated from those of other Key Points; there needed to be a 1:1 correspondence between the correlation value and the associated Key Point. As the tests progressed in time, the correlation needed to change monotonically (increasing was selected in this analysis).

The correlation development proceeds from a chugging-type relationship. As certain Key Points are thought to reflect transitions in the DCC regime, a correlation for the chugging regime boundary such as Aya and Nariai's (Eq. (1) [28]) or Liang and Griffith's (Eq. (2) [29]) was considered a good starting point. Due to the difficulties in directly applying Eq. (1) to the current system, Liang and Griffith's correlation (Eqs. (2)/(3)) was selected as the starting point. While bubbling does appear to play a significant role late in the tests, no consistent feature is present in the thermal profiles and therefore no Key Point is defined at temperatures specifically very close to saturation; condensation is expected to be a major part of every phenomenological Key Point. As a result, while one would expect that, near saturation, the primary relationship would be of a bubbling-type, the transformation from a chugging-type to bubbling-type relationship is far from complete for the current data set. Without the necessary data near or at saturation, the development of a bubbling-type relationship for the end-state data cannot be performed and the transition from the chugging-type to the bubbling-type relationship from the data gathered in this endeavor is at best incomplete and left for future researchers to explore. With adjustments for the latter Key Points, the form of the chugging-type relationship is believed to be valid for the current data.

In every test performed where the Suppression Chamber was isolated from atmospheric conditions, the pressure in the vapor space built up significantly as the pool temperature increased. This comes as no surprise; the air inventory was constant and heating up. In addition, the partial pressure of water vapor increased along with the pool surface and airspace temperatures. It is simple enough to estimate such conditions, and is an important phenomenon in thermal hydraulics. As exemplified by Equation 7-23 in the classic text by Todreas and Kazimi, the containment pressure has contributions from water vapor and from the volume's heated air as shown in Eq. (8) [55].

$$p_2 = p_{w_2}\left(T_2\right) + p_{a_1}\frac{T_2}{T_1} \tag{8}$$

Not only was the pressure increase predictable in the tests, it was significant. The only tests that achieved pool temperatures close to saturation were those with some sort of vent mechanism. Indeed, Eq. (8) [55] reveals that such systems under reasonable isolation conditions can never fully saturate; in order for the water vapor pressure to equal the airspace pressure, all the noncondensibles would need to be vented away. While a local hot spot could produce localized boiling, such would be suppressed over the pool as a whole by the presence of noncondensibles.

With the qualitative observations of the operators noting that the chugging noises would be relatively quiet at the point that thermal stratification was accelerating, with a fair degree of support by the recorded data, it is considered here that Key Point #4 (peak temperature difference between the upper and middle vertical regions of the pool) represents the overall minimum of active mixing in the pool, and effectively represents a termination of the chugging regime. This is not to suggest that a chugging-type correlation would immediately lose meaningfulness after progression through the general end of major chugging events, or even that the chugging regime has such a sharp boundary. However, the relationship would be expected to begin transformation at that point into another form, if it is to continue to relate to the phenomena present in the system after the cessation of major chugging. Key Points 2 and 3, then, represent the weakening of the chugging oscillations that the resultant decrease in overall pool mixing that allow their respective phenomena to appear. Key Points 5, 7, and 10 would then indicate increasing pool circulation from buoyancy-driven flows and an increasing role of bubbles surviving past the sparger outlet as the condensation rate slows.

Direct application of the chugging correlation from Liang and Griffith [29], as Eq. (3), to Key Point #4 reveals strong residual dependencies/unaccounted-for trends and that, on its own, it is insufficient to adequately describe the Key Point. The other Key Points have similar dependencies when examined with the correlation. This should come as little surprise, given the differing situations as well as the inclusion of two-phase injection and pressurization in these tests. In addition, gravitational effects are not addressed; these may be significant given the downward vertical orientation of the steam injection as buoyancy would tend to act in opposition to the direction of flow and cause an ultimate reversal of the injected fluid, especially later in the tests. Of lesser relevance to a strict chugging correlation, but of note here, is the depth of the outlet beneath the water surface; as a thermal plume forms around the sparger, the depth of the plume and its flows would conceivably affect the bulk vessel circulation.

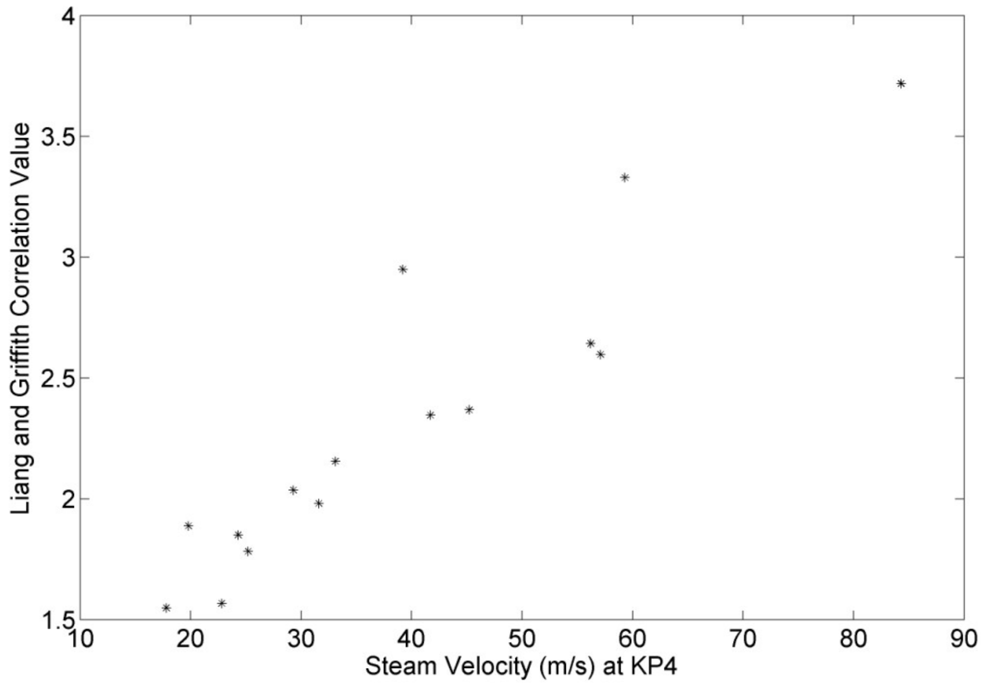

Figure 78: Liang and Griffith Correlation at Key Point #4

It can be seen in Figure 78 that the steam velocity has a strong residual dependency in Key Point #4. The sparger depth shows some dependency as well. If gravity is included, these can be grouped together in the form of a steam injection Froude number (Eq. (9) [57]) as in Eq. (10), where v_s is the velocity of the steam in the sparger and $d_{depth,outlet}$ is the depth of the outlet of the tube beneath the surface of the water; this again shows a trend at Key Point #4 when compared against the Liang and Griffith correlation as demonstrated in Figure 79. While this adaptation might be considered a stretched definition of the Froude number, it is useful in this analysis. The depth term provides a characteristic scale for natural convection in conjunction with the gravitational term; such was not part of the original correlation.

$$Fr = \frac{v}{\sqrt{g \cdot L}} \tag{9}$$

$$Fr_s \equiv \frac{v_s}{\sqrt{g \cdot d_{depth,outlet}}} \tag{10}$$

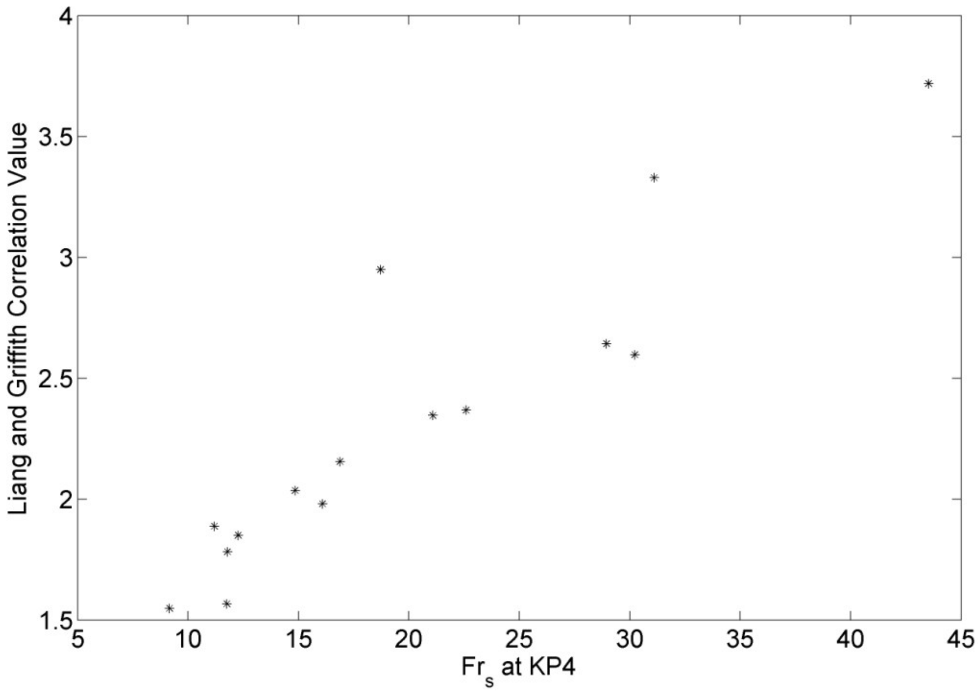

Figure 79: Liang and Griffith Correlation at Key Point #4, nondimensional

Multiplying the original correlation from Liang and Griffith, Eq. (3), by the Froude number expressed in Eq. (10) to a power of -0.5 will eliminate the trend, but another dependency remains (Figure 80, dropping the leading coefficient of 0.06): the steam and water density ratio. Upon inspection, the cleanest profile shows dependency on the ratio of steam and water at saturation, where the saturation pressure is taken to be that of the steam line just upstream of the sparger. Cleary this in some form, or a surrogate for it, needs to be accounted for in the relationship. To account, the correlation can be casted to be that of Eq. (11):

$$\mathrm{Pr}_w^{\frac{1}{2}}\left(\frac{\mu_s}{\mu_w}\right)^{\frac{1}{2}}\left(\frac{\rho_s}{\rho_w}\right)^{\frac{1}{2}} Ja_w^{-1}\,\mathrm{Re}_s^{\frac{1}{2}}\,Fr_s^{-\frac{5}{8}}\left(\frac{\rho_{w,sat}}{\rho_{s,sat}}\right)^{\frac{5}{16}} \qquad (11)$$

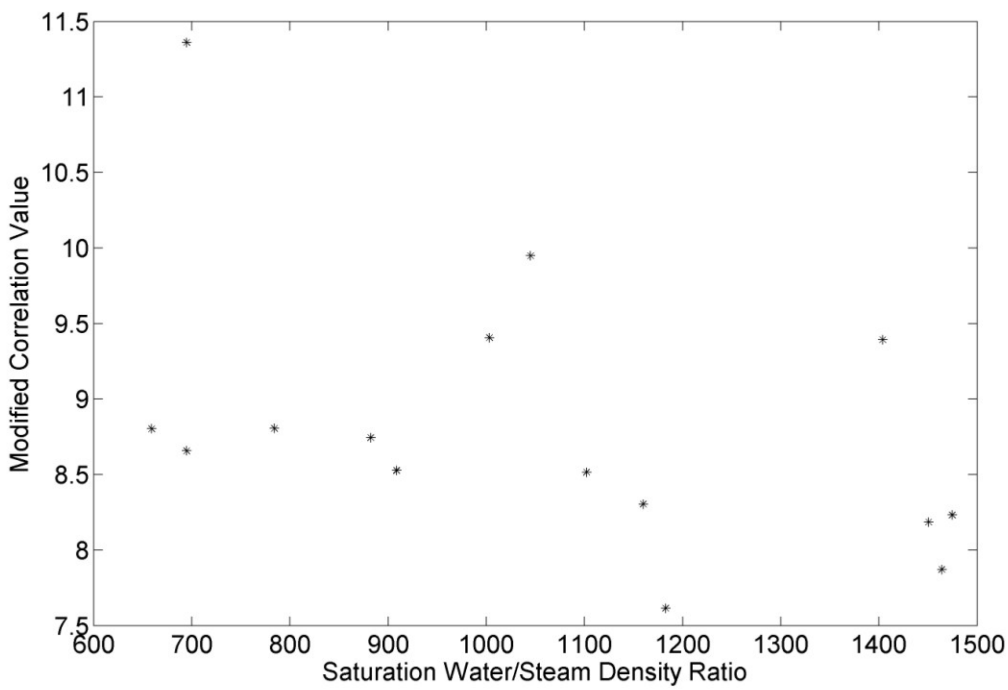

Figure 80: Saturation Water/Steam Density Ratio Dependency

Inclusion of the density ratio, to account for the dependencies, required adjustment of the exponent of the Froude number. It should be noted at this point that inclusion of a form of the Froude number with this density ratio can be rearranged to reveal a form of the Richardson number (used in various forms in meteorology and in mixed convection problems; Eq. (12) [56] is occasionally used as a definition). With the Grashof number (Eq. (13) [58]) and considering a simplification not unlike the Boussinesq approximation in Eq. (14) [58], it follows that (when density differences are enormous) a simple density ratio shown in Eq. (15) leads to Eq. (16).

$$Ri = \frac{Gr}{\mathrm{Re}^2} \tag{12}$$

$$Gr = \frac{g\beta(T_s - T_\infty)L^3}{\nu^2} \tag{13}$$

$$\beta \approx -\frac{1}{\rho}\frac{\Delta\rho}{\Delta T} = -\frac{1}{\rho}\frac{\rho_\infty - \rho}{T_\infty - T} \tag{14}$$

$$\beta\left(T_{hot} - T_{ref}\right) \approx \frac{\rho_{ref}}{\rho_{hot}} \tag{15}$$

$$\begin{aligned} Ri &= \frac{Gr}{\mathrm{Re}^2} = \frac{\left(\dfrac{g\beta\left(T_h - T_{ref}\right)L^3}{\nu^2}\right)}{\left(\dfrac{vL}{\nu}\right)^2} = \frac{g\beta\left(T_h - T_{ref}\right)L}{v^2} \\ &\approx \frac{g\dfrac{\rho_{ref}}{\rho_{hot}}L}{v^2} = \frac{g \cdot L}{v^2} \cdot \frac{\rho_{ref}}{\rho_{hot}} = \frac{1}{Fr^2} \cdot \frac{\rho_{ref}}{\rho_{hot}} \end{aligned} \tag{16}$$

While Eq. (11) – the Liang and Griffith correlation with corrections – resolves the dependencies that were shown to exist in the uncorrected version at Key Point #4, when applied to other Key Points, dependencies re-enter the picture. However, they are dependencies on terms already in the corrected relationship; resolving the dependencies means adjusting the exponents rather than the addition of terms at the end of the formula. As the dependencies seemed to increase the further away in time/Key Points the period of interest is, a method to smoothly correct the growing dependencies was sought. One of the more promising enhancements came from defining a pressure ratio β_p in Eq. (17) to assist in defining the progression within a test. It compares the vapor pressure of the bulk liquid at the level of the sparger outlet (a function of its temperature) to the overall pressure at that level.

$$\beta_p \equiv \sqrt{\frac{P_{vap}}{P}} \tag{17}$$

Instead of attaching the parameter to the end of the relationship as with the other correction factors, Eq. (17) was inserted into the changing exponents. This was not limited to those of the correction factors, but to the Jakob number as well, producing a corrected correlation of Eq. (18):

$$\mathrm{Pr}_w^{\frac{1}{2}} \left(\frac{\mu_s}{\mu_w}\right)^{\frac{1}{2}} \left(\frac{\rho_s}{\rho_w}\right)^{\frac{1}{2}} Ja_w^{-1+\frac{1}{16}\beta_p} \,\mathrm{Re}_s^{\frac{1}{2}}\, Fr_s^{-\frac{3}{8}-\frac{1}{2}\beta_p} \left(\frac{\rho_{w,sat}}{\rho_{s,sat}}\right)^{\frac{1}{4}+\frac{3}{16}\beta_p} \tag{18}$$

While Eq. (18) was sufficient for relating to Key Points 2-4 for single-phase tests, two-phase injection required additional accounting. Careful inspection revealed a correction that was surprisingly simple: division of the Jakob number by the steam quality. If the quality term is “unbounded” – that is, allowed to be greater than 1 for superheated steam following Eq. (19), then the Jakob number can be re-expressed as a “Two-Phase Jakob Number” shown in Eq. (20), which expresses a ratio of the thermal energy needed to bring the pool's water to saturation to that needed to fully condense the two-phase steam. While not explored here, the "unbounded" quality may enable the extension of the correlation into the superheated steam region.

$$x_u = \frac{h_s - h_{w,sat}}{h_{s,sat} - h_{w,sat}} \tag{19}$$

$$Ja_{TP} = \frac{Ja_w}{x_u} = \frac{h_{w,sat} - h_w}{h_s - h_{w,sat}} \tag{20}$$

$$\mathrm{Pr}_w^{\frac{1}{2}} \left(\frac{\mu_s}{\mu_w}\right)^{\frac{1}{2}} \left(\frac{\rho_s}{\rho_w}\right)^{\frac{1}{2}} \left(\frac{Ja_w}{x_u}\right)^{-1+\frac{1}{16}\beta_p} \mathrm{Re}_s^{\frac{1}{2}}\, Fr_s^{-\frac{3}{8}-\frac{1}{2}\beta_p} \left(\frac{\rho_{w,sat}}{\rho_{s,sat}}\right)^{\frac{1}{4}+\frac{3}{16}\beta_p} \tag{21}$$

In addition to the steam quality, a definition for the two-phase viscosity in the Reynolds number was needed if the viscosity terms would remain. Here, a volumetric mean (with no slip between water and steam phases; a presumed equality of their velocities) was considered, along with other homogenization methods such as quality-weighted reciprocals [59]. However, it was recognized that the viscosity terms cancel out of the correlation as currently expressed (including those from the Prandtl number, viscosity ratio, and Reynolds number).

With the above corrections, the chugging-type relationship of Eq. (21) was found to work well for Key Points 2-4. However, at Key Point #5, the saturation steam/water density ratio again shows a major dependency; correcting it greatly altered its exponent. The same is true of all later phenomenological Key Points. Worse, the exponent for the saturation steam/water density ratio is not the only one that may need adjusting. With adjustments made to it, by the final phenomenological Key Point (Key Point #10), a new dependency on the Jakob number can be seen to be developing (compare Figure 81 and

Figure 82). This is evidence to suggest that, at that point, the chugging-style relationship is finally breaking down and likely giving way to another type, probably bubbling-type, or one unencumbered by a zero/infinite value resulting from applying the Jakob number approaching saturation. However, even with the new dependency beginning to emerge at Key Point 10, the experiment's state can still be described with the final corrected form of the chugging-type relationship (henceforth called the "Mixing Number" or Mx) given in Eq. (22); it simplifies to Eq. (23). The F_1 term is expressed as part of Eq. (23). Unfortunately, Key Point 5 and later were unable to be smoothly transitioned through by use of β_p in the density ratio exponent; individual expressions for the exponent became the cleanest way to resolve the destratification Key Points.

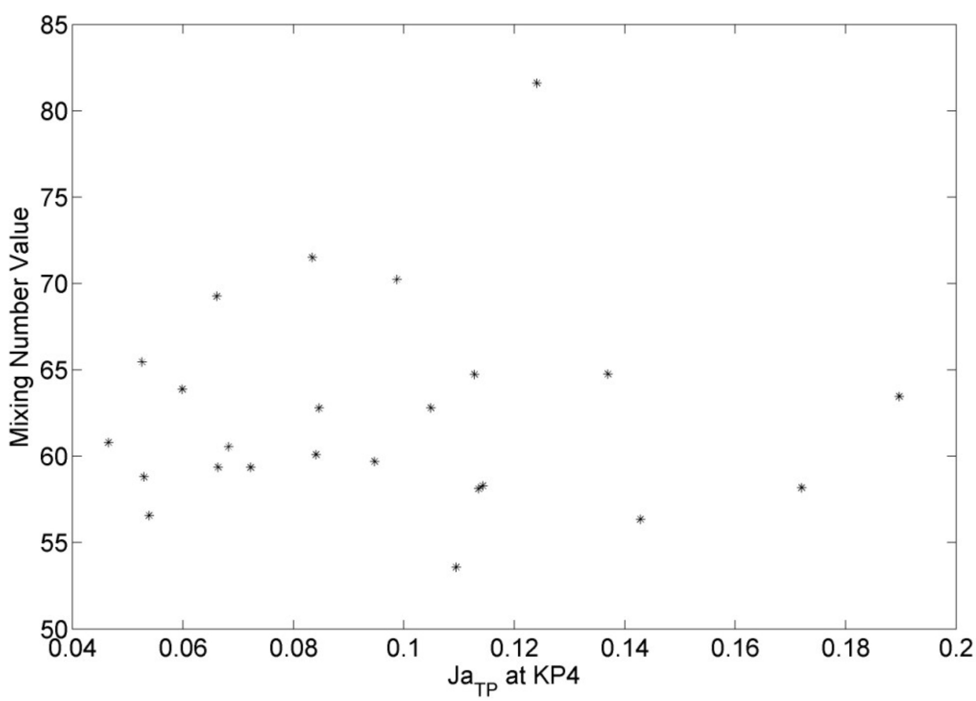

Figure 81: Mixing Number at Key Point #4

$$Mx = \Pr_w^{\frac{1}{2}} \left(\frac{\mu_s}{\mu_w}\right)^{\frac{1}{2}} \left(\frac{\rho_s}{\rho_w}\right)^{\frac{1}{2}} \left(\frac{Ja_w}{x_u}\right)^{-1+\frac{1}{16}\beta_p} \mathrm{Re}_{TP}^{\frac{1}{2}} Fr_s^{-\frac{3}{8}-\frac{1}{2}\beta_p} \left(\frac{\rho_{w,sat}}{\rho_{s,sat}}\right)^{F_1} \qquad (22)$$

$$Mx = \left(\frac{c_{p,w} \cdot G_s \cdot d_{outlet}}{k_w}\right)^{\frac{1}{2}} \left(\frac{\rho_s}{\rho_w}\right)^{\frac{1}{2}} Ja_{TP}^{-1+\frac{1}{16}\beta_p} Fr_s^{-\frac{3}{8}-\frac{1}{2}\beta_p} \left(\frac{\rho_{w,sat}}{\rho_{s,sat}}\right)^{F_1}$$

where

$$F_1 = \begin{cases} \text{Value} & \text{KP} \\ \frac{1}{4} + \frac{3}{16}\beta_p, & 2-4 \\ 13/16, & 5 \\ 15/16, & 6-7 \\ 1, & 8-10 \end{cases} \qquad (23)$$

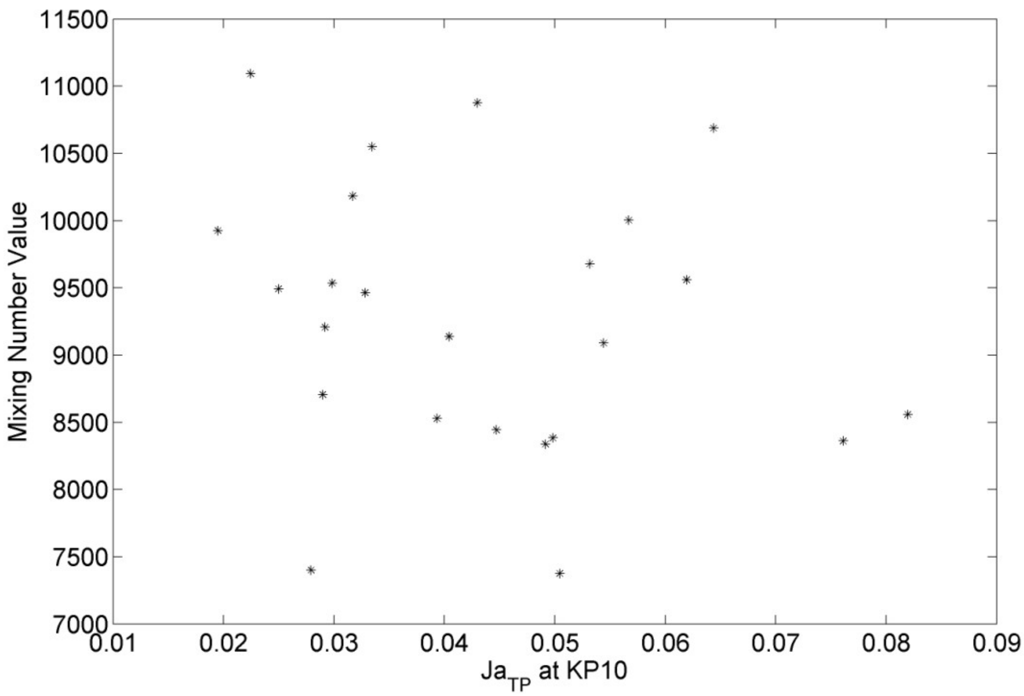

Figure 82: Mixing Number at Key Point #10

A summary of the results of the new correlation can be found in Table 11. For the decreasing-circulation period (Key Points 2-4), the relationship shows good agreement between the tests as well as clear separation between the Key Points. The increased spread for Key Point #3 (onset of bulk thermal stratification) is likely due to the difficulty of detection in the data processing; the other Key Points tend to be better defined and easier to detect in the data. Even with the expression beginning to break down by Key Point #10, the results were still within 11%.

Table 11: Spread in As-Measured Correlation Values

	Correlation Mean	Min	Max	σ	σ/mean
KP2	42.95	38.50	46.33	1.99	4.64%
KP3	47.11	29.23	73.24	7.67	16.3%
KP4	62.51	53.58	81.60	6.03	9.64%
KP5	1796	1614	1923	94.7	5.27%
KP7	5064	3894	5701	377	7.45%
KP10	9274	7376	11093	1009	10.9%

5.4 ERROR ANALYSIS

Due to the lack of a large number of tests with the same testing parameters, full statistical development of repeatability is not possible with the data gathered in this testing program. While Test Nos. 1&2 and 4&32 demonstrated a capacity for repeatability, they are insufficient for full quantitative analysis and reflect more qualitative measures. However, that does not preclude an analysis of the uncertainty in the collected data; it simply adds a limitation on its scope. Furthermore, if the correlation developed is assumed to be valid, then the comparison of data at phenomenological Key Points can provide some insight into the overall spread, especially when combined with individual major contributions to error (i.e., instrument error) that would tend to shift the position/correlation value of the individual Key Point.

The approach used here to determine the error in the Mixing Number presents two outcomes: a probable conservative evaluation, and what should be a bounding evaluation that produced almost twice the value. Covariances were ignored/assumed to be zero (the use of the same instruments to compute multiple terms in the correlation will result in covariance terms), and in a number of cases "worst-case" evaluations were used. The relative standard deviations were calculated for each major term of the simplified expression for the Mixing Number; as a result, due to their dropping out of the final form, viscosities produced no impact on the error determination. The oft-used error propagation formula given by Eq. (24) [60] was used to propagate instrument error through to the total instrument error contribution.

$$\sigma_u^2 = \left(\frac{\partial u}{\partial x}\right)^2 \sigma_x^2 + \left(\frac{\partial u}{\partial y}\right)^2 \sigma_y^2 + \left(\frac{\partial u}{\partial z}\right)^2 \sigma_z^2 + \cdots \quad (24)$$

$$where$$

$$u = u(x, y, z, \ldots)$$

The single largest contributor in the baseline evaluation was the error propagated through the two-phase Jakob number (σ = 2.2%). This has contributions not only from the vortex flowmeter instrument cluster and pool conditions, but also includes significant uncertainty due to an approximately 13% value in the heat loss coefficient in the main steam line (the effects of this are limited by the low heat loss values). The Froude number comes in a distant second in its contribution (σ = 1.2%).

In what should be a bounding determination, the uncertainty in β_p becomes the dominant factor, enlarging every term that utilizes it. This is no surprise, as it exists in the exponents and constitutes a significant part of their overall values. In that evaluation, the Froude number becomes the largest single contributor (σ = 3.2%) and the two-phase Jakob number drops to second place (σ = 2.2%).

As the Mixing Number has multiple expressions for different points in the experiment's progression, multiple error terms have been developed. In the early stages (Key Points 2-4), the likely conservative estimate is that the Mixing Number can be determined by the experiment's instruments to a standard deviation of 2.7%; a bounding estimate puts it at 4.4%. Later (when $F_1 = 1$, which is applied to Key Points 5-10 as an overestimate), the measurements should produce a standard deviation of 2.8% in the Mixing Number. The respective bounding value is 4.0%.

With the bounding estimate, the measurement error in the Mx correlation is comparable to the spread in measured values for Key Points 2 and 5. As the measurement error applies to every datum, it contributes additional error to the measured values for each Key Point. Inclusion of the measurement error (using the bounding value of 4.4%) as well as the spread in measured correlation values at the various Key Points produce the estimated total uncertainty values show in Table 12. This assumes correct placement of the Key Point by the data processing script. Further development of the measurement error analysis can be found in Appendix B.

Table 12: Total Error in Correlation

	Correlation Mean	Total Error, σ/mean
KP2	42.95	4.72%
KP3	47.11	16.31%
KP4	62.51	9.69%
KP5	1796	5.35%
KP7	5064	7.50%
KP10	9274	10.92%

5.5 FULL SYSTEM MODEL CONSIDERATIONS

With the developed expression for the Key Points, one may begin to model the progression from state to state, given certain modeling assumptions. A number are made for the sake of simplicity, and significant room is left for future efforts to enhance the model.

The water in the pool is assumed to be representable by two separate volumes vertically stacked, and each is assumed to be homogenous. In the early parts of a test, Key Points 2-4, the upper volume consists of all the water at a vertical level above that of the RCIC sparger outlet. The lower level has the remainder of the water (below the sparger outlet). The upper volume is assumed to be in thermal equilibrium with the vapor space above it (including a relative humidity of 100%), and as a result it drives the pressurization of the chamber. Steam is injected and condensed in the upper volume. The lower volume provides water for the pump suction, and defines the pump inlet conditions.

From the beginning of steam injection up through Key Point #3, both water volumes are intermixed; the entire pool is uniform. In the data, stratification begins at

Key Point 3, but residual mixing tends to remain through Key Point #4 as different levels have their temperatures branch off from the upper level at different times, and tend to flatten out around Key Point #4. This is seen not only in the data gathered here but also in a number of profiles from the University of Tokyo [54], POOLEX [35], and SIET [40] tests, which have a greater vertical thermal resolution; the separation resembles a retreating front between the well-mixed upper and poorly-mixed lower regions. In this model, after Key Point #3, mixing between the upper and lower volumes ceases; the lower volume maintains its state, while heat is dumped solely to the upper volume.

The greatest thermal stratification in the upper pool regions in the data define Key Point #4, which is taken to represent the minima of pool mixing. Due to the modeling simplification of a uniform upper volume, no thermal separation is defined here in the upper regions. As the peak is relatively low, this simplification is thought to be less significant than others present in this model. Once Key Point #5 is reached, the upper region is considered to be well mixed.

After Key Point #5, there appears a vertical (downward) progression of a mixing front; the bottom of the upper water volume progresses down from the level of the sparger outlet. The upper volume, therefore, grows while remaining thoroughly mixed; the lower volume, maintaining the thermal state it had in Key Point #3, shrinks.

At Key Point #7, the vertical progression of the mixing front has reached the lower levels in the pool (8 inches above bottom), shifting considerable inventory from the lower volume to the upper. The peak mid-lower thermal separation in this model can be taken to be just prior to this point. In the data, the peak separation is defined by Key Point #6, which typically occurs shortly before the temperature reading at the lower vertical level quickly rises to that of the middle and upper pool regions.

At Key Point #10, the advancing mixing front has reached the very bottom of the vessel; peak lower-outlet temperature differences are shortly prior to this (Key Point #8 in the data). After this point, the lower volume ceases to exist, and the upper water volume defined in this model encompasses the entirety of the pool. It continues to be well-mixed through the end of the test.

This model has several limitations. The instantaneous flattening of the lower-volume temperatures after Key Point #3 is a gross simplification of the data, and misses the continued temperature rise seen especially in the lower-level (not bottom/outlet) readings; this rise can continue PAST Key Point #5 before flattening out (as it appears to do even in Test #4). Whether this is residual circulation from prior steam injection or active mixing from concurrent steam injection is unclear. Additional water volumes, or thermal profiles within the volumes, may be useful. Furthermore, some profiles never flatten out; many of the two-phase injection tests show some intermixing between the upper and lower volumes for the entirety of the test. As a result, the peak temperature differences between the lower and outlet reading will be overstated by this model; those of the middle to lower level readings will be overstated even more. Due to the overstatements, this model should be considered to provide bounding values for the thermal stratification of the lower levels of the pool.

With regard to the upper levels, this model overstates the heat dumped into the upper volume. However, as it assumes complete mixture of the upper volume, there is no considered potential for the development of a thermal profile. The thermal separation between the top and the middle of the pool is ignored completely. The pressurization condition of the chamber, then, is not guaranteed to be overstated as a possible hot spot on the top of the volume is not considered.

5.6 SCALING DISCUSSION

While scaling from this experiment to full size in operating BWR systems cannot be completely established solely from the data gathered in testing, there is some basis for scalability. It was determined during the design phase that the full range of applicable Reynolds numbers in the sparger would be irreproducible with the equipment in the NHTS Laboratory. Even approaching them with the current steam supply would require sonic flows; this would drastically affect the condensation and steam jet profile at the sparger outlet. Instead, the Mach number was chosen as a scaling parameter for preservation. The facility can produce a peak sparger Mach number near 0.18; the full scale system was estimated to produce Mach numbers in the range of 0.1, which is easily attainable with less than full power operation of the steam generator. Preserving the Mach number has the added benefit of, in many of these tests, preserving the flow velocity and mass flux (Suppression Chamber conditions are comparable).

If a Fukushima-scale RCIC system consumes approximately 2.1 kg/s of steam, it would produce a mass flux at the sparger of 33 kg/m^2s. At 2.51 kg/s [40], the mass flux is 39.7 kg/m^2s. With enough subcooling in the Suppression Pool, this would land squarely in the chugging regime for DCC according to the traditional maps. The mid-power (107 kW) tests produce similar mass fluxes (~34 kg/m^2s), and were originally thought to provide phenomenological similarity. However, given the multitude of regime maps (as well as the correlation developed here), the similarity becomes less clear.

An additional distortion affecting the utility of the correlation developed here is the aspect ratio between the Suppression Chamber and the sparger outlet. While the vessel used in these tests has a volume that scales from roughly 1:750 for a small BWR pool of 70,000 cubic feet to 1:1300 for a larger one of 125,000 cubic feet, the non-toroidal shape results in a much different diameter scale than expected – 1:5.9 in the case of Fukushima Daiichi Unit 2 [61]. The sparger diameter, however, scales to 1:6.9 – at least for Unit 2 [6], and the effect of position (closer to wall vs. near pool center) is unclear. Further testing with additional varied parameters can provide insight into some of these unknowns.

Beyond the previous distortions, the depth of the sparger outlet in the pool is not matched; here, it is roughly at half depth, while in Unit 2, it appears to be much closer to the pool's surface [6]. Furthermore, full-scale systems tend to operate with Suppression Pool levels below the center of the Torus (this will be affected by injection from the Condensate Storage Tank before RCIC System realignment to draw suction from the Suppression Pool). The depth term in the Fr_s component of the new correlation should account for this, but more tests at more varied pool depths are needed for confirmation.

The end result is that scaling to full-size systems is best thought of as a work-in-progress that would greatly benefit from experimental data with additional varied parameters.

6. CONCLUSIONS

In this work, an experiment has been performed to investigate the conditions a RCIC System may be exposed to in long-term operations, especially in a prolonged SBO scenario. Of major interest was the thermal behavior of the Suppression Pool, which in the long term serves as both the heat sink for steam from the reactor (through SRV as well as RCIC System operations) as well as the source of makeup water for the reactor. This work has shown a demonstrable capacity for thermal stratification in the Suppression Pool resulting from RCIC System operations.

Thermal stratification can contribute to extended RCIC Pump operability by limiting the pump's exposure to elevated temperatures. This has the trade-off of exposing the Suppression Chamber to increased pressure loading driven by warmer water at the surface of the pool. However, in these tests, the extra pressure was limited, as the warmer upper regions of the pool tended to have larger volumes of water than the cooler lower regions by virtue of pool and sparger geometry. The pressurization concern would be greater in cases where the cooler water volume is larger than the warmer water volume. Therefore, in a full-scale BWR Suppression Pool with similarity in design to the system here (which differs on a plant-by-plant basis), thermal stratification in the Suppression Pool is likely to act in an overall beneficial manner; the RCIC Pump would be protected (so long as its thermal limit is above the temperatures at which stratification forms), while the extra burden placed on the containment would be limited. Depending on the scenario, the pool may fully destratify before containment pressure limits are reached.

The thermal conditions for pump suction (when the RCIC System is aligned to the Suppression Pool) are key determinants of the operating envelope for the pump, but are not the only important conditions. Net positive suction head requirements and temperature/pressure/speed/flow curves for the RCIC Turbine and Pump are also very important. While no cavitation in the pump in these tests during data operations, this cannot be guaranteed to be the case in full-scale systems without better piping details, loss terms, and TDP response curves.

The thermal behavior of the Suppression Pool can be modeled in manners developed in this work. A notable inadequacy of the traditional DCC regime maps was seen in these tests, and corrections to the chugging correlations were necessary to describe the data. While this was not a strict DCC study, parameters explored here have not been addressed in previous DCC experiments; the effects of pressure conditions are limited in the literature, while the effect of steam quality (saturated two-phase through the superheated region) appear to be completely absent from previous experiments. Characteristic thermal profiles were observed, and it was seen that sparger design and location are key in the thermal profile development.

In these tests, steam injection through an SRV analog was very effective at circulating and mixing the water in the Suppression Chamber. Injection through the RCIC Sparger analog, however, produced a characteristic thermal stratification profile. While variation of the test parameters resulted in sometimes significant distortions to the characteristic profile, every RCIC-Alignment test produced thermal stratification. In most tests, the stratified profile eventually disappeared as mixing increased with decreasing pool subcooling. However, not every test (largely due to equipment limitations) proceeded all the way through to full destratification. The peak thermal stratification found in these tests ranged from weak to severe; one test saw a difference of 65.1 °C between the mixed and unmixed regions.

The characteristic thermal profiles from the RCIC-Alignment tests had a number of common features that were expressed in the tests. Identification and examination of those features, expressed as "Key Points" here, allowed the development of an empirical correlation that expresses the aggregate pool mixing state developed in this testing program. As chugging at the steam-water interface in the RCIC Sparger played a very prominent role in pool mixing conditions, the correlation development began with Liang and Griffith's [29] expression for the boundary of the chugging; corrections were then applied to adapt it to the data gathered here.

Further testing would allow full scalability to be established. Specifically, further work remains for determining the effects of the aspect ratio between the sparger outlet size and pool dimensions as well as the effect of pool and sparger depth (the variations here are very limited in range); these are key for defining the scalability of these tests and the correlation developed from them. Without such work, the model developed here cannot be guaranteed to reflect full-scale conditions in a BWR.

In addition, a more complete exploration of the two-phase steam/water injection conditions should be performed. Although two-phase steam/water exploration has been performed here, the limited number of tests that could be performed in a timely manner prevented a complete, thorough exploration of the two-phase steam-water regime as motivated by scenarios depicting reactor overfill from an uncontrolled RCIC System.

6.1 KEY FINDINGS

Of the results presented, there are several findings of broad substance:

- Thermal stratification can form in large pools where heat is injected through DCC of very pure steam; BWR Suppression Pools are not immune
- Thermal stratification can limit the high-temperature exposure to pumps drawing suction from the bottom of thermally stratified pools
- Chugging (at high pool subcooling) and bubbling (at low pool subcooling) can cause significant bulk mixing currents, but at intermediate levels of subcooling mixing currents are limited, permitting thermal stratification
- Vent tube/sparger design and placement are significant factors in the ability of stratification to form
- While steam injection rate, quality, and Suppression Chamber pressure conditions all affect the development of thermal profiles, pressure conditions are the most significant
- With the correlation developed in this effort, key events and phenomena in the development of thermal profiles in similar pools can be predicted

6.2 RELEVANCE TO THE EVENTS AT FUKUSHIMA DAIICHI

In the progression of events in the accidents at Fukushima Daiichi, the RCIC Systems continued operation into essentially uncharted territory. The data gathered here may be able to provide insight into the operational details for the Fukushima RCIC Systems.

The thermal stratification developed here would tend to limit exposure of the RCIC Pump to hot water, and could act to protect it. However, for the thermal stratification to develop, SRV operations would need to be limited, as injection through an SRV analog in these tests tended to mix the entire pool. It would also be affected by the specific design of the vent line – which was different between Unit 2 and Unit 3. Check valves and vacuum breakers are used in plant systems, but were not installed in this experimental facility. They would tend to limit the backpropagation of some phenomena to the RCIC Turbine, weaken chugging, and prevent the damaging mechanical loading of structures. This dampening of chugging oscillations could encourage thermal stratification to begin earlier, but the degree to which this is the case is uncertain.

At Fukushima, SRV actuation was contemporaneous with RCIC System operation. While this places the Suppression Pool in the role of primary heat sink, the large masses of other material in containment can act as additional thermal reservoirs. Further, flooding in the Torus room can seriously affect thermal distributions, and act to remove heat from containment. None of these conditions were explored in this work.

As a result, while these tests have demonstrated the potential for thermal stratification, they are not proof of its occurrence at Fukushima. More phenomena and specific operational details need to be considered to draw such conclusions. In addition, to apply the correlation developed herein, scalability to such systems needs to be established.

6.3 FUTURE WORK

Even the most exhaustive studies leave room for future development, and this is no different. Three categories of future efforts are identified here based on the necessary level of anticipated effort to perform the work.

Can be done quickly with limited system modification:

- Further analysis of existing data
- Two-phase regime fill-in
- Additional power levels
- Additional pressurization/venting conditions
- More/less water in the pool (varied depth)
- Closer adherence to plant operating procedures

Can be done with system overhaul:

- Other sparger sizes and designs
- Better vertical thermal resolution and additional plume details
- More instruments in/on/around sparger

- Ability to run pool/pump much hotter and explore bubbling
- Exploration of the effects of RCIC Pump suction aligned to the Condensate Storage Tank (no water extraction from the Suppression Pool)

Can be done only with major changes:

- Video recording of important locations
- Alternate Suppression Chambers
- Strict DCC investigation to produce new regime maps with additional variables (pressure, steam quality, vent tube design)
- Installation and investigation of Terry turbine-driven pump
- Effect of external cooling of the Suppression Chamber vessel (i.e., flooding of the Torus room in a BWR with the Mk. I containment)

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APPENDIX A

SYSTEM P&ID COLLECTION

This Appendix contains the P&IDs for the complete system and in more detail than those given in the main text. The analog to the RCIC Turbine is given in Figure 83 and the system overview is in Figure 84. The four subsequent P&IDs contain the more detailed drawings of the system, starting with the water deionization system and hot water tank in Figure 85. The bulk of the experiment in operating mode is then split into two parts along the physical separation imposed by the loading bay; the Steam Generator and connected equipment is given in Figure 86, and the Suppression Chamber side is diagrammed in Figure 87. After a test is finished, the system is realigned to Cooldown Mode; this is given in Figure 88.

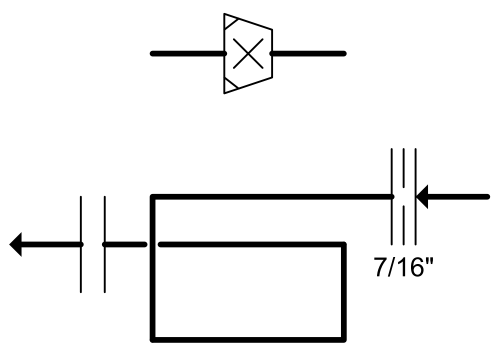

Figure 83: Turbine Analog Design

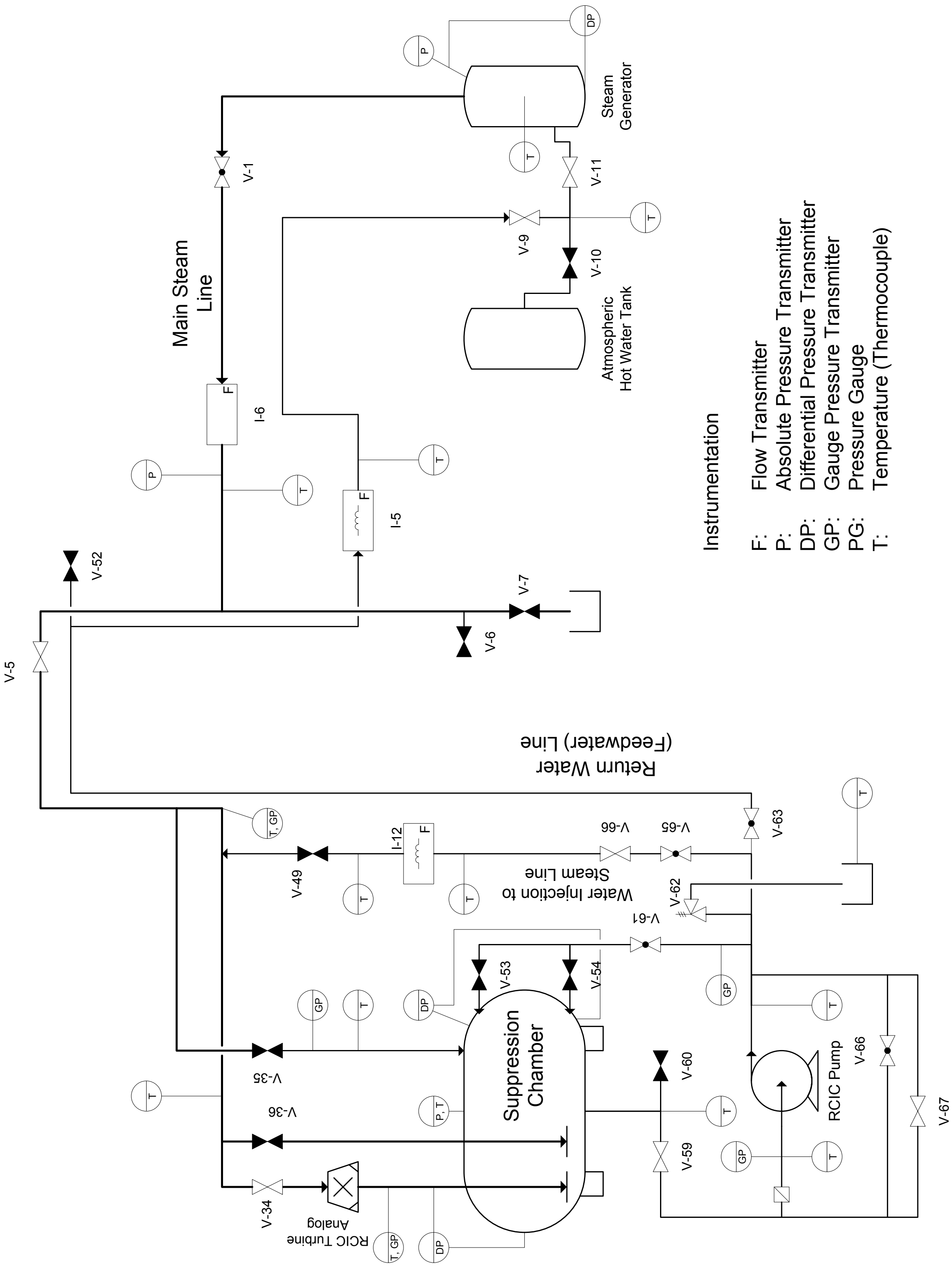

Figure 84: Enhanced System P&ID Overview

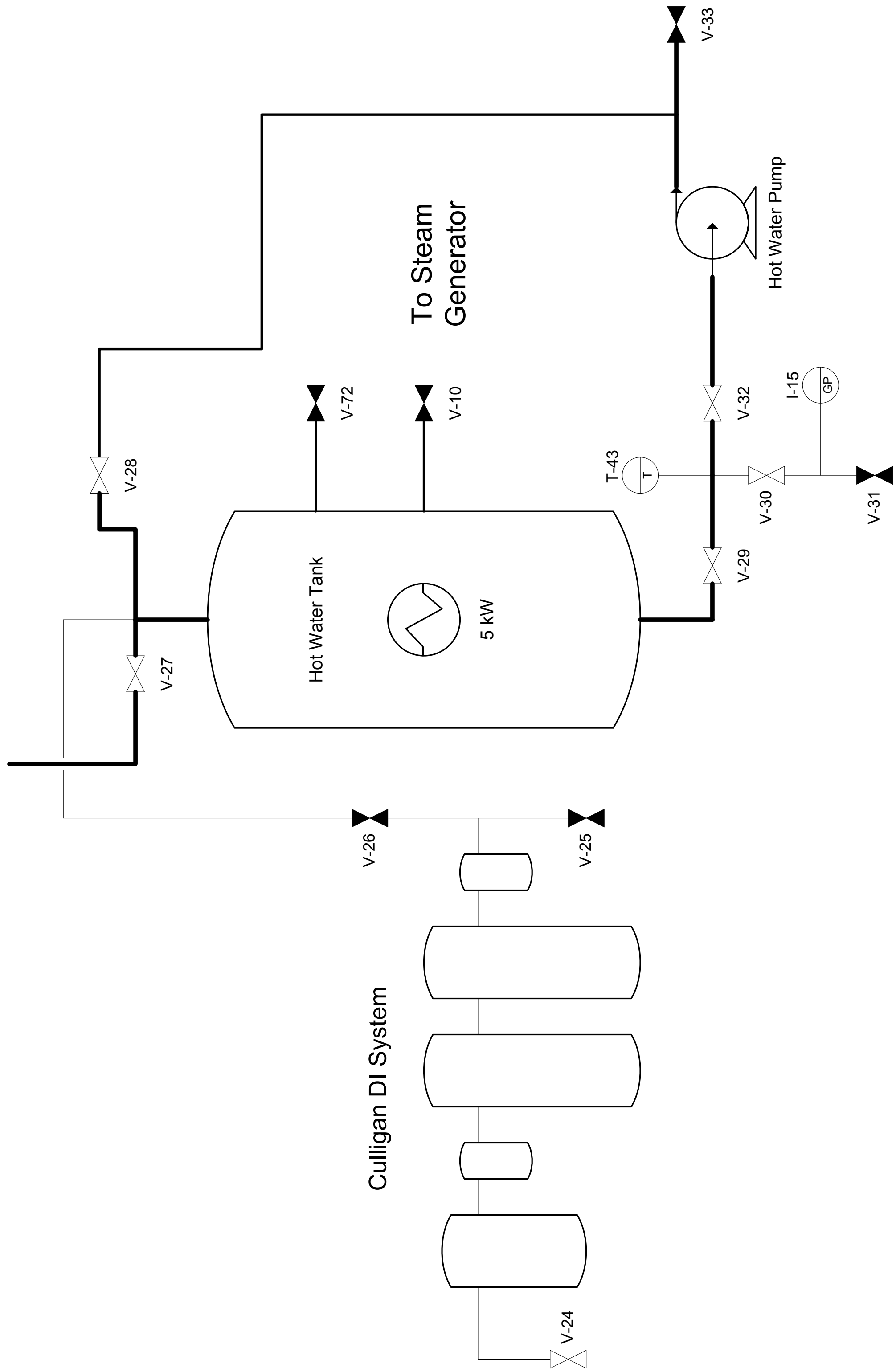

Figure 85: DI System and Hot Water Tank

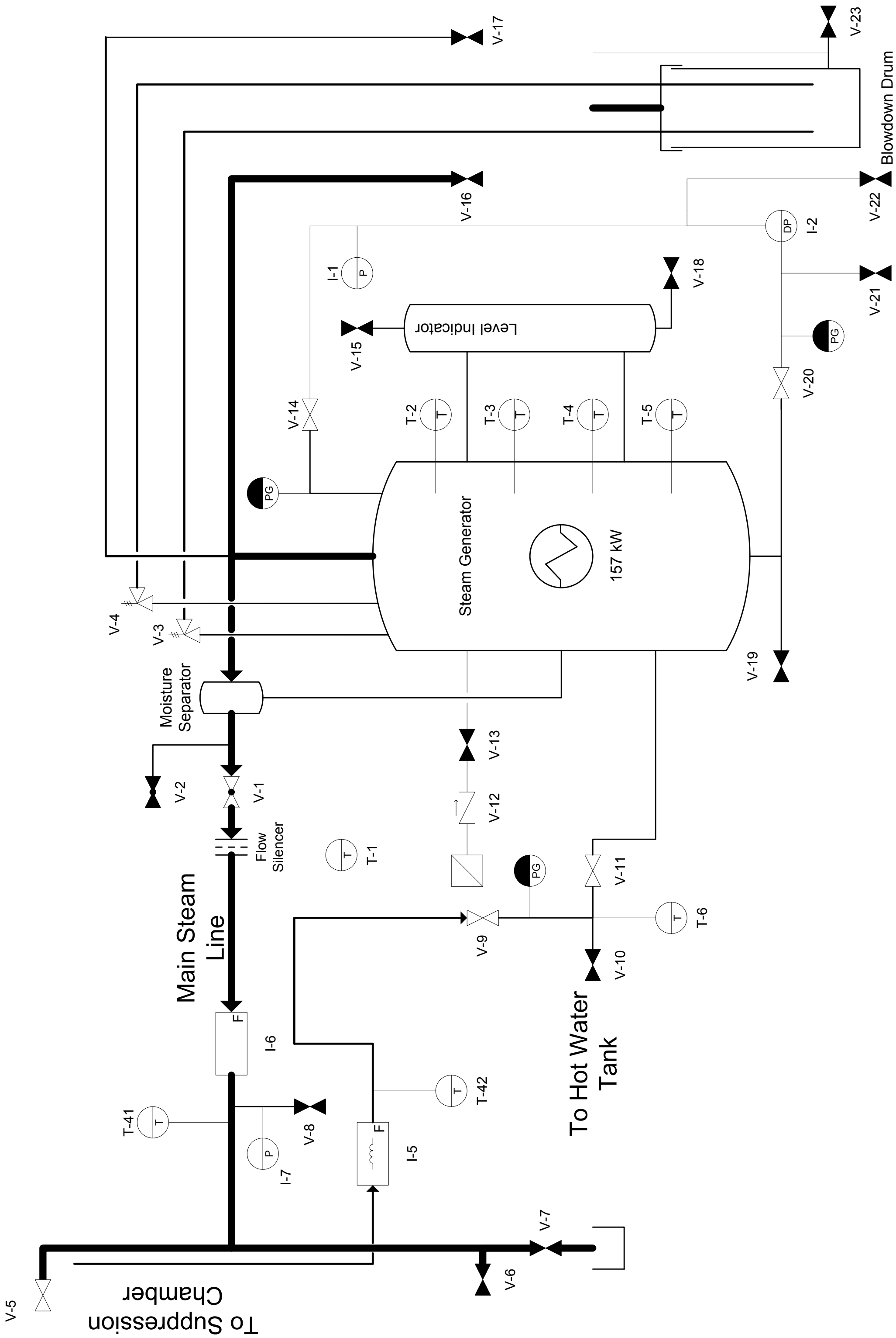

Figure 86: Steam Generator System P&ID

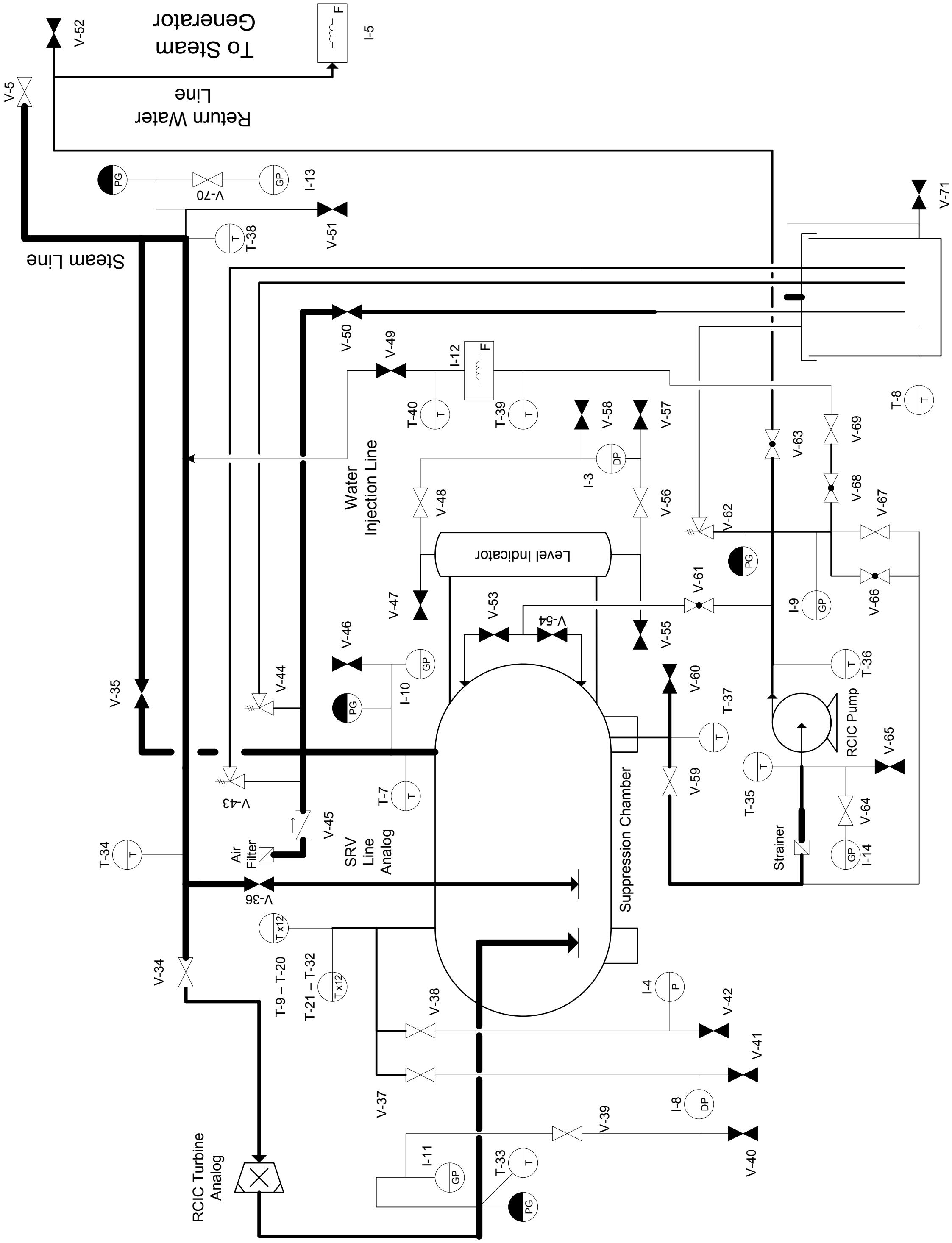

Figure 87: Suppression Chamber System

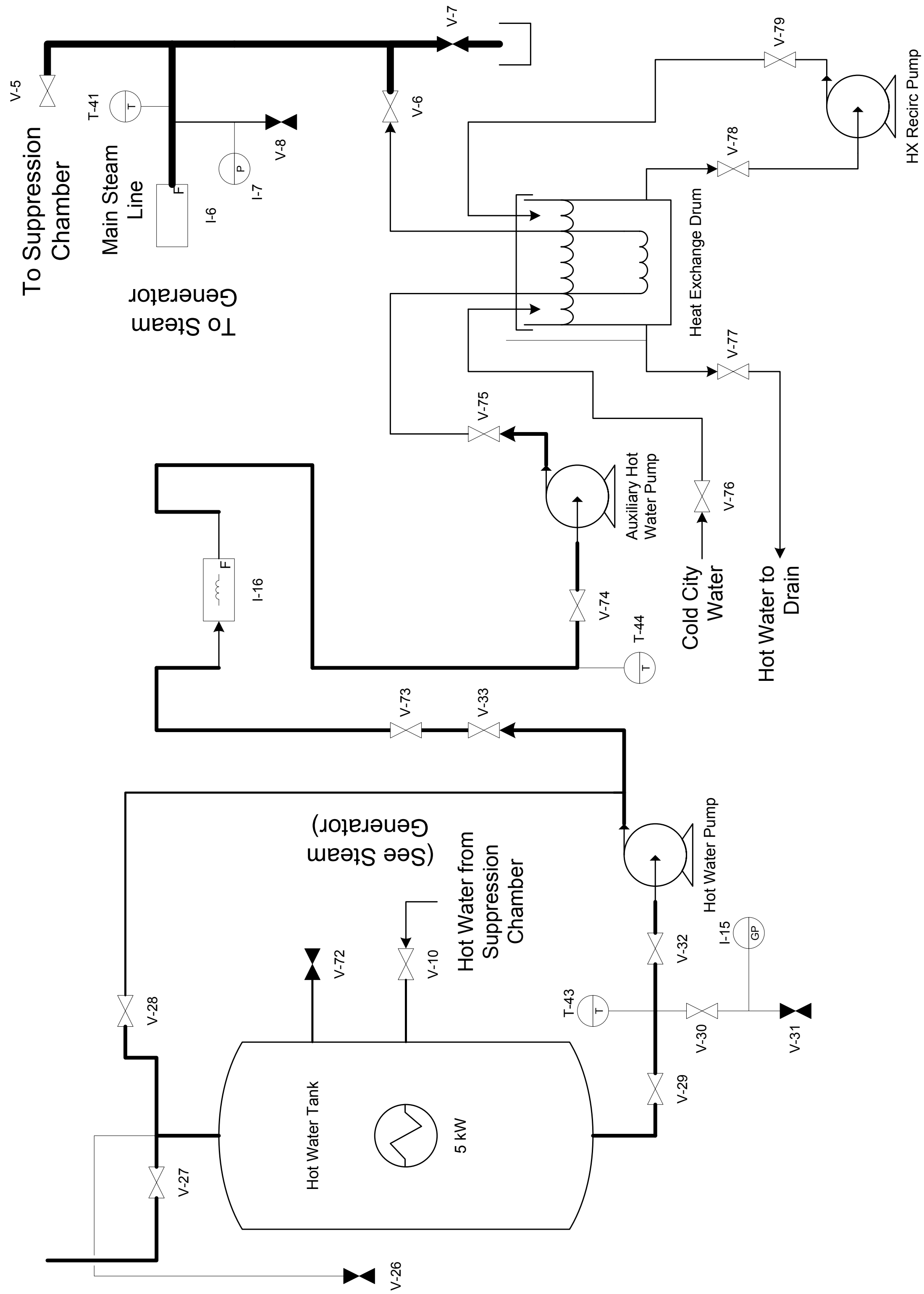

Figure 88: Cooldown Setup

APPENDIX B

MEASUREMENT ERROR ANALYSIS

This Appendix contains the details on the error analysis performed to propagate instrument error through to its resulting measurement error in the Mixing Number.

B.1 MAIN STEAM LINE MASSFLOW

To determine mass flows in the main steam line prior to water injection, the vortex flowmeter (I-6) is collocated with the main steam line pressure transmitter (I-7) and a main steam line temperature reading (T-41). The vortex flowmeter, when flow is in its accurate range, has an associated error of 1%. The pressure transmitter has an error of 0.1% of its Upper Range Value (130 psia, resulting in an error of 0.13 psi), and the Type T thermocouple with Special Limits of Error has an error of 0.5 °C. An ideal gas treatment for steam around 1 atm and 100 °C will lead to the greatest fractional error in computed density for the range of interest; the contribution of the pressure transmitter (proportional to P) translates to 0.884%, and the temperature error contribution (proportional to 1/T) is 0.134%. Application of the temperature error to the K-factor correction term (translates to a 0.0026% error) becomes vanishingly small when propagated through.

$$\left(\frac{\sigma_u}{u}\right)^2 = \left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2 \tag{25}$$

$$\sigma_u^2 = \sigma_x^2 + \sigma_y^2 \tag{26}$$

Application of Eq. (24) to multiplication or division (u = xy or x/y) results in Eq. (25), while addition and subtraction (u = x ± y) results in Eq. (26) [60]. Utilizing these formulae, respecting the vortex flowmeter's outputs defined by Eqs. (4) - (7), yields an error in the mass flowrate measurement of 1.342% (contributions of 1% from the meter itself, 0.884% from the pressure measurement, and 0.134% from the temperature measurement).

In two-phase injection tests, the Badger M2000 magnetic flowmeter (I-12) monitors a secondary flow of material into the main steam line. The density difference of water across the 0.5 °C error of the thermocouples is not great, especially when the two measurement points are taken in conjunction. As a result, the 0.25% volumetric flow error of the flowmeter translates to 0.252% error in the mass flowrate. This includes the contribution of thermal expansion error from temperature measurement error, where the thermal expansion of water near 100 °C was estimated from steam table data to be ~ 0.0007 1/°C. In two-phase tests, the flowrates and therefore the variances are additive by Eq. (26). The relative error, therefore, will improve under addition. To account for single-phase testing, the vortex flowmeter's mass flowrate relative error of 1.34% will be taken as a bounding value for the relative error of total massflow in single and two-phase tests.

B.2 POOL PRESSURE AND LEVEL

As with the Main Steam Line pressure transmitter, the Suppression Chamber's absolute pressure transmitter (I-4) has an error of 0.1% of its Upper Range Value (100 psia); this results in an error of 0.1 psi. The relative error, most limiting under atmospheric conditions, would be 0.68%. The pressure in the RCIC Sparger analog's outlet was assumed to be that of the steam line as it enters the vessel en route to the outlet; this is determined by summing the Suppression Chamber's airspace pressure with the differential pressure between it and the steam line (using I-8). The DP transmitter has an error of 0.075% URV, which at 400 inH_2O translates to 0.011 psi. Combined with the AP transmitter's error under atmospheric conditions, the relative error of the steam injection pressure is 0.684%. It should be noted that in the processing script, smoothing was used to limit the influence of pressure spikes appearing from chugging oscillations.

The level of the pool is measured with another DP transmitter (I-3), comparing the airspace pressure with the hydraulic head at the pool bottom. Its common-mode pressure issue was assumed to be resolved in data processing with a compensation curve (see Section 3.3.6), and density-based adjustments for hot levels are provided as well. Its URV of 80 inH_2O translates to an error of 0.06 inH_2O (0.166 cmH_2O). The density-correction for a hot pool is expected to be worst as the pool approaches its hot limits (before relief valve actuation); near 150 °C, use of the X-Steam steam tables revealed a partial derivative of density with respect to temperature of -0.934 kg/m^3-K (with a density of 917 kg/m^3). With 4 vertical temperature measurements in the pool to account for local density, a simplification of the processing algorithm for hot pool levels resembles Eq. (27).

$$z = \frac{\Delta P_{level}}{\frac{1}{4} g\left(\rho_{outlet} + \rho_{low} + \rho_{middle} + \rho_{upper}\right)} \tag{27}$$

The 0.467 kg/m^3 error in density at each measurement point propagates through, with the 0.166 cmH_2O error of the DP transmitter, to a final level error of 0.167 cm. With a pool level near 82 cm hot (lower when cold), this is a 0.205% relative error.

B.3 ENTHALPIES

The enthalpies of both injected two-phase steam and nearby pool water are involved in the correlation as well as their saturation conditions. This analysis takes into account heat loss when determining the enthalpy of steam in the RCIC sparger analog.

B.3.1 Heat Loss

Data recorded during Test #4 was used to estimate a heat loss coefficient for the Main Steam Line. With a room temperature of 24.9 °C and a pressure of 51.6 psia in the MSL, the steam temperature dropped from 147.3 °C at the flowmeter to 141.9 °C near the turbine analog inlet. Massflow was 46.3 g/s, and there was assumed to be no significant pressure drop between the temperature measurements. Under these conditions, the heat loss was approximately 560 W. Using a simple heat loss formulation ($\dot{Q} = H\Delta T$) with the difference between only the room temperature and steam temperature at the vortex flowmeter, H is approximately 4.58 W/K. The error in H, owing to the limited temperature difference between the upstream and downstream temperatures as well as inclusion of the mass flowrate error, is 12.969%. A $c_p = 2.21$ kJ/kg around 144.5 °C was applied to the temperature errors in the calculation. With this error in the coefficient, its use with uncertain temperatures (room temperature of 25 °C, steam of 100 °C) will result in an estimated heat loss error of 13.003%. While the relative error is large, the heat loss itself is not (560 W is less than 1% of the low-power tests' steam generator power of 57 kW).

B.3.2 Pool Subcooling

The pool subcooling enthalpy ($h_{w,sat}$ - h_w) depends on local pressure and temperature. The saturation enthalpy of water increases at a rate of 1.179 x 10^{-3} kJ/kg-Pa around 1 bar, and c_p for water is around 4.18 kJ/kg-K. Temperature error is, as with every other thermocouple used here, 0.5 °C. Combining the temperature and pressure error (0.1 psi), the error in the subcooling enthalpy is 2.244 kJ/kg. When the pool is on the order of 25 °C subcooled, this yields a relative error of 2.148%.

B.3.3 Steam Enthalpy

At the vortex flowmeter, when steam is around 1 bar at 100 °C, the partial derivative of enthalpy with respect to pressure is -12.7 kJ/kg-bar (and closer to -7.6 kJ/kg-bar near 8 bar). With the error in the pressure measurement (0.13 psi), this results in an error in enthalpy of 0.114 kJ/kg. The c_p value for saturated steam, in the range of interest here, goes from 2.08 kJ/kg-K at 1 bar to 2.60 kJ/kg-K at 8 bar. Application of the temperature error (0.5 °C) at 8 bar yields an error of 1.30 kJ/kg. When combined (unrealistically) with the pressure contribution (value from 1 bar), the overall error in enthalpy at the vortex flowmeter is 1.305 kJ/kg.

$$h_{mix} = \frac{\dot{m}_{st} h_{st} + \dot{m}_w h_w - \dot{Q}_{loss}}{\dot{m}_{st} + \dot{m}_w} \tag{28}$$

Downstream of the vortex flowmeter, at the inlet to the turbine analog, the enthalpy of the two-phase mixture is estimated by Eq. (28). Application of Eq. (24) to Eq. (28) produces Eq. (29). For this determination, certain reference conditions are helpful. Steam will be initially be referenced to 150 °C with an enthalpy of 2758 kJ/kg, a room temperature of 25 °C, and the flowrate will be 24 g/s steam in a single-phase test for analytical simplicity. This reduces Eq. (28) to Eq. (30):

$$\sigma_{mix}^2 = \frac{1}{(\dot{m}_s + \dot{m}_w)^2}\sigma_{\dot{Q}}^2 + \left(\frac{\dot{m}_s}{\dot{m}_s + \dot{m}_w}\right)^2 \sigma_{h_s}^2 + \left(\frac{\dot{m}_w}{\dot{m}_s + \dot{m}_w}\right)^2 \sigma_{h_w}^2 + \left[\frac{\dot{m}_w(h_s - h_w) + \dot{Q}}{(\dot{m}_s + \dot{m}_w)^2}\right]^2 \sigma_{\dot{m}_s}^2 + \left[\frac{\dot{m}_s(h_w - h_s) + \dot{Q}}{(\dot{m}_s + \dot{m}_w)^2}\right]^2 \sigma_{\dot{m}_w}^2 \tag{29}$$

$$h = h_{st} - \frac{\dot{Q}_{loss}}{\dot{m}_{st}} \tag{30}$$

At the vortex flowmeter, the steam enthalpy's error was 1.305 kJ/kg. The Badger flowmeter's two thermocouples enables registration of water enthalpy to ± 1.478 kJ/kg. To bound two-phase tests as the main steam line goes near water-solid, the 1.478 kJ/kg value will be the value applied. Here, heat loss is estimated at 572 W; this produces a loss of 23.846 ± 3.117 kJ/kg. Propagation of the initial enthalpy error brings the total error in enthalpy to 3.450 kJ/kg for Eq. (30). The full treatment from Eq. (29) for a two-phase test (the same steam conditions with 12 g/s water at 65 °C) results in h_{mix} = 1913.559 ± 10.769 kJ/kg, a value greater than either saturated steam or saturated water conditions.

Pressure in the Suppression Chamber was always less than 8 bar, which has a latent heat of vaporization of 2047.67 kJ/kg; it is greater at lower pressures and will therefore be used as a minimum bounding value. Used as such, the steam quality can be determined to ± 0.00526 in the described two-phase case.

The determination of the error in the "Two-Phase Jakob Number" from Eq. (20), Ja/x_u, proceeds with additional error due to the uncertain saturation enthalpy of water.

Previously in B.3.2, the subcooling enthalpy error was found to be 2.244 kJ/kg. Inclusion of the saturation enthalpy error (0.818 kJ/kg due to pressure measurement error) brings the full condensation enthalpy (the enthalpy the two-phase saturated steam-water mixture would need to lose to bring it to fully saturate water at the same pressure) error from 10.769 to 10.800 kJ/kg. Combining this all for the two-phase case above, with an atmospheric pool, Ja_{TP} is 0.09818 ± 0.00166 (a 1.692% relative error). Warming the pool to 25 °C subcooling brings it to 0.07030 ± 0.00159 (a 2.255% relative error). This will be considered the representative relative error in Ja_{TP} moving forward.

B.4 PRESSURE BETA PARAMETER

An estimate for the error in β_p defined in Eq. (17) can be estimated for pressures around 1 bar and water temperatures near 40 °C by applying a value of dP_{sat}/dT, which ranges from 0.128 bar/°C at 150 °C, through 0.036 bar/°C at 100 °C, down to 0.00394 bar/°C at 40 °C. With a vapor pressure of 0.0738 bar, temperature error (0.5 °C) brings the relative error in computed vapor pressure to 2.666%. Bringing in the error in the measured pressure (0.684%) brings the relative error to 2.752% for everything under the radical. Including the effects of the radical follows Eq. (31), as it proceeds from Eq. (24).

$$u = x^a$$
$$\sigma_u^2 = \left(\frac{\partial u}{\partial x}\right)^2 \sigma_x^2 = \left(ax^{a-1}\right)^2 \sigma_x^2 = \left(\frac{au}{x}\right)^2 \sigma_x^2 = a^2\left(\frac{\sigma_x}{x}\right)^2 \quad (31)$$

The effect of the radical is to halve the relative error. Therefore, the relative error for β_p is 1.376%

B.5 DENSITY

Densities appear in the final form of the correlation as two density ratios. One includes two-phase steam and subcooled water, while the other density ratio is between saturated water and saturated steam.

B.5.1 Saturation Density Ratio

The density ratio of saturated water to saturated steam is a function of saturation pressure, and has its steepest changes at low pressure. Upon steam table inspection at 1 bar, the ratio is decreasing at a rate of 1553/bar from 1624. Applying the pressure measurement error, the error in the density ratio becomes 0.663%.

B.5.2 Subcooled Water Density

The density of subcooled water in the range of applicable pressures is primarily a function of temperature. At the upper range of temperatures in this experiment (150 °C), water density is 917 kg/m^3 and dropping at a rate of 0.934 kg/m^3-K. Use of the temperature error gives a relative error in subcooled water density of 0.0509%.

B.5.3 Two-Phase Steam Density

Steam here is treated homogeneously. Therefore, in the two-phase region, the two-phase steam density can be expressed as a function of liquid and vapor saturation densities along with the quality as shown in Eq. (32):

$$\rho_{TP} = \frac{\rho_{l,sat}\rho_{v,sat}}{x\rho_{l,sat} + (1-x)\rho_{v,sat}} \tag{32}$$

Application of Eq. (24) to Eq. (32) yields Eq. (33), which simplifies to Eq. (34):

$$\sigma_{\rho_{TP}}^2 = \left\{ \frac{-\rho_{l,sat}\rho_{v,sat}\left(\rho_{l,sat} - \rho_{v,sat}\right)}{\left(x\rho_{l,sat} + (1-x)\rho_{v,sat}\right)^2} \right\}^2 \sigma_x^2 + \left\{ \frac{\rho_{v,sat}\left(x\rho_{l,sat} + [1-x]\rho_{v,sat}\right) + x\rho_{l,sat}\rho_{v,sat}}{\left(x\rho_{l,sat} + [1-x]\rho_{v,sat}\right)^2} \right\}^2 \sigma_{\rho_{l,sat}}^2 + \left\{ \frac{\rho_{l,sat}\left(x\rho_{l,sat} + [1-x]\rho_{v,sat}\right) + [1-x]\rho_{l,sat}\rho_{v,sat}}{\left(x\rho_{l,sat} + [1-x]\rho_{v,sat}\right)^2} \right\}^2 \sigma_{\rho_{v,sat}}^2 \quad (33)$$

$$\left(\frac{\sigma_{\rho_{TP}}}{\rho_{TP}}\right)^2 = \left\{ \frac{\rho_{l,sat}\rho_{v,sat}}{x\rho_{l,sat} + [1-x]\rho_{v,sat}} \right\}^2 \sigma_x^2 + \left\{ \frac{1}{\rho_{l,sat}} + \frac{x}{x\rho_{l,sat} + [1-x]\rho_{v,sat}} \right\}^2 \sigma_{\rho_{l,sat}}^2 + \left\{ \frac{1}{\rho_{v,sat}} + \frac{1-x}{x\rho_{l,sat} + [1-x]\rho_{v,sat}} \right\}^2 \sigma_{\rho_{v,sat}}^2 \quad (34)$$

When the steam is superheated (no water injection), ideal gas treatments near 100 °C and 1 bar produce a relative error from pressure and temperature of 0.706%. Near 1 bar saturation pressure, the saturation density of water changes at approximately -19.9 kg/m^3-bar. For steam, the rate is 0.552 kg/m^3-bar. These produce water and steam saturation density relative errors of 0.0144% and 0.642%, respectively. Upon insertion into Eq. (34), at 1 bar, the relative error in wet steam density ranges from 0.526% near saturated water (x = 0) to nearly 1.22% at dry saturated steam (x = 1).

B.6 OTHER PROPERTIES

Two of the three properties which constitute the subcooled water's Prandtl number remain in the final correlation; the viscosity term drops out. The remaining ratio, c_p/k, depends largely on the water's temperature. The largest swings in the temperatures of interest happen at low temperatures. At 40 °C, the ratio has a value of 6647.286 1/Pa-s (as estimated from application of steam tables) and is changing at a rate of -13.473 1/Pa-s-K. Applying the temperature measurement error produces a relative error of 0.101%.

B.7 CORRELATION TERMS

The final form of the correlation is expressed in 5 nondimensional groups; two of these, Ja_{TP} and the saturation density ratio, have already had their instrumentation-related relative errors derived.

B.7.1 Steam Froude Number

The Froude number from Eq. (10) can be re-expressed as Eq. (35) to utilize terms with previously defined error.

$$Fr_s = \frac{\dot{m}_{TP}}{\rho_{TP} A \sqrt{g \cdot d_{outlet}}} \tag{35}$$

The depth term is the depth of the sparger's outlet, not that of the entire pool. It takes the pool depth and subtracts 39.4 cm (the height of the outlet above the pool bottom). With a pool depth of 75 cm, the outlet would be at a depth of 35.6 cm. This readily increases the relative error to 0.469% in the depth term (the level error from B.2 is 0.167 cm). Propagation of the errors from the depth, mass flowrate (1.342%), and density (1.22%) results in a relative error of 1.828% in this Froude number.

B.7.2 Two-Phase Density Ratio

Recalling the subcooled water density relative error of 0.0509% and the wet steam density relative error of 1.219% enables quick propagation through to the relative error of the density ratio. For the wet steam / subcooled water density ratio, this is 1.220%

B.7.3 Radical Group

The group c_p*G*d/k, which is the leading group in Eq. (23) and can be placed under a radical (it is raised to the power of ½), is ready for its terms to have their errors propagate to the group as a whole. The result is a relative error of 1.345%, recalling the error in c_p/k (0.101%) and G (1.342%).

B.8 INCLUSION OF EXPONENTS

Each of the nondimensional groups is raised to a power that is nonunity, with the exception of the saturation density group at KP10. Some of the exponents are constant, while others vary with β_p.

B.8.1 Constant Powers

The radical group, two-phase density ratio, and saturation density ratio at KP10 all have constant exponents. Following from Eq.(31), computing their relative error is straightforward. For the radical group, the relative error becomes 0.673% (from 1.345%). The two-phase density ratio has its relative error drop to 0.610% from 1.220%. Finally, at KP10, the saturation density ratio, with a power of 1, remains at 0.663%. The KP10 value was chosen rather than KP5 or KP7 to provide an estimate that would be applicable to all the constant-power Key Points, and would not be an underestimate.

B.8.2 Variable Powers

The use of exponents with error requires another formulation for error propagation in addition to those defined previously. This formulation is shown in Eq. (32).

$$
\begin{aligned}
&u = x^{y};\\
&\sigma_u^2 = \left(yx^{y-1}\right)\sigma_x^2 + \left[\ln(x)\right]^2 \sigma_y^2;\\
&\left(\frac{\sigma_u}{u}\right)^2 = \left(y\frac{\sigma_x}{x}\right)^2 + \left(\ln(x)\sigma_y\right)^2
\end{aligned}
\qquad (36)
$$

For the parameters that have exponents with β_p, two values will be considered for β_p. One, a bounding value where β_p=1, and a more realistic value applicable to the Key Points. The realistic, nonbounding value of β_p is that of a pressure of 1 bar with a pool temperature of 40 °C; β_p is then 0.272 and the relative error computed for the parameter in B.4 is 1.376%.

The value for the Two-Phase Jakob number (which has a relative error of 2.255% as computed in B.3.3 before consideration of the exponent) is slightly unrealistic for a 1-bar pool at 40 °C, being based on a subcooling of 25 °C. Nevertheless, it shall be used as a reference point. A quirk of the value for the exponent (Ja_{TP} is raised to a power of -1 + β_p /16) results in the greater β_p value slightly reducing the relative error (2.127%) when compared to the lesser value for β_p (producing 2.218% error), as it brings the exponent closer to zero than it otherwise would be. Therefore, the bounding estimate will be set to 2.218%.

The steam Froude number is estimated from a mass flowrate of 75 g/s, a pool depth of 75 cm, and a pressure of 1 bar with saturated steam. The resultant value for Fr_s

is then 51.758. Propagation of the error (1.828% in B.7.1) through with the exponents (a power of -3/8 - β_p/2) brings its final relative error to 1.190%, which increases to 3.151% in the bounding estimate.

The final term, the saturated density ratio, uses the previous reference value of 1624 from B.5.1 with a relative error of 0.663%. Its expression for the exponent changes; Key Points 2-4 use ¼ + 3β_p/16, while Key Point #10 uses a value of 1. The realistic relative error was computed to be 0.555%, while the bounding estimate increased to 1.929%.

B.9 OVERALL ESTIMATES

With the completed estimates, bounding and realistic, for each of the terms in the Mixing Number correlation (including exponents), four cases will be considered: a bounding case and a realistic case for early stages (KP2-4) and the same consideration for late stages, using KP10 as the reference formulation.

Due to constant exponents or limiting assumptions, three of the terms in the Mixing Number correlation have relative errors that do not change with stage or case. These are the radical group (0.673%), the steamflow/pool water density ratio (0.610%), and the two-phase Jakob Number (2.218%). The steam injection Froude Number has a realistic error estimate of 1.190% and a bounding value of 3.151% for early and late stages. Finally, the saturation density ratio, in late stages, has a 0.663% error in both realistic and bounding cases; early stages have a realistic estimate of 0.555% error and a bounding estimate of 1.929% relative error.

Propagation to the overall measurement error for the Mixing Number in the early stages produces a realistic estimate of 2.733%; the bounding estimate increases it to 4.359%. Late-stage error similarly ranges from a base case of 2.757% to a bounding estimate of 4.014%. Considering these four cases, in all cases the measurement error for the Mixing number should be better than 5%.

APPENDIX C

DATA PROCESSING SCRIPT

This Appendix lists the Matlab script used for processing the collected data.

C.1 GUIDELINES

In order to run, the saved data file must be loaded into memory in Matlab and stored in the 'data' array; the command

```
data = load('outputfile.dat');
```

will perform the task where outputfile.dat is the filename of the saved data file. From there, a number of parameters need to be specified. These include a name for the run, test beginning detection options (using a smoothed or instantaneous temperature), starting temperature, whether or not to save the generated figures, whether or not to put titles on the figures, whether it was an SRV or RCIC run, and a base output directory. The run's name is set by

```
testname = 'NAME_OF_TEST';
```

where NAME_OF_TEST is the string expressing the name. The start detection conditions are set by

```
smooth_sp12 = 1;
startingtemp = 40;
```

where the 1 tells the script to use a smoothing algorithm to detect the threshold temperature for the test beginning detection (use a value of 0 to use instantaneous temperature readings for this purpose). The value of 40 sets the threshold temperature to 40 °C; this can be set lower as in the cool-start tests. The commands to set the options for the figures are

```
savefigs = 'y';
```

```
showtitles = 0;
```

where 'y' tells the script to save the figures ('n' will instruct it to save nothing), and the 0 instructs the script to NOT place titles on the figures (useful for reports; setting it to 1 will insert titles). The remaining options, set by

```
use_turbine = 1;
outpath = 'C:\OUTPUTDIR';
```

tell the script to process the data as a RCIC test (setting use_turbine to 0 instructs the script to process the data as an SRV run) and to save the output in the C:\OUTPUTDIR directory.

The script was written to be able to take advantage of parallel processing capabilities when available. In older versions of Matlab, the command

```
matlabpool open
```

opens up a parallel computing pool for use by the script; it can be closed after processing is complete. Before running the script, it is important to have the XSteam.m steam table function available to Matlab. Originally written by Magnus Holmgren, it returns water properties according to the IAPWS IF-97 standard, and is available for download from the MathWorks community site. With everything ready, the processing script can be invoked at the Matlab prompt with the command

```
rcic_processor
```

which can then take significant time to complete. Progress indication is given by occasional notices printed to screen as processing steps complete; the charts will appear once processing has completed. At the termination of the script, the savefigs variable will be reset to ‘n’.

Besides the figures, there is a text file generated by the script as output containing the processed results in a somewhat human-readable form. If one wishes to dump the processed numeric data into a spreadsheet, a subsequent script can be called after setting the savefigs variable to ‘y’. It is invoked at the Matlab prompt with

```
spreadshout
```

and will save a more spreadsheet-friendly set of results in a separate text file elsewhere in the output directory; the savefigs option will again be reset to ‘n’. Opening the file, copying, and pasting into MS-Excel will put the numbers extracted from the processed output into individual cells.

The data processing script depends on the saved data file having the correct structure. This file is a text file, containing n rows and 136 columns of numbers. Each row is for a specific point in time (set in LabVIEW to be 0.1 s apart for the current data set), and each column contains data from a specific computation. These include mean voltages over the 0.1-s period, temperatures, derived data, etc. Not every column is used by the data processing script.

The meanings of the columns in the data file recorded by LabVIEW are given in Table 13, Table 14, Table 15, Table 16, and Table 17. Cooldown mode records additional data, which is stored in subsequent additional columns in the output files. These additional columns have data as given by Table 18.

Table 13: Output File Columns 1-28

Column	Datum
1	Time, s
2	Room Temperature, C (T-1)
3	RT σ
4	Steam Generator Top Temperature, C (T-2)
5	SG T σ
6	Steam Generator Upper Temperature, C (T-3)
7	SG U σ
8	Steam Generator Middle Temperature, C (T-4)
9	SG M σ
10	Steam Generator Lower Temperature, C (T-5)
11	SG L σ
12	Steam Generator Water Injection Temperature, C (T-6)
13	SG WI σ
14	Suppression Chamber Top Flange Temperature, C (T-7)
15	SP TF σ
16	Suppression Chamber Blowdown Drum Temperature, C (T-8)
17	SP BD σ
18	SP 24 (T-9)
19	SP 24 σ
20	SP 23 (T-10)
21	SP 23 σ
22	SP 22 (T-11)
23	SP 22 σ
24	SP 21 (T-12)
25	SP 21 σ
26	SP 20 (T-13)
27	SP 20 σ
28	SP 19 (T-14)

Table 14: Output File Columns 29-56

Column	Datum
29	SP 19 σ
30	SP 18 (T-15)
31	SP 18 σ
32	SP 17 (T-16)
33	SP 17 σ
34	SP 16 (T-17)
35	SP 16 σ
36	SP 15 (T-18)
37	SP 15 σ
38	SP 14 (T-19)
39	SP 14 σ
40	SP 13 (T-20)
41	SP 13 σ
42	SP 12 (T-21)
43	SP 12 σ
44	SP 11 (T-22)
45	SP 11 σ
46	SP 10 (T-23)
47	SP 10 σ
48	SP 9 (T-24)
49	SP 9 σ
50	SP 8 (T-25)
51	SP 8 σ
52	SP 7 (T-26)
53	SP 7 σ
54	SP 6 (T-27)
55	SP 6 σ
56	SP 5 (T-28)

Table 15: Output File Columns 57-84

Column	Datum
57	SP 5 σ
58	SP 4 (T-29)
59	SP 4 σ
60	SP 3 (T-30)
61	SP 3 σ
62	SP 2 (T-31)
63	SP 2 σ
64	SP 1 (T-32)
65	SP 1 σ
66	Turbine Analog Downstream Temperature (T-33)
67	Turbine DS σ
68	Steam Line Downstream of Water Injection Temperature (T-34)
69	MSL WI DS σ
70	Pump Inlet Temperature (T-35)
71	Pump In σ
72	Pump Outlet Temperature (T-36)
73	Pump Out σ
74	Suppression Pool Outlet Temperature (T-37)
75	SP Out σ
76	Steam Line Upstream of Water Injection Temperature (T-38)
77	MSL US WI σ
78	Water Injection Line to MSL Upstream Temperature (T-39)
79	WIMSL US σ
80	Water Injection Line to MSL Downstream Temperature (T-40)
81	WIMSL DS σ
82	Main Steam Line Temperature (T-41)
83	MSL σ
84	Feedwater Temperature at Flowmeter (T-42)

Table 16: Output File Columns 85-112

Column	Datum
85	FWM σ
86	SG Pressure V (I-1)
87	SG P σ
88	SG Pressure psia
89	SG DP V (I-2)
90	SG DP σ
91	SG Level, inH2O
92	SP DP V (I-3)
93	SP DP σ
94	Suppression Pool Level cmH2O
95	SC Pressure V (I-4)
96	SC P σ
97	Suppression Chamber Pressure psia
98	Feedwater to SG V (I-5)
99	FW SG σ
100	Water Return to SG GPM
101	Water Return to SG Density kg/m3
102	Water Return to SG Mass Flow kg/s
103	Main Steam Line Vortex Flowmeter V (I-6)
104	MSL VF σ
105	Steam Density, kg/m3
106	Corrected K Factor
107	Steam Flow Rate, kg/s
108	Main Steam Line Pressure V (I-7)
109	MSL P σ
110	MSL Pressure psia
111	RCIC Turbine Outlet-SP DP V (I-8)
112	RCIC TO-SP DP σ

Table 17: Output File Columns 113-136

Column	Datum
113	Turbine Outlet-SP DP inH2O
114	Pump Discharge GP V (I-9)
115	Pump Out GP σ
116	RCIC Pump Outlet Pressure psig
117	SC GP V (I-10)
118	SC GP σ
119	Suppression Chamber Gauge Pressure psig
120	Turbine Outlet GP V (I-11)
121	TO GP σ
122	Turbine Outlet Gauge Pressure psig
123	Water Injection to Steam Line V (I-12)
124	WISL σ
125	WISL GPM
126	WISL Water Density kg/m3
127	Water Injection to Steam Line Mass Flowrate kg/s
128	Main Steam Line GP V (I-13)
129	MSL GP σ
130	Main Steam Line Gauge Pressure, psig
131	Pump Cavitation Sensor V (not present)
132	Pump CS σ
133	Pump Cavitation Sensor Placeholder (unused)
134	Pump Inlet GP V (I-14)
135	Pump Inlet GP σ
136	Pump Inlet Gauge Pressure, psi

Table 18: Additional Cooldown Output File Columns

Additional Column	Datum
1	Hot Water Tank Outlet Temperature, C (T-43)
2	HWTO σ
3	Between Hot Water Pumps Temperature, C (T-44)
4	BHWP σ
5	Hot Water Tank Magnetic Flowmeter (I-16)
6	HWTMF σ
7	Hot Water Tank Outlet Flowrate, GPM
8	Hot Water Tank Level GP (I-15)
9	HWTL σ
10	Hot Water Tank Flow-Corrected Level, inches

C.2 SOURCE – RCIC_PROCESSOR.M

```
% Matlab script rcic_plots_rcicland.m
% Makes plots for a pre-loaded output data file from the RCIC LabVIEW
% program.  The array to load is 'data', which is n x 136.  n is
% expected to be huge, having recorded a full output set of 136 values 10
% times per second for hours.
% Here, a full set of analysis is performed and plots are generated that
% should be comprehensible in B&W with the markers applied to the lines


%
% ========================
% DATA PREPARATION SECTION
% ========================
%

outstring=[];
filehandle=[];
crlf = sprintf('\r\n');
spargeroffset = -4.0956; % offset, inH2O, for Sparger DP transmitter
% reading as gathered from mean(mar13(1:9000,113))
disp(' ')
disp('Welcome to    R C I C - L A N D !')

% Determine export condition
if (strcmp(testname, '') == 0) && strcmp(savefigs, 'y') && (strcmp(outpath, '') == 0)
    % save the figures to disk
    outdir = [outpath '\Export\' testname '\'];
    disp(['Saving Text and JPEG Files to ' outdir])
    mkdir(outdir);
    disp(' ')
    save_em=1;
    filehandle=fopen([outdir testname '_results_rcicland.txt'], 'w+');
    fprintf(filehandle, '%s\r\n', ['Output Saved to ' outdir]);
    mfigoutdir = [outpath '\MFigs\' testname '\'];
    disp(['Saving MATLAB Figure Files to ' mfigoutdir])
    mkdir(mfigoutdir);
```

```
else
    save_em=0;
    disp('Not Saving Figures to Disk')
end

% Determine the beginning and end times

% Test Begins when SP12 first hits 40 degrees C
% Test Ends one minute before the steam flowrate drops below 10 g/s
foundbeg=0;
foundend=0;
indices=[1201, size(data, 1)-1200];

% Some, esp. SRV, tests make initial noises on SP 12 that can trigger a
% premature test beginning
% If so, a 20-second mean value can be used instead of the instantaneous
% value for SP 12
begintemps=data(:, 42);
if smooth_sp12 == 1
    % use smoothing
    outstring = 'Using 20-second SP 12 averages for beginning detection';
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
    for index = 101:(size(data,1)-100)
        begintemps(index)=mean(data(index-100:index+100, 42));
    end
else
    % do not use smoothing
    outstring = 'Using instantaneous 0-s SP 12 values for beginning detection';
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
    begintemps=data(:,42);
end


for index=1201:size(data, 1)-1200
    if begintemps(index) >= startingtemp
        if foundbeg == 0
            % found beginning
            foundbeg=1;
            indices(1)=index;
        end
    end
    if (foundbeg == 1) && (foundend == 0)
        % check to see if end has been found
        if data(index, 107) <= 0.01
            % found end
            foundend=1;
            indices(2)=index;
        end
    end
end
trunind = indices(1);
if foundend == 1
    % found end signal
    % step back to end limit one minute before signal
    for index=indices(2): -1: 1
        if data(index,1) <= (data(indices(2),1) - 60)
            % found the correct end
            break
        end
    end
else
```

```
    index = size(data,1)-1200;
end

trunind = [trunind index indices(2)];
% set up trimmed data array

trmdat=data(indices(1):index,:);
trmdat(:,1) = trmdat(:,1) - data(indices(1),1);

% set up expanded trimmed array for regression through both ends
trmreg = data( (indices(1)-1200) : (index+1200), :);
trmreg(:,1) = trmreg(:,1) - data(indices(1),1);

% Time data is in Column 1.

t=trmdat(:,1);

if foundbeg == 0
    outstring='Beginning NOT detected, using t_first';
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
end

if foundend == 0
    outstring='End NOT detected, using t_final';
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
end

outstring=['Beginning (KEY POINT #1) detected at t plus ' num2str(data(indices(1),1)) ' s,
       and ending (KEY POINT #11) at t plus ' num2str(data(index,1)) ' s, for a time
       period of ' num2str(t(end)) ' s.'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

outstring=['Original Data Record Time:  ' num2str(data(end,1)) ' s'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end



%
% ======================
% DATA PROCESSING SECTION
% ======================
%

% initialize the Key Points Vector
ind_end = length(t);
keypoints_ind = [1, ind_end, ind_end, ind_end, ind_end, ind_end, ind_end, ind_end,
       ind_end, ind_end, ind_end, ind_end, ind_end, ind_end];
% Beginning Key Point
keypoints_ind(1) = 1;
% Ending Key Point
keypoints_ind(11) = ind_end;

% Test Start, Plume Detection, Stratification Onset, Peak Top-Mid, Top-Mid
% Reconverge, Peak Mid-Low, Mid-Low reconverge, Peak Low-Out,
% Stratification End, Test End,  Min Mixing Number, Max Mixing Number
```

```
% Initialize the Pool Level Offset Correction Routine
% data gathered in 2015_05_19_test2_pressures.dat
% The following was used to generate the coefficients
% linear extrapolation was used on both the high-pressure and low-pressure
% ends in order to extend the approximate valid range
%
% The approximate valid range is from ~13 to ~103 psia (gas space pressure)
% in the Suppression Chamber
%
%
% pressurelevelcurve = load('..\Data\2015_05_19_test2_pressures.dat');
% [n,ind] = min( pressurelevelcurve(1:23670,97));
% unsortedx = [n; pressurelevelcurve(1240:23670,97)];
% unsortedy = [(pressurelevelcurve(ind,94)- pressurelevelcurve(ind,94));
       (pressurelevelcurve(1240:23670,94) - pressurelevelcurve(ind,94))];
% c3 = polyfit(unsortedx(1:500), unsortedy(1:500), 1);
% c2 = polyfit(unsortedx(5761:11760), unsortedy(5761:11760), 1);
% low_y = polyval(c3, [10; 10.5; 11; 11.5; 12; 12.5; 13; 13.5; 14]);
% high_y = polyval(c2, [101; 101.5; 102; 102.5; 103; 103.5; 104; 104.5; 105]);
% coeffs = polyfit([10; 10.5; 11; 11.5; 12; 12.5; 13; 13.5; 14; unsortedx; 101; 101.5;
       102; 102.5; 103; 103.5; 104; 104.5; 105], [low_y; unsortedy; high_y], 21);
%

% The instrument repots 0 cm when the fill is at or below 7.62 cm (to the
% very bottom) -- its bottom pickup is at z = 7.62 cm (the offsets will be
% subtracted from the indication/reading)
pool_levelgauge_offset = -7.62;

pool_level_offset_coeffs = zeros(1,22);

pool_level_offset_coeffs(01) = -4.704607582712959e-33;
pool_level_offset_coeffs(02) = 2.276830460057674e-30;
pool_level_offset_coeffs(03) = 7.536374883715246e-28;
pool_level_offset_coeffs(04) = -1.026160591394114e-24;
pool_level_offset_coeffs(05) = 4.494410880292239e-22;
pool_level_offset_coeffs(06) = -1.196603784791618e-19;
pool_level_offset_coeffs(07) = 2.229530134698593e-17;
pool_level_offset_coeffs(08) = -3.091202409527790e-15;
pool_level_offset_coeffs(09) = 3.296650614743879e-13;
pool_level_offset_coeffs(10) = -2.756730928255758e-11;
pool_level_offset_coeffs(11) = 1.827364042074039e-09;
pool_level_offset_coeffs(12) = -9.651355766825126e-08;
pool_level_offset_coeffs(13) = 4.063655352840353e-06;
pool_level_offset_coeffs(14) = -1.359106037748376e-04;
pool_level_offset_coeffs(15) = 0.003582795870262;
pool_level_offset_coeffs(16) = -0.073514262386104;
pool_level_offset_coeffs(17) = 1.152395400243147;
pool_level_offset_coeffs(18) = -13.428940832825903;
pool_level_offset_coeffs(19) = 1.116385190403100e+02;
pool_level_offset_coeffs(20) = -6.195804714026652e+02;
pool_level_offset_coeffs(21) = 2.032312773917644e+03;
pool_level_offset_coeffs(22) = -2.931852420874044e+03;

% Determine Pool Saturation Temperatures
poolsat=t;
for index=1:size(poolsat,1)
    poolsat(index)=XSteam('Tsat_p', trmdat(index, 97)*0.0689475728);
end


% Then smooth the rear temperatures
stratsmooth_0 = zeros(size(trmreg,1)-2400, 1); % time
stratsmooth_1 = stratsmooth_0; % Upper
```

```
stratsmooth_2 = stratsmooth_0; % Lower
stratsmooth_3 = stratsmooth_0; % Condensing SP8
stratsmooth_4 = stratsmooth_0; % Mid SP9
stratsmooth_5 = stratsmooth_0; % Out
midsmooth_up = stratsmooth_0; % SP 11
midsmooth_mid = stratsmooth_0; % SP 12
midsmooth_low = stratsmooth_0; % SP 13
smoothwater = stratsmooth_0; % water injection to steam line
smoothedP = stratsmooth_0;
smoothedDP = smoothedP;
smoothedMSLP = stratsmooth_0;
smoothedMSLT = stratsmooth_0;
smoothedMSLmdot = stratsmooth_0;
smoothedwaterT = stratsmooth_0;
smoothedRoomT = stratsmooth_0;
steamenthreg = stratsmooth_0;
smoothedMSLEnth = stratsmooth_0;
MTMDeltaT = stratsmooth_0;
MMLDeltaT = stratsmooth_0;
MLODeltaT = stratsmooth_0;
% Regression analysis
disp('Smoothing 1, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % time
    stratsmooth_0(relind) = trmreg(index, 1);
    % compute and store smoothed temps
    % rear upper SP 3
    p1 = polyfit(x, trmreg( (index-300)  : (index+300), 60), 1);
    stratsmooth_1(relind) = p1(2);
end
disp('Smoothing 2, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % rear lower SP 5
    p2 = polyfit(x, trmreg( (index-300)  : (index+300), 56), 1);
    stratsmooth_2(relind) = p2(2);
end
disp('Smoothing 3, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % near exhaust/middle SP 8
    p3 = polyfit(x, trmreg( (index-300)  : (index+300), 50), 1);
    stratsmooth_3(relind) = p3(2);
end
disp('Smoothing 4, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % further from exhaust/middle SP 9
    p4 = polyfit(x, trmreg( (index-300)  : (index+300), 48), 1);
    stratsmooth_4(relind) = p4(2);
end
disp('Smoothing 5, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % pool outlet
    p5 = polyfit(x, trmreg( (index-300)  : (index+300), 74), 1);
```

```
    stratsmooth_5(relind) = p5(2);
end
disp('Smoothing 6, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % water injection to steamline kg/s
    p5 = polyfit(x, trmreg( (index-300)  : (index+300), 127), 1);
    smoothwater(relind) = p5(2);
end
disp('Smoothing 7, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Suppression Pool P, psia
    p5 = polyfit(x, trmreg( (index-300)  : (index+300), 97), 1);
    smoothedP(relind) = p5(2);
end
disp('Smoothing 8, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % Instead of 1-minute values, 2-minute values are used here to really
    % smooth out the effects of the chugging spikes (+/- 1 minute,
    % shouldn't go further out than that due to the stopping criterion)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-600)  : (index+600), 1) - trmreg(index,1);
    % Sparger DP, inH2O (should eliminate chugging oscillations)
    p5 = polyfit(x, trmreg( (index-600)  : (index+600), 113) - spargeroffset, 1);
    smoothedDP(relind) = p5(2);
end
% P in the line upstream of the sparger, bar absolute
spargerP = (0.0689475728 * smoothedP) + (0.0024884 * smoothedDP);
disp('Smoothing 9, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Steam Line P, psia
    p5 = polyfit(x, trmreg( (index-300)  : (index+300), 110), 1);
    smoothedMSLP(relind) = p5(2);
end
disp('Smoothing 10, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Steam Line T, degrees C
    p5 = polyfit(x, trmreg( (index-300)  : (index+300), 82), 1);
    smoothedMSLT(relind) = p5(2);
end
disp('Smoothing 11, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Steam Flowrate, kg/s
    p5 = polyfit(x, trmreg( (index-300)  : (index+300), 107), 1);
    smoothedMSLmdot(relind) = p5(2);
end
disp('Smoothing 12, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Water Injection to Steam Line Temperature, C
```

```
    p5 = polyfit(x, 0.5 * (trmreg( (index-300)  : (index+300), 78) + trmreg( (index-
        300)  : (index+300), 80)), 1);
    smoothedwaterT(relind) = p5(2);
end
disp('Smoothing 13, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Lab Temperature, C
    p5 = polyfit(x, (trmreg( (index-300)  : (index+300), 2)), 1);
    smoothedRoomT(relind) = p5(2);
end
disp('Smoothing 14, ...')
parfor relind = 1: (size(trmreg,1))
    % get source data and compute immediate MSL enthalpy at the flowmeter
    s_enth=XSteam('h_pT', trmreg(relind, 110)*0.0689475728, trmreg(relind, 82));
    steamenthreg(relind) = s_enth;
end
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Steam Flowrate, kg/s
    p5 = polyfit(x, (steamenthreg( (index-300)  : (index+300) )), 1);
    smoothedMSLEnth(relind) = p5(2);
end
disp('Smoothing 15, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Pool Mid-Axis Top-Mid Smoothed Delta T
    p5 = polyfit(x, (trmreg( (index-300)  : (index+300), 44) - trmreg( (index-300)  :
        (index+300), 42)), 1);
    MTMDeltaT(relind) = p5(2);
end
disp('Smoothing 16, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Pool Mid-Axis Mid-Low Smoothed Delta T
    p5 = polyfit(x, (trmreg( (index-300)  : (index+300), 42) - trmreg( (index-300)  :
        (index+300), 40)), 1);
    MMLDeltaT(relind) = p5(2);
end
disp('Smoothing 17, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % Pool Mid-Axis Mid-Low Smoothed Delta T
    p5 = polyfit(x, (trmreg( (index-300)  : (index+300), 40) - trmreg( (index-300)  :
        (index+300), 74)), 1);
    MLODeltaT(relind) = p5(2);
end
disp('Smoothing 18, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % SP 11 Temperatures
    p5 = polyfit(x, (trmreg( (index-300)  : (index+300), 44)), 1);
    midsmooth_up(relind) = p5(2);
end
disp('Smoothing 19, ...')
```

```
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % SP 12 Temperatures
    p5 = polyfit(x, (trmreg( (index-300)  : (index+300), 42)), 1);
    midsmooth_mid(relind) = p5(2);
end
disp('Smoothing 20, ...')
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index,1);
    % SP 13 Temperatures
    p5 = polyfit(x, (trmreg( (index-300)  : (index+300), 40)), 1);
    midsmooth_low(relind) = p5(2);
end

disp('Correcting Pool Levels...')
% compute the commone-mode pressure reading offset:
leveloffsets = polyval(pool_level_offset_coeffs, trmreg(:, 97));
% remove the offsets from the reading
reglevels = trmreg(:, 94) - leveloffsets - pool_levelgauge_offset;
% smooth it to get cold levels
coldlevels = stratsmooth_0;
hotdepth = stratsmooth_0;
parfor relind = 1: (size(trmreg,1)-2400)
    % get source data
    index = relind + 1200;
    x = trmreg( (index-300)  : (index+300), 1) - trmreg(index, 1);
    % Pool Water Level, cm
    p5 = polyfit(x, (reglevels( (index-300)  : (index+300) ) ), 1);
    % find the cold-water level
    coldlevels(relind) = p5(2);
    currentlevel = p5(2);
    % translate to hot (around measured T) levels
    sgref = 999.9720; % peak density at 1 atm, 4 degrees C
    sgref_out = XSteam('rho_pT', (smoothedP(relind)*0.0689475728 + 0.100),
       stratsmooth_5(relind)) / sgref;
    sgref_low = XSteam('rho_pT', (smoothedP(relind)*0.0689475728 + 0.055),
       midsmooth_low(relind)) / sgref;
    sgref_mid = XSteam('rho_pT', (smoothedP(relind)*0.0689475728 + 0.037),
       midsmooth_mid(relind)) / sgref;
    sgref_top = XSteam('rho_pT', (smoothedP(relind)*0.0689475728 + 0.020),
       midsmooth_up(relind)) / sgref;
    sgtopmid = 0.5 * (sgref_top + sgref_mid);
    sgmidlow = 0.5 * (sgref_mid + sgref_low);
    sglowout = 0.5 * (sgref_low + sgref_out);

    % determine the heated level (cm) of the pool
    if 8*2.54*sglowout + 7*2.54*sgmidlow + 7*2.54*sgtopmid <= currentlevel
        % level is above the top thermocouple
        hotdepth(relind) = ((currentlevel - ( (8*2.54*sglowout) + (7*2.54*sgmidlow) +
        (7*2.54*sgtopmid) ) ) / sgref_top) + ( (8*2.54*sglowout) + (7*2.54*sgmidlow) +
        (7*2.54*sgtopmid) );
    elseif 8*2.54*sglowout + 7*2.54*sgmidlow <= currentlevel
        % level is between the top and mid thermocouple
        hotdepth(relind) = ((currentlevel - ( (8*2.54*sglowout) + (7*2.54*sgmidlow) ) ) /
       sgref_mid) + ( (8*2.54*sglowout) + (7*2.54*sgmidlow) );
    elseif 8*2.54*sglowout  <= currentlevel
        % level is between the mid and low thermocouple
        hotdepth(relind) = ((currentlevel - (8*2.54*sglowout)) / sgref_low) +
        (8*2.54*sglowout);
    else
        % level is between the low thermocouple and outlet
        hotdepth(relind) = currentlevel / sgref_out;
    end
```

```
end

% do one more iteration for pre-start readings, unsmoothed readings

% find the cold-water level
coldlevelprestart = data(1, 94) - pool_levelgauge_offset -
       polyval(pool_level_offset_coeffs, data(1, 97));
currentlevel = coldlevelprestart;
hotlevelprestart = coldlevelprestart;
% translate to hot (around measured T) levels
sgref = 999.9720; % peak density at 1 atm, 4 degrees C
sgref_out = XSteam('rho_pT', (data(1,97)*0.0689475728 + 0.100), data(1,74)) / sgref;
sgref_low = XSteam('rho_pT', (data(1,97)*0.0689475728 + 0.055), data(1,40)) / sgref;
sgref_mid = XSteam('rho_pT', (data(1,97)*0.0689475728 + 0.037), data(1,42)) / sgref;
sgref_top = XSteam('rho_pT', (data(1,97)*0.0689475728 + 0.020), data(1,44)) / sgref;
sgtopmid = 0.5 * (sgref_top + sgref_mid);
sgmidlow = 0.5 * (sgref_mid + sgref_low);
sglowout = 0.5 * (sgref_low + sgref_out);

% determine the heated level (cm) of the pool
if 8*2.54*sglowout + 7*2.54*sgmidlow + 7*2.54*sgtopmid <= currentlevel
    % level is above the top thermocouple
    hotlevelprestart = ((currentlevel - ( (8*2.54*sglowout) + (7*2.54*sgmidlow) +
        (7*2.54*sgtopmid) ) ) / sgref_top) + ( (8*2.54*sglowout) + (7*2.54*sgmidlow) +
        (7*2.54*sgtopmid) );
elseif 8*2.54*sglowout + 7*2.54*sgmidlow <= currentlevel
    % level is between the top and mid thermocouple
    hotlevelprestart = ((currentlevel - ( (8*2.54*sglowout) + (7*2.54*sgmidlow) ) ) /
        sgref_mid) + ( (8*2.54*sglowout) + (7*2.54*sgmidlow) );
elseif 8*2.54*sglowout  <= currentlevel
    % level is between the mid and low thermocouple
    hotlevelprestart = ((currentlevel - (8*2.54*sglowout)) / sgref_low) +
        (8*2.54*sglowout);
else
    % level is between the low thermocouple and outlet
    hotlevelprestart = currentlevel / sgref_out;
end






% Determine Stratification Period
disp('Examinig Pool Stratification...')
stratstart=[-1 -1];
stratend= [-1 -1];

comptemps = [trmreg(:,1), (trmreg(:,44) + trmreg(:,42) + trmreg(:,40))/3, trmreg(:,74)];
pooldt = zeros(size(comptemps,1),1);
poolt=pooldt;
outletdt = poolt;
outlett=outletdt;
% Regression analysis
disp('Processing, 1...')
parfor index = 601: (size(comptemps,1)-600)
    % get source data
    x = comptemps( (index-600)  : (index+600), 1) - trmreg(index,1);
    y = comptemps( (index-600)  : (index+600), 2:3);
    % compute and store smoothed temps
    p1 = polyfit(x,y(:,1),1);
    p2 = polyfit(x,y(:,2),1);
    % pooldt(index)=p1(1);
    poolt(index)=p1(2);
    % outletdt(index) = p2(1);
```

```
    outlett(index)=p2(2);
end
disp('Processing, 2...')
parfor index = 901: (size(comptemps,1)-900)
    % get source data
    x = comptemps( (index-900)  : (index+900), 1) - trmreg(index,1);
    y = [poolt( (index-900)  : (index+900) ), outlett( (index-900)  : (index+900) )];
    % compute and store dT/dt
    p1 = polyfit(x,y(:,1),1);
    p2 = polyfit(x,y(:,2),1);
    pooldt(index)=p1(1);
    % poolt(index)=p1(2);
    outletdt(index) = p2(1);
    % outlett(index)=p2(2);
end

%average the slopes
m1 = zeros(size(comptemps,1),1);
m2 = zeros(size(comptemps,1),1);
disp('Analyzing...')
parfor index = 901: (size(comptemps,1)-900)
    m1(index)=mean(pooldt((index-300): (index+300)));
    m2(index)=mean(outletdt((index-300): (index+300)));
end
onsets=zeros(size(comptemps,1),1);
endsets=onsets;
unsets=endsets;
checkunsets=0;
unsetind=0;
% determine onset of stratification
for index = 1201: (size(comptemps,1)-1200)
    if (poolt(index) - outlett(index) >= 2) && ( m2(index) <= 0.75 * m1(index) )
        % could be stratifying
        onsets(index)=1;
    end
    % check for high rate of change
    if ( m2(index) >= 0.95 * m1(index) )
        % might not be stratifying
        unsets(index)=1;
    end
end
beg_ind=0;
stratified=0;
destratified=0;
end_ind=0;
for index = 1: size(onsets,1)
    if stratified == 0
        % find the defined onset
        if (onsets(index) == 0)
            % nope
            beg_ind=0;
        elseif beg_ind == 0
            % start counting
            beg_ind = index;
        else
            % check if duration long enough
            if (comptemps(index,1) - comptemps(beg_ind,1) >= 60)
                %maybe stratified, check unsets
                % stratified
                stratified=1;
                unsetind=index;
            end
        end
    elseif checkunsets == 0
        if unsets(index) == 0
            if (comptemps(index,1) - comptemps(unsetind,1) >= 180)
                % stratified
```

```
                checkunsets=1;
            end
        else
            % rose too high, not stratified
            stratified = 0;
        end
    elseif destratified == 0
        % find end of stratification
        if (outletdt(index) >= 2 * pooldt(index))
            % maybe destratifying
            endsets(index) = 1;
            if end_ind == 0
                %start counting
                end_ind = index;
            else
                %check counter
                if (comptemps(index,1) - comptemps(end_ind,1) >= 60)
                    % destratifying
                    destratified=1;
                end
            end
        else
            % not destratifying
            end_ind = 0;
            endsets(index) = 0;
        end
    else
        if (outletdt(index) >= 2 * pooldt(index))
            % maybe destratifying
            endsets(index) = 1;
        else
            % not destratifying
            endsets(index) = 0;
        end
    end
end

if stratified == 1
    % translate to the trimmed data
    stratstartind = beg_ind - 1200;
    if destratified == 1
        stratendind = end_ind - 1200;
    else
        % sort of a dummy value
        stratendind = size(trmdat, 1);
    end
else
    % dummy value
    stratstartind = size(trmdat, 1);
    stratendind = stratstartind;
end

% store indices in the Key Points
keypoints_ind(3) = stratstartind;
keypoints_ind(9) = stratendind;

if stratified == 1
    outstring=['Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT
       #3) at t plus ' num2str(comptemps(beg_ind, 1)) ' s, T_bulk = '
       num2str(comptemps(beg_ind, 2)) ' C and T_out = ' num2str(comptemps(beg_ind, 3)) '
       C'];
    outstring = [outstring crlf 'Stratification Beginning SP12 Temperature = '
       num2str(trmdat(beg_ind - 1200, 42)) ' C'];
    outstring = [outstring crlf 'Stratification Beginning Pressure = '
       num2str(trmdat(beg_ind - 1200, 97)) ' psia'];
else
```

```
    outstring = 'No Bulk Pool to Outlet Thermal Stratification Detected (KEY POINT #3), 0
        0 0 0 0 0. ';
end
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

if destratified == 1
    outstring = ['Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY
        POINT #9) at t plus ' num2str(comptemps(end_ind, 1)) ' s, T_bulk = '
        num2str(comptemps(end_ind, 2)) ' C and T_out = ' num2str(comptemps(end_ind, 3)) '
        C'];
    outstring = [outstring crlf 'Stratification Ending SP12 Temperature = '
        num2str(trmdat(end_ind - 1200, 42)) ' C'];
    outstring = [outstring crlf 'Stratification Ending Pressure = '
        num2str(trmdat(end_ind - 1200, 97)) ' psia'];
else
    outstring = 'No Bulk Pool to Outlet Destratification Detected (KEY POINT #9), 0 0 0 0
        0 0. ';
end
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end



outstring='Detecting Plume Appearance...';
disp(outstring)
plume_ind = length(t);
outstring = ['No Plume detected, setting t_plume (KEY POINT #2) to the end at '
        num2str(t(plume_ind)) ' s. '];

for ind = 1:length(t) - 600
    % using smoothed temps, for each of the current and subsequent 600
    % points, if the hotspot temperature is greater than the upper level
    % temperature by more than one degree AND MORE THAN 2 DEGREES greater
    % than the mid-level temperature, a plume is assumed to be present
    if (sum( (stratsmooth_3(ind:ind+600) - stratsmooth_4(ind:ind+600)) > 2) == 601) &&
        (sum( (stratsmooth_3(ind:ind+600) - stratsmooth_1(ind:ind+600)) > 1) == 601)
        % detected plume formation!
        plume_ind = ind;
        outstring = ['Plume detected!  Setting t_plume (KEY POINT #2) to '
        num2str(t(plume_ind)) ' s. '];
        break
    end
end

keypoints_ind(2) = plume_ind;

avppcrdt = mean(stratsmooth_3(plume_ind:stratendind) -
        stratsmooth_4(plume_ind:stratendind));
avppcrdtsd = std(stratsmooth_3(plume_ind:stratendind) -
        stratsmooth_4(plume_ind:stratendind));
avpptrdt = mean(stratsmooth_3(plume_ind:stratendind) -
        stratsmooth_1(plume_ind:stratendind));
avpptrdtsd = std(stratsmooth_3(plume_ind:stratendind) -
        stratsmooth_1(plume_ind:stratendind));
if isinf(avppcrdt) || isnan(avppcrdt)
    avppcrdt = 0;
end
if isinf(avppcrdtsd) || isnan(avppcrdtsd)
    avppcrdtsd = 0;
end
if isinf(avpptrdt) || isnan(avpptrdt)
    avpptrdt = 0;
```

```
end
if isinf(avpptrdtsd) || isnan(avpptrdtsd)
    avpptrdtsd = 0;
end
outstring = [outstring crlf 'At t = ' num2str(t(plume_ind)) ' s, the pool pressure is '
       num2str(trmdat(plume_ind, 97)) ' psia while the Smoothed Upper, Mid, SP8, Lower,
       and Outlet Temperatures are ' num2str(stratsmooth_1(plume_ind)) ', '
       num2str(stratsmooth_4(plume_ind)) ', ' num2str(stratsmooth_3(plume_ind)) ', '
       num2str(stratsmooth_2(plume_ind)) ', and ' num2str(stratsmooth_5(plume_ind)) ' C,
       respectively. ' ];
outstring = [outstring crlf 'Over the Plume Period (Plume Detected to Destratification),
       the mean Smothed SP8-SP9 temperatures were ' num2str(avppcrdt) ' +/- '
       num2str(avppcrdtsd) ' C.'];
outstring = [outstring crlf 'Over the Plume Period (Plume Detected to Destratification),
       the mean Smoothed SP8-Upper temperatures were ' num2str(avpptrdt) ' +/- '
       num2str(avpptrdtsd) ' C.'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end


outstring='Processing Enthalpies and Steam Quality...';
disp(outstring)

% time, steam_enth, steam_sat_enth, water_enth, water_sat_enth,
% mixture_enth, quality, turbine_hg, turbine_hl, turbine_quality
steamarray=[t t t t t t t t t t];
smoothedenth = [t t t];
velocities = 0*[t t t t];
smoothedenthtemp = smoothedenth;
steamarraytemp = steamarray;
hsteam = t;
htop = hsteam;
hmid = hsteam;
hcondensing = hsteam;
hlow = hsteam;
hout = hsteam;
hmidsat = hsteam;
rhomid = hsteam;
rhocond = hsteam;
mdcond = hsteam;
mdcondcool = hsteam;
mdcondvol = mdcond;
mdcondcoolvol = mdcondcool;
mdcondinj = hsteam;
mdcondinjcool = hsteam;
mdcondinjvol = mdcond;
mdcondcoolinjvol = mdcondcool;
smoothwaterh = smoothwater;
hsatL = [t t];
hsatG = [t t];
if mean(smoothwater) > 0.001
    % water-injected test
    twophasetest = 1;
else
    % steam only
    twophasetest = 0;
end
hlcoeff=4.57841; % W/K (MSL T to Room T, from V Flowmeter to DS of W Inj.)
% do the calculations
parfor index=1:size(steamarray,1)
    % enthalpy at water injection
    s_enth=smoothedMSLEnth(index);
    steamarray(index,2) = s_enth - (hlcoeff * (smoothedMSLT(index)-smoothedRoomT(index))
       / (1000*smoothedMSLmdot(index)) );
```

```
    htop(index) = XSteam('h_pT', (smoothedP(index)*0.0689475728 + 0.020),
        stratsmooth_1(index));
    hmid(index) = XSteam('h_pT', (smoothedP(index)*0.0689475728 + 0.037),
        stratsmooth_4(index));
    hlow(index) = XSteam('h_pT', (smoothedP(index)*0.0689475728 + 0.055),
        stratsmooth_2(index));
    hout(index) = XSteam('h_pT', (smoothedP(index)*0.0689475728 + 0.100),
        stratsmooth_5(index));
    hcondensing(index) = XSteam('h_pT', (smoothedP(index)*0.0689475728 + 0.037),
        stratsmooth_3(index));
    hmidsat(index) = XSteam('hL_p', (smoothedP(index)*0.0689475728 + 0.037));
    rhomid(index) = XSteam('rho_pT', (smoothedP(index)*0.0689475728 + 0.037),
        stratsmooth_4(index));
    rhocond(index) = XSteam('rho_pT', (smoothedP(index)*0.0689475728 + 0.037),
        stratsmooth_3(index));
    % steam pre-injection velocities
    steamrho = XSteam('rho_ph', smoothedMSLP(index)*0.0689475728, s_enth);
    velocities(index, 1) = (smoothedMSLmdot(index) / steamrho) / (pi() * (0.020447^2));
    % saturation enthalpies, DS of orifice
    hsatL(index, 2) = XSteam('hL_p', spargerP(index));
    hsatG(index, 2) = XSteam('hV_p', spargerP(index));
end
parfor index=1:size(steamarray,1)
    % saturated steam enthalpy (MSL pressure)
    steamarray(index,3) = XSteam('hV_p', smoothedMSLP(index)*0.0689475728);
    hsatG(index, 1) = steamarray(index,3);
end
parfor index=1:size(steamarray,1)
    % estimated liquid enthalpy (DS measurement)
    steamarray(index,4) = XSteam('h_pT', smoothedMSLP(index)*0.0689475728,
        trmdat(index,80));
    smoothwaterh(index) = XSteam('h_pT', smoothedMSLP(index)*0.0689475728,
        smoothedwaterT(index));
    % water pre-injection velocities
    waterrho = XSteam('rho_ph', smoothedMSLP(index)*0.0689475728, smoothwaterh(index));
    velocities(index, 2) = (smoothwater(index) / waterrho) / (pi() * (0.004625^2));
end
parfor index=1:size(steamarray,1)
    % saturated liquid enthalpy (MSL pressure)
    steamarray(index,5) = XSteam('hL_p', smoothedMSLP(index)*0.0689475728);
    hsatL(index, 1) = steamarray(index,5);
end
parfor index=1:size(steamarray,1)
    % MSL flow enthalpy post-injection
    steamarraytemp(index,6) = (steamarray(index,2)*trmdat(index,107) +
        steamarray(index,4)*trmdat(index,127)) / (trmdat(index,107) + trmdat(index,127));
    smoothedenth(index, 1) = (steamarray(index,2)*smoothedMSLmdot(index) +
        twophasetest*smoothwaterh(index)*smoothwater(index)) / (smoothedMSLmdot(index) +
        twophasetest*smoothwater(index));
end
steamarray(:,6) = steamarraytemp(:,6);

%total flow energy, including velocities
if twophasetest == 1
    % include water E
    TotalEnth = smoothedenth(:, 1) + (0.001*(((velocities(:,1).^2) .* smoothedMSLmdot) +
        ((velocities(:,1).^2) .* smoothwater)) ./ (smoothedMSLmdot + smoothwater));
else
    % steam only
    TotalEnth = smoothedenth(:, 1) + 0.001*(velocities(:,1).^2);
end

% Determine new (including flow energy) enthalpies US&DS of turbine analog
%
sparger_area = (pi() * (0.020447^2));
AdjustedEnth_US = 0 * TotalEnth;
AdjustedEnth_DS = 0 * TotalEnth;
```

```
tempvels1 = t;
tempvels2 = t;
disp('Accounting for Density Changes and Acceleration Energetics ... ');
parfor index = 1:length(TotalEnth)
    % get conditions
    h_tot = TotalEnth(index);
    p_curr = smoothedMSLP(index)*0.0689475728;
    mdot_tot = smoothedMSLmdot(index) + smoothwater(index);
    % set up loop
    h_new = h_tot;
    looplim = 1000;
    numloops = 0;
    executeloop = 1;
    % find the new flow (subtracting velocity energy) enthalpy for the
    % conditions just upstream of the orifice
    while executeloop == 1
        % loop counter
        numloops = numloops + 1;
        % get new density, velocity, enthalpy
        temprho = XSteam('rho_ph', p_curr, h_new);
        tempvel = mdot_tot / (temprho * sparger_area);
        temph = h_tot - ((tempvel^2)/1000);
        h_old = h_new;
        h_new = (0.382*h_old) + (0.618*temph);
        % end the loop?
        if (numloops > looplim) || abs(h_old - h_new) < 1e-9
            % end the loop
            executeloop = 0;
        end
    end
    % store it
    AdjustedEnth_US(index) = h_new;
    tempvels1(index) = tempvel;

    % set up the next loop
    p_curr = spargerP(index);
    h_new = h_tot;
    looplim = 1000;
    numloops = 0;
    executeloop = 1;
    % find the new flow (subtracting velocity energy) enthalpy for the
    % conditions just downstream of the orifice
    while executeloop == 1
        % loop counter
        numloops = numloops + 1;
        % get new density, velocity, enthalpy
        temprho = XSteam('rho_ph', p_curr, h_new);
        tempvel = mdot_tot / (temprho * sparger_area);
        temph = h_tot - ((tempvel^2)/1000);
        h_old = h_new;
        h_new = (0.382*h_old) + (0.618*temph);
        % end the loop?
        if (numloops > looplim) || abs(h_old - h_new) < 1e-9
            % end the loop
            executeloop = 0;
        end
    end
    % store it
    AdjustedEnth_DS(index) = h_new;
    tempvels2(index) = tempvel;
end
disp(' ... Done!  Continuing with the Qualities ... ');
velocities(:, 3:4) = [tempvels1, tempvels2];
AdjustedQuality = [t, t];

parfor index=1:size(steamarray,1)
    % quality in MSL
```

```
    steamarraytemp(index,7) = (steamarray(index,6) - steamarray(index,5)) /
        (steamarray(index,3) - steamarray(index,5));
    smoothedenthtemp(index, 2) = (smoothedenth(index, 1) - steamarray(index,5)) /
        (steamarray(index,3) - steamarray(index,5));
    AdjustedQuality(index, 1) = (AdjustedEnth_US(index) - hsatL(index, 1)) / (hsatG(index,
        1) - hsatL(index, 1));
end
steamarray(:,7) = steamarraytemp(:,7);
smoothedenth(:, 2) = smoothedenthtemp(:, 2);
parfor index=1:size(steamarray,1)
    % saturated vapor enthalpy, estimated from post-turbine GP
    steamarray(index,8) = XSteam('hV_p', (trmdat(index, 97) + (0.0361272918274*(4.1 +
        trmdat(index,113))))*0.0689475728);
end
parfor index=1:size(steamarray,1)
    % saturated liquid enthalpy, estimated from post-turbine GP
    steamarray(index,9) = XSteam('hL_p', (trmdat(index, 97) + (0.0361272918274*(4.1 +
        trmdat(index,113))))*0.0689475728);
end
parfor index=1:size(steamarray,1)
    % estimated post-turbine quality
    steamarraytemp(index,10)= (steamarray(index,6) - steamarray(index,9)) /
        (steamarray(index,8) - steamarray(index,9));
    smoothedenthtemp(index, 3) = (smoothedenth(index, 1) - steamarray(index,9)) /
        (steamarray(index,8) - steamarray(index,9));
    AdjustedQuality(index, 2) = (AdjustedEnth_DS(index) - hsatL(index, 2)) / (hsatG(index,
        2) - hsatL(index, 2));
end
steamarray(:,10) = steamarraytemp(:,10);
smoothedenth(:, 3) = smoothedenthtemp(:, 3);
hsteam = AdjustedEnth_DS;
% condensation flowrates

parfor index=1:size(steamarray,1)
    % all flowrates are strictly the condensing/cooling side -- they do not
    % include the injected steam flow quantities
    mdcond(index) = ((hsteam(index) - hmidsat(index)) / (hmidsat(index) - hmid(index))) *
        smoothedMSLmdot(index);
    mdcondvol(index) = mdcond(index) / rhomid(index);
    mdcondcool(index) = ((hsteam(index) - hcondensing(index)) / (hcondensing(index) -
        hmid(index))) * smoothedMSLmdot(index);
    mdcondcoolvol(index) = mdcondcool(index) / rhocond(index);
    % water-injection adjusted values
    mdcondinj(index) = mdcond(index);
    mdcondinjvol(index) = mdcondvol(index);
    mdcondinjcool(index) = mdcondcool(index);
    mdcondcoolinjvol(index) = mdcondcoolvol(index);
    if twophasetest == 1
        % water-injection
        mdcondinj(index) = ((smoothedenth(index,1) - hmidsat(index)) / (hmidsat(index) -
        hmid(index))) * (smoothedMSLmdot(index) + smoothwater(index));
        mdcondinjvol(index) = mdcondinj(index) / rhomid(index);
        mdcondinjcool(index) = ((smoothedenth(index,1) - hcondensing(index)) /
        (hcondensing(index) - hmid(index))) * (smoothedMSLmdot(index) +
        smoothwater(index));
        mdcondcoolinjvol(index) = mdcondinjcool(index) / rhocond(index);
    end
end


outstring='     ...done!';
disp(outstring)

qualinfo = [NaN NaN NaN NaN NaN NaN NaN NaN NaN NaN NaN NaN];
[qualinfo(1) qualinfo(2)] = min(steamarray(:,7));
[qualinfo(3) qualinfo(4)] = max(steamarray(:,7));
qualinfo(5) = mean(steamarray(:,7));
```

```
qualinfo(6) = std(steamarray(:,7));
[qualinfo(7) qualinfo(8)] = min(steamarray(:,10));
[qualinfo(9) qualinfo(10)] = max(steamarray(:,10));
qualinfo(11) = mean(steamarray(:,10));
qualinfo(12) = std(steamarray(:,10));

outstring=['Minimum Steam Quality:  ' num2str(qualinfo(1)) ' at t plus '
       num2str(t(qualinfo(2))) ' s'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

outstring=['Maximum Steam Quality:  ' num2str(qualinfo(3)) ' at t plus '
       num2str(t(qualinfo(4))) ' s'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

outstring=['Time-Averaged Steam Quality:  ' num2str(qualinfo(5)) ' +/- '
       num2str(qualinfo(6)) ];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

if use_turbine == 1
    outstring=['Minimum Turbine Outlet Steam Quality:  ' num2str(qualinfo(7)) ' at t plus
       ' num2str(t(qualinfo(8))) ' s'];
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end

    outstring=['Maximum Turbine Outlet Steam Quality:  ' num2str(qualinfo(9)) ' at t plus
       ' num2str(t(qualinfo(10))) ' s'];
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end

    outstring=['Time-Averaged Turbine Outlet Steam Quality:  ' num2str(qualinfo(11)) '
       +/- ' num2str(qualinfo(12)) ];
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
else
    outstring='SRV Alignment, no RCIC Turbine 0 0 0 0 0 0 ';
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
end


% Finding min and max T-changerates
inclusionlen = 1500;
sindex = trunind;
if sindex(1) < inclusionlen+1
    sindex(1) = inclusionlen+1;
end
if sindex(3) + inclusionlen > size(data,1)
    sindex(3) = size(data,1) - inclusionlen;
elseif sindex(3) - inclusionlen > sindex(2)
    sindex(3) = sindex(2);
```

```
end
disp('Processing slopes of rear stratification set ...')
vsmooth_top = zeros(size(data,1), 2);
vsmooth_mid = vsmooth_top;
vsmooth_low = vsmooth_top;
vsmooth_out = vsmooth_top;
vsmooth_hot = vsmooth_top;

parfor ind=sindex(1):sindex(3)
    xvals = data(ind - inclusionlen : ind + inclusionlen, 1) - data(ind, 1);
    yvals_top = data(ind - inclusionlen : ind + inclusionlen, 60);
    yvals_mid = data(ind - inclusionlen : ind + inclusionlen, 48);
    yvals_low = data(ind - inclusionlen : ind + inclusionlen, 56);
    yvals_out = data(ind - inclusionlen : ind + inclusionlen, 74);
    yvals_hot = data(ind - inclusionlen : ind + inclusionlen, 50);
    p1 = polyfit(xvals, yvals_top, 1);
    vsmooth_top(ind, :) = p1;
    p2 = polyfit(xvals, yvals_mid, 1);
    vsmooth_mid(ind, :) = p2;
    p3 = polyfit(xvals, yvals_low, 1);
    vsmooth_low(ind, :) = p3;
    p4 = polyfit(xvals, yvals_out, 1);
    vsmooth_out(ind, :) = p4;
    p5 = polyfit(xvals, yvals_hot, 1);
    vsmooth_hot(ind, :) = p5;
end
disp('Searching...')
% find max and min slopes
topdt = [0, 0, 0, 0];
[topdt(1) topdt(2)] = max(vsmooth_top(sindex(1):sindex(3)-inclusionlen,1));
[topdt(3) topdt(4)] = min(vsmooth_top(sindex(1):sindex(3)-inclusionlen,1));
middt = [0, 0, 0, 0];
[middt(1) middt(2)] = max(vsmooth_mid(sindex(1):sindex(3)-inclusionlen,1));
[middt(3) middt(4)] = min(vsmooth_mid(sindex(1):sindex(3)-inclusionlen,1));
lowdt = [0, 0, 0, 0];
[lowdt(1) lowdt(2)] = max(vsmooth_low(sindex(1):sindex(3)-inclusionlen,1));
[lowdt(3) lowdt(4)] = min(vsmooth_low(sindex(1):sindex(3)-inclusionlen,1));
outdt = [0, 0, 0, 0];
[outdt(1) outdt(2)] = max(vsmooth_out(sindex(1):sindex(3)-inclusionlen,1));
[outdt(3) outdt(4)] = min(vsmooth_out(sindex(1):sindex(3)-inclusionlen,1));
hotdt = [0, 0, 0, 0];
[hotdt(1) hotdt(2)] = max(vsmooth_hot(sindex(1):sindex(3)-inclusionlen,1));
[hotdt(3) hotdt(4)] = min(vsmooth_hot(sindex(1):sindex(3)-inclusionlen,1));

% find max and min slope differences

stopmid = vsmooth_top((sindex(1):sindex(3) - inclusionlen), 1) -
       vsmooth_mid((sindex(1):sindex(3) - inclusionlen), 1);
smidlow = vsmooth_mid((sindex(1):sindex(3) - inclusionlen), 1) -
       vsmooth_low((sindex(1):sindex(3) - inclusionlen), 1);
slowout = vsmooth_low((sindex(1):sindex(3) - inclusionlen), 1) -
       vsmooth_out((sindex(1):sindex(3) - inclusionlen), 1);
shotmid = vsmooth_hot((sindex(1):sindex(3) - inclusionlen), 1) -
       vsmooth_mid((sindex(1):sindex(3) - inclusionlen), 1);

stopmiddt = [0 0 0 0];
smidlowdt = [0 0 0 0];
slowoutdt = [0 0 0 0];
shotmiddt = [0 0 0 0];

[stopmiddt(1) stopmiddt(2)] = max(stopmid);
[stopmiddt(3) stopmiddt(4)] = min(stopmid);
[smidlowdt(1) smidlowdt(2)] = max(smidlow);
[smidlowdt(3) smidlowdt(4)] = min(smidlow);
[slowoutdt(1) slowoutdt(2)] = max(slowout);
[slowoutdt(3) slowoutdt(4)] = min(slowout);
[shotmiddt(1) shotmiddt(2)] = max(shotmid);
```

```
[shotmiddt(3) shotmiddt(4)] = min(shotmid);

outstring = ['Smoothed Changerates may not fully include test beginning and end periods,
       analysis ending at t plus ' num2str(data((sindex(3)-inclusionlen),1) -
       data(sindex(1),1)) ' s; using ' num2str(inclusionlen * 2/10) ' s smoothing'];
outstring=[outstring crlf 'Max and min smoothed upper level changerates:  '
       num2str(60*topdt(1)) ' degrees/min at t plus ' num2str(t(topdt(2))) ' s and '
       num2str(60*topdt(3)) ' degrees/min at t plus ' num2str(t(topdt(4))) ' s,
       respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed mid (SP9) level changerates:  ' num2str(60*middt(1)) '
       degrees/min at t plus ' num2str(t(middt(2))) ' s and ' num2str(60*middt(3)) '
       degrees/min at t plus ' num2str(t(middt(4))) ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed upper-mid level changerate differences:  '
       num2str(60*stopmiddt(1)) ' degrees/min at t plus ' num2str(t(stopmiddt(2))) ' s
       and ' num2str(60*stopmiddt(3)) ' degrees/min at t plus ' num2str(t(stopmiddt(4)))
       ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed lower level changerates:  ' num2str(60*lowdt(1)) '
       degrees/min at t plus ' num2str(t(lowdt(2))) ' s and ' num2str(60*lowdt(3)) '
       degrees/min at t plus ' num2str(t(lowdt(4))) ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed mid-lower level changerate differences:  '
       num2str(60*smidlowdt(1)) ' degrees/min at t plus ' num2str(t(smidlowdt(2))) ' s
       and ' num2str(60*smidlowdt(3)) ' degrees/min at t plus ' num2str(t(smidlowdt(4)))
       ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed outlet level changerates:  ' num2str(60*outdt(1)) '
       degrees/min at t plus ' num2str(t(outdt(2))) ' s and ' num2str(60*outdt(3)) '
       degrees/min at t plus ' num2str(t(outdt(4))) ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed lower-outlet level changerate differences:  '
       num2str(60*slowoutdt(1)) ' degrees/min at t plus ' num2str(t(slowoutdt(2))) ' s
       and ' num2str(60*slowoutdt(3)) ' degrees/min at t plus ' num2str(t(slowoutdt(4)))
       ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed hot (SP8) level changerates:  ' num2str(60*hotdt(1)) '
       degrees/min at t plus ' num2str(t(hotdt(2))) ' s and ' num2str(60*hotdt(3)) '
       degrees/min at t plus ' num2str(t(hotdt(4))) ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
outstring=['Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  '
       num2str(60*shotmiddt(1)) ' degrees/min at t plus ' num2str(t(shotmiddt(2))) ' s
```

```
        and ' num2str(60*shotmiddt(3)) ' degrees/min at t plus ' num2str(t(shotmiddt(4)))
        ' s, respectively'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Property Collection
steamprops = zeros(length(t), 60 );
testrelationship = 0*t;
testrelationship2 = testrelationship;
testrelationship3 = testrelationship;
testrelationship4 = testrelationship;

disp('Determining and Collecting Fluid Properties ... ');

parfor index=1:length(t)
    % put the sparger & pool middle steam/water properties together in a
    % table, where the source P/T/h used smoothing algorithms
    e1 = TotalEnth(index); % sparger steam enthalpy + velocity
    e2 = AdjustedEnth_DS(index); % sparger enthalpy
    e3 = hmid(index); % pool mid enthalpy (bulk)
    e4 = hsatL(index, 2); % sparger water saturation enthalpy
    e5 = hsatG(index, 2); % sparger steam saturation enthalpy
    e6 = e4 - e3; % pool mid subcooling enthalpy
    e7 = e1 - e4; % sparger steam full condensation enthalpy
    e8 = XSteam('h_pT', (smoothedP(index)*0.0689475728 + 0.037), stratsmooth_3(index)); %
        smoothed plume hot spot enthalpy
    e9 = htop(index); % pool rear upper smoothed enthalpy
    e10 = hlow(index); % pool rear lower smoothed enthalpy
    e11 = hout(index); % pool outlet smoothed enthalpy
    rho1 = XSteam('rho_ph', spargerP(index), e3); % pool mid (bulk) density
    rho2 = XSteam('rhoL_p', spargerP(index)); % sparger saturated water density
    rho3 = XSteam('rhoV_p', spargerP(index)); % sparger saturated steam density
    rho4 = XSteam('rho_ph', spargerP(index), e2); % sparger steam flow density
    x1 = AdjustedQuality(index, 2); % sparger steam quality - unbounded
    x2 = x1; % sparger steam quality -- within bounds
    if x2 > 1
        % keep x2 within [0,1]
        x2 = 1;
    elseif x2 < 0
        x2 = 0;
    end
    vf1 = x2 / (x2 + ((1 - x2)*rho3/rho2)); % sparger void fraction
    v1 = velocities(index, 4); % sparger velocity
    md1 = smoothedMSLmdot(index); % mdot steam
    md2 = smoothwater(index); % mdot water into steam line
    if twophasetest == 1
        md3 = smoothedMSLmdot(index) + smoothwater(index); % mdot sparger steam total
    else
        md3 = smoothedMSLmdot(index);
    end
    mu1 = XSteam('my_ph', spargerP(index), e3); % sparger subcooled water viscosity
    mu2 = XSteam('my_ph', spargerP(index), e4); % sparger saturated water viscosity
    mu3 = XSteam('my_ph', spargerP(index), e5); % sparger saturated steam viscosity
    mu4 = XSteam('my_ph', spargerP(index), e2); % sparger steam viscosity
    if isnan(mu4)
        % homogeneous two-phase sparger steam viscosity
        mu4 = (x2 * mu3 * rho4 / rho3) + ( (1-x2) * mu2 * rho4 / rho2);
    end
    sig1 = XSteam('st_T', stratsmooth_4(index)); % s/w surface tension for Tsat = Tmid
    sig2 = XSteam('st_p', spargerP(index)); % s/w surface tension for Psat = sparger P
    p1 = spargerP(index); % sparger pressure (bar)
    p2 = smoothedP(index)*0.0689475728; % pool airspace pressure, bar
    p3 = p2 + 0.037; % approx mid-level P, bar
    p4 = XSteam('psat_T', stratsmooth_4(index)); % saturation (vapor) pressure at Tmid
    p5 = XSteam('psat_T', stratsmooth_3(index)); % saturation (vapor) pressure at Tplume
```

```
t1 = stratsmooth_4(index); % mid-level bulk temperature
t2 = XSteam('T_ph', spargerP(index), e2); % sparger steam temperature
t3 = XSteam('Tsat_p', spargerP(index)); % sparger steam saturation temperature
t4 = stratsmooth_3(index); % smoothed plume T
t5 = stratsmooth_1(index); % Upper-Level Pool Rear Smoothed Temperature
t6 = stratsmooth_2(index); % Lower-Level Pool Rear Smoothed Temperature
t7 = stratsmooth_5(index); % Pool Outlet Smoothed Temperature
cp1 = XSteam('Cp_ph', p3, e3); % pool mid bulk heat capacity
cp2 = XSteam('CpL_p', p1); % sparger saturated water heat capacity
cp3 = XSteam('CpV_p', p1); % sparger saturated steam heat capacity
k1 = XSteam('tc_ph', p3, e3); % pool bulk mid thermal conductivity
k2 = XSteam('tcL_p', p1); % sparger saturated water thermal conductivity
k3 = XSteam('tcL_p', p1); % sparger saturated steam thermal conductivity
g1 = md3 / sparger_area;
d1 = 2*0.020447; % sparger diameter (m)
d2 = 2*0.004625; % water injection line diameter
d3 = 15.5*0.0254; % sparger outlet elevation
d4 = coldlevels(index)/100;% pool cold level
d5 = hotdepth(index)/100; % pool hot level
re_tp = g1 * d1 / mu4; % two-phase Reynolds number (sparger steam)
pr1 = 1000 * mu1 * cp1 / k1; % pool mid (bulk) water Prandtl number
pr2 = 1000 * mu2 * cp2 / k2; % sparger saturated water Prandtl number
pr3 = 1000 * mu3 * cp3 / k3; % sparger saturated steam Prandtl number
cs1 = XSteam('w_ph', p3, e3); % pool mid bulk sonic velocity
cs2 = XSteam('wL_p', p1); % sparger saturated water sonic velocity
cs3 = XSteam('wV_p', p1); % sparger saturated steam sonic velocity
cs4 = XSteam('w_ph', p1, e2); % sparger steam sonic velocity
if isnan(cs4)
    % determine a homogeneous 2-phase sonic velicity
    % DOUBLE-CHECK THIS RELATIONSHIP!!!!
    cs4 = 1 / ( ((1-vf1)*sqrt( ((1-vf1)/(cs2^2)) + ((vf1*rho2/rho3)/(cs3^2)) )) +
    ((vf1)*sqrt(   ((vf1)/(cs3^2)) + (((1-vf1)*rho3/rho2)/(cs2^2))  )));
end

% additional derived quantities for use in the computation
bp = sqrt(p4./p1);
ja_tp = e6 ./ e7;
ja_w = (e4-e3)./(e5-e4);
gr_s = 9.81 * ((rho2 - rho4)./rho4) .* (d5 - d3).^3 ./ (mu4./rho4).^2;
gr_ss = 9.81 * ((rho1 - rho3)./rho3) .* (d5 - d3).^3 ./ (mu3./rho3).^2;
gr_w = 9.81 * ((rho1 - rho2)./rho2) .* (d5 - d3).^3 ./ (mu2./rho2).^2;
ri_s = 9.81 * ((rho1 - rho4)./rho4) .* (d5 - d3).^1 ./ (v1.^2);
fr_s = v1 ./ sqrt(9.81 * (d5-d3));
we = rho4 .* v1.^2 .* d1 ./ sig2;

% store it all
steamprops(index, :) = [g1, d1, d2, d3, d4, d5, x1, x2, vf1, v1, re_tp, sig1, sig2,
   md1, md2, md3, t1, t2, t3, t4, t5, t6, t7, cp1, cp2, cp3, k1, k2, k3, pr1, pr2,
   pr3, rho1, rho2, rho3, rho4, mu1, mu2, mu3, mu4, cs1, cs2, cs3, cs4, p1, p2, p3,
   p4, p5, e1, e2, e3, e4, e5, e6, e7, e8, e9, e10, e11];

% calculate the Mixing Number
% testrelationship_older(index) = ((e6 ./e7) .^(9/8)) .* (e3 ./ e6) .^ (1/4) .*
   (e4 ./ e5) .* (e2 ./ e7) .^ (1/6) .* (re_tp .^(-1/8)) .*
   ( (  (0.5 .*rho4 .*v1 .*v1/100000) + p4)  ./(p1) ) .* ((p1 ./ p4) ) .* (rho3 ./
   rho4) .* (rho2 ./ rho3) .^0.5 .* (rho2 ./ rho1) .* (sig1 ./ sig2) .*
   (pr1 .^(1/4)) .* (p1 .* d1 ./ sig2) .^(-3/8) .* x2 .^(1/8)  .* (p4 .* d1 ./
   sig1) .^(1/8);

% there's still a weird v1 dependence
% (ja_w.^(-1/8) .* x1.^(-5/8) .* re_tp.^(1/2) .* pr1.^(1/4) .* ( (p4 + (0.5 .*
   rho4 .* v1 .^ 2 ./100000))./p1 ).^(1/2) .* (gr_w ./ (re_tp.^2)).^(1/2) .*
   (rho3./rho2).^(1/4) .* (v1./cs2).^(3/8) .* (cs3./cs2).^(1/2) .* (sig2./sig1).^(-
   1/4) .* ((t3+273.15)./(t1+273.15)) .^ (-1/4)) .* ((d5-d3)./1.5).^(-1/2) .*
   gr_w .^(1/16) .* ( (1 - (p4./p1).^4) + (p4./p1).^4 .* gr_s ./ gr_w  .*
   pr1 .^(1))  .^ (8/16) .* (pr1.*pr2./(pr1 + pr2)).^(1/4) ;
```

```
    % testrelationship_old(index) = (re_tp ).^(10/16) .* pr1 .^(1/8) .* ja_w .^ (-1/2) .*
       (rho2./rho3).^(8/64) .* (gr_w./(re_tp.^2)) .^(+21/64) .* ((d5-d3)./1.5 ).^(-
       3/4) .* x1.^(-2/16) .* ((1-(p4./p1).^4) + (p4./p1).^4 .*gr_s./gr_w.*1) .^ (21/64);


    % derived from Key Point #2 and #4, but probably won't work for x < 0.5
    % or for mdot < 20 g/s

    % set for KP 2, 4, 5, 7, 10
    % there is a common core, and a multiplier
    % the multiplier is common through KP 4, but is unique for KP 5, 7, and
    % 10 (correlation numbers 2, 3, and 4, respectively)
    partcrazy = pr1 .^ (8/16) .* (mu4./mu1) .^ ((+8/16) ) .* (rho4./rho1) .^ ((8/16) ) .*
       (ja_w./x1) .^ (-16/16 + ((1/16).*bp)) .* re_tp .^ (8/16) .* fr_s .^ ((-6/16) +
       ((-8/16).*bp) );
    testrelationship(index)  =   partcrazy .* (rho2./rho3).^((4/16) + ((3/16).*bp)) ;
    testrelationship2(index) =   partcrazy .* (rho2./rho3).^((13/16) ) ;
    testrelationship3(index) =   partcrazy .* (rho2./rho3).^((15/16) ) ;
    testrelationship4(index) =   partcrazy .* (rho2./rho3).^((16/16) ) ;
    % testrelationship(index) =    pr1 .^ (1/2) .* (mu4./mu1) .^ (1/4) .* (rho4./rho1) .^
       (1/2) .* (rho4 .* 1000.*e7 ./ (100000.*p1) ) .^ (1/2) .* ja_w .^ (-6/8 +
       ((8/16).*bp)) .* x1 .^ (12/16 - ((1/2).*bp)) .* re_tp .^ (1/2) .* ri_s .^ ((1/4)
       + ((1/2).*bp)) .* fr_s .^ ((3/16) + ((3/8).*bp) );
    % testrelationship(index) =    x2 .^(12/16) .* ((re_tp.^0.5)./ja_w) .^ (16/16) .*
       pr1.^(+16/32).* ( (ri_s) .^(16/16) .*x2 .^ (-8/16)) .^( 0.25 +
       0.5*(p4./p1).^(32/64) ) .* (mu4./mu1).^(2/8) .*
       ((0.5*v1.^2)./(1000*e6)).^(5/32) .* ja_w.^(+8/16) .*
       ((1000*e7)./(100000*p1./rho4)).^(+1/2) .* (rho4./rho1).^(1/2) ;
    % testrelationship(index) =    x2 .^(12/16) .* ((re_tp.^0.5)./ja_w) .^ (16/16) .*
       pr1.^(+16/32).* pr2.^(1/2).* ( (ri_s) .^(16/16) .*x2 .^ (-
       8/16)) .^( (p4./p1).^(32/64) ) .* ((t1+273.15)./(t2+273.15)).^(-16/8) .*
       (mu4./mu1).^(2/8) .* ((0.5*v1.^2)./(1000*e6)).^(4/32) .* ja_w.^(+8/16) .*
       ((1000*e7)./(100000*p1./rho4)).^(1/1) .* (rho4./rho1).^(1/2).*(sig1./sig2);
    % testrelationship(index) =    x1 .^(1/16) .* ((re_tp.^0.5)./ja_w) .^ (12/16) .*
       pr1.^(-0/32).* pr2.^(1/2).* (pr1.^(-8/16).*(pr2./pr1) .^ (-32/16) .*
       ri_s .^0.5 .*x1.^(-4/16)) .^( (p4./p1).^(32/64) ) .* ((d5-d3)./1.5 ).^(+2/4) .*
       exp(-1*(16/16).*(p4./p1).^(2/4)) .* ((t1+273.15)./(t3+273.15)).^(-16/8) .*
       (rho2./rho3).^(-4/16) .* (mu3./mu2).^(1/2) .* ja_w.^(-4/16) .*
       ((1000*e7)./(100000*p1./rho4)).^(1/1) .* (rho3./rho4).^0.25 .*
       ((rho1)./rho2).^(2);
    % testrelationship(index) =    x1 .^(32/32) .* ja_w .^ (-8/16) .* re_tp .^ (28/16) .*
       pr1.^(4/32).* pr2.^(6/4).* ri_s .^((t1+273.15)./(t3+273.15)) .* ((d5-
       d3)./1.5 ).^(-3/4) .* exp(-(p4./p1).^(2/4)) .*
       ((t1+273.15)./(t3+273.15)).^(4/8) .* (rho2./rho3).^(1/16);
    % testrelationship2(index) =   (re_tp ).^(8/16) .* pr1 .^(2/16) .* pr2 .^ (1/16) .*
       ja_w .^ (-8/16) .* ri_s .^(+4/16) .* ((d5-d3)./1.5 ).^(-1/4) .* x1.^(+4/16) .*
       exp(-((p4)./p1).^0.5) .* (p4./p1).^(1/16);

end

steampropsdesc = 'Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection
        Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level
        d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1,
        Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface
        Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot
        (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1,
        Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4,
        Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool
        Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water
        Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal
        Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat
        Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2,
        Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water
        Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger
        Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger
        Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity
        (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity
```

```
        cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx
        Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total
        Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water
        Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam
        Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed
        Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy
        e11';

disp(' ... Done! ');


% To decompose the steam properties table:
%
%  g1 = steamprops(:, 01 );
%  d1 = steamprops(:, 02 );
%  d2 = steamprops(:, 03 );
%  d3 = steamprops(:, 04 );
%  d4 = steamprops(:, 05 );
%  d5 = steamprops(:, 06 );
%  x1 = steamprops(:, 07 );
%  x2 = steamprops(:, 08 );
%  vf1 = steamprops(:, 09 );
%  v1 = steamprops(:, 10 );
%  re_tp = steamprops(:, 11 );
%  sig1 = steamprops(:, 12 );
%  sig2 = steamprops(:, 13 );
%  md1 = steamprops(:, 14 );
%  md2 = steamprops(:, 15 );
%  md3 = steamprops(:, 16 );
%  t1 = steamprops(:, 17 );
%  t2 = steamprops(:, 18 );
%  t3 = steamprops(:, 19 );
%  t4 = steamprops(:, 20 );
%  t5 = steamprops(:, 21 );
%  t6 = steamprops(:, 22 );
%  t7 = steamprops(:, 23 );
%  cp1 = steamprops(:, 24 );
%  cp2 = steamprops(:, 25 );
%  cp3 = steamprops(:, 26 );
%  k1 = steamprops(:, 27 );
%  k2 = steamprops(:, 28 );
%  k3 = steamprops(:, 29 );
%  pr1 = steamprops(:, 30 );
%  pr2 = steamprops(:, 31 );
%  pr3 = steamprops(:, 32 );
%  rho1 = steamprops(:, 33 );
%  rho2 = steamprops(:, 34 );
%  rho3 = steamprops(:, 35 );
%  rho4 = steamprops(:, 36 );
%  mu1 = steamprops(:, 37 );
%  mu2 = steamprops(:, 38 );
%  mu3 = steamprops(:, 39 );
%  mu4 = steamprops(:, 40 );
%  cs1 = steamprops(:, 41 );
%  cs2 = steamprops(:, 42 );
%  cs3 = steamprops(:, 43 );
%  cs4 = steamprops(:, 44 );
%  p1 = steamprops(:, 45 );
%  p2 = steamprops(:, 46 );
%  p3 = steamprops(:, 47 );
%  p4 = steamprops(:, 48 );
%  p5 = steamprops(:, 49 );
%  e1 = steamprops(:, 50 );
%  e2 = steamprops(:, 51 );
%  e3 = steamprops(:, 52 );
%  e4 = steamprops(:, 53 );
%  e5 = steamprops(:, 54 );
```

```
%  e6 = steamprops(:, 55 );
%  e7 = steamprops(:, 56 );
%  e8 = steamprops(:, 57 );
%  e9 = steamprops(:, 58 );
%  e10 = steamprops(:, 59 );
%  e11 = steamprops(:, 60 );


%
% ====================
% DATA ANALYSIS SECTION
% ====================
%

% present some run details
meansteam = mean(1000*trmdat(:,107));
sigsteam = std(1000*trmdat(:,107));
meanfeedwater = mean(1000*trmdat(:,102));
sigfeed = std(1000*trmdat(:,102));
meaninject = mean(1000*trmdat(:,127));
siginject = std(1000*trmdat(:,127));

outstring=['The mean steam flow rate was ' num2str(meansteam) ' +/- ' num2str(sigsteam) '
       g/s'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

outstring=['The mean feedwater flow rate was ' num2str(meanfeedwater) ' +/- '
       num2str(sigfeed) ' g/s'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

outstring=['The mean water injection to steam flow rate was ' num2str(meaninject) ' +/- '
       num2str(siginject) ' g/s'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end



% condensing region data



if stratified == 1
    % condensing SP8-SP9 average DT
    avcrdt = mean(stratsmooth_3(stratstartind:stratendind) -
       stratsmooth_4(stratstartind:stratendind));
    avcrdtsd = std(stratsmooth_3(stratstartind:stratendind) -
       stratsmooth_4(stratstartind:stratendind));

    % upper-SP8 average DT
    avtcdt = mean(stratsmooth_3(stratstartind:stratendind) -
       stratsmooth_1(stratstartind:stratendind));
    avtcdtsd = std(stratsmooth_3(stratstartind:stratendind) -
       stratsmooth_1(stratstartind:stratendind));

    outstring=['Mean Smoothed Condensing Region SP8-SP9 delta T is ' num2str(avcrdt) '
       +/- ' num2str(avcrdtsd) ' C over the Stratification Period, beginning at '
       num2str(stratsmooth_3(stratstartind)-stratsmooth_4(stratstartind)) ' C and ending
       at ' num2str(stratsmooth_3(stratendind)-stratsmooth_4(stratendind)) ' C'];
```

```
    outstring=[outstring crlf 'Mean Smoothed SP8-Upper Pool delta T is ' num2str(avtcdt)
       ' +/- ' num2str(avtcdtsd) ' C over the Stratification Period, beginning at '
       num2str(stratsmooth_3(stratstartind)-stratsmooth_1(stratstartind)) ' C and ending
       at ' num2str(stratsmooth_3(stratendind)-stratsmooth_1(stratendind)) ' C'];
    outstring = [outstring crlf 'The stratification period begins and ends with Smoothed
       SP8 readings of ' num2str(stratsmooth_3(stratstartind)) ' and '
       num2str(stratsmooth_3(stratendind)) ' C, respectively' ];
    outstring = [outstring crlf 'The stratification period begins and ends with
       condensing flows of ' num2str(mdcondinj(stratstartind)) ' and '
       num2str(mdcondinj(stratendind)) ' kg/s, respectively.'];
    outstring = [outstring crlf 'The stratification period begins and ends with
       condensing+cooling flows of ' num2str(mdcondinjcool(stratstartind)) ' and '
       num2str(mdcondinjcool(stratendind)) ' kg/s, respectively.'];
    outstring = [outstring crlf 'The stratification period had a mean sparger steam
       enthalpy of ' num2str(mean(AdjustedEnth_DS(stratstartind:stratendind))) ' +/- '
       num2str(std(AdjustedEnth_DS(stratstartind:stratendind))) ' kJ/kg.'];
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
else

    outstring = 'No stratification; 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0. ';
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
end

outstring = ['At plume detection, the condensing and condensing+cooling flows are '
       num2str(mdcondinj(plume_ind)) ' and ' num2str(mdcondinjcool(plume_ind)) ' kg/s,
       respectively'];
plumepse = [NaN, NaN];
plumepse(1) = mean(smoothedenth(plume_ind:stratendind));
plumepse(2) = std(smoothedenth(plume_ind:stratendind));
if isnan(plumepse(1)) || isinf(plumepse(1))
    plumepse(1) = 0;
end
if isnan(plumepse(2)) || isinf(plumepse(2))
    plumepse(2) = 0;
end
outstring = [outstring crlf 'The plume period had a mean steam enthalpy of '
       num2str(plumepse(1)) ' +/- ' num2str(plumepse(2)) ' kJ/kg.'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% stratification data

% Top-Mid temps
topmidsm = stratsmooth_1 - stratsmooth_4;


% Top-Lower temps
toplowsm = stratsmooth_1 - stratsmooth_2;

% Mid-Lower temps
midlowsm = stratsmooth_4 - stratsmooth_2;


% Upper-Outlet temps
upoutsm = stratsmooth_1 - stratsmooth_5;

% Mid-outlet temps
midoutsm = stratsmooth_4 - stratsmooth_5;
```

```
% Lower-outlet temps
lowoutsm = stratsmooth_2 - stratsmooth_5;

% Find Max Smoothed Top-Mid stratification
[y, ind] = max(topmidsm);
outstring=['Maximum Smoothed Top-Mid delta T is ' num2str(y) ' degrees C at t plus '
       num2str(t(ind)) ' s with T_upper = ' num2str(stratsmooth_1(ind)) ' C and T_mid =
       ' num2str(stratsmooth_4(ind)) ' C'];
outstring = [outstring crlf 'At t plus ' num2str(t(ind)) ' s, Smoothed SP8-SP9 is '
       num2str(stratsmooth_3(ind) - stratsmooth_4(ind)) ' C and Smoothed SP8-Top is '
       num2str(stratsmooth_3(ind) - stratsmooth_1(ind)) ' C, where Smoothed SP8 is '
       num2str(stratsmooth_3(ind)) ' C and Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end


% Find Max Smoothed Top-Lower stratification
[y, ind] = max(toplowsm);
outstring=['Maximum Smoothed Top-Lower delta T is ' num2str(y) ' degrees C at t plus '
       num2str(t(ind)) ' s with T_upper = ' num2str(stratsmooth_1(ind)) ' C and T_low =
       ' num2str(stratsmooth_2(ind)) ' C'];
outstring = [outstring crlf 'At t plus ' num2str(t(ind)) ' s, Smoothed SP8-SP9 is '
       num2str(stratsmooth_3(ind) - stratsmooth_4(ind)) ' C and Smoothed SP8-Top is '
       num2str(stratsmooth_3(ind) - stratsmooth_1(ind)) ' C, where Smoothed SP8 is '
       num2str(stratsmooth_3(ind)) ' C and Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find Max Smoothed Mid-lower stratification
[y, ind] = max(midlowsm);
outstring=['Maximum Smoothed Mid-Lower delta T is ' num2str(y) ' degrees C at t plus '
       num2str(t(ind)) ' s with T_mid = ' num2str(stratsmooth_4(ind)) ' C and T_low = '
       num2str(stratsmooth_2(ind)) ' C'];
outstring = [outstring crlf 'At t plus ' num2str(t(ind)) ' s, Smoothed SP8-SP9 is '
       num2str(stratsmooth_3(ind) - stratsmooth_4(ind)) ' C and Smoothed SP8-Top is '
       num2str(stratsmooth_3(ind) - stratsmooth_1(ind)) ' C, where Smoothed SP8 is '
       num2str(stratsmooth_3(ind)) ' C and Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end


% Find Max Smoothed Top-Outlet stratification
[y, ind] = max(upoutsm);
outstring=['Maximum Smoothed Top-Outlet delta T is ' num2str(y) ' degrees C at t plus '
       num2str(t(ind)) ' s with T_upper = ' num2str(stratsmooth_1(ind)) ' C and T_out =
       ' num2str(stratsmooth_5(ind)) ' C'];
outstring = [outstring crlf 'At t plus ' num2str(t(ind)) ' s, Smoothed SP8-SP9 is '
       num2str(stratsmooth_3(ind) - stratsmooth_4(ind)) ' C and Smoothed SP8-Top is '
       num2str(stratsmooth_3(ind) - stratsmooth_1(ind)) ' C, where Smoothed SP8 is '
       num2str(stratsmooth_3(ind)) ' C and Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find Max Smoothed Mid-Outlet stratification
[y, ind] = max(midoutsm);
outstring=['Maximum Smoothed Mid-Outlet delta T is ' num2str(y) ' degrees C at t plus '
       num2str(t(ind)) ' s with T_mid = ' num2str(stratsmooth_4(ind)) ' C and T_out = '
       num2str(stratsmooth_5(ind)) ' C'];
```

```
outstring = [outstring crlf 'At t plus ' num2str(t(ind)) ' s, Smoothed SP8-SP9 is '
       num2str(stratsmooth_3(ind) - stratsmooth_4(ind)) ' C and Smoothed SP8-Top is '
       num2str(stratsmooth_3(ind) - stratsmooth_1(ind)) ' C, where Smoothed SP8 is '
       num2str(stratsmooth_3(ind)) ' C and Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end


% Find Max Smoothed Lower-Outlet stratification
[y, ind] = max(lowoutsm);
outstring=['Maximum Smoothed Lower-Outlet delta T is ' num2str(y) ' degrees C at t plus '
       num2str(t(ind)) ' s with T_low = ' num2str(stratsmooth_2(ind)) ' C and T_out = '
       num2str(stratsmooth_5(ind)) ' C'];
outstring = [outstring crlf 'At t plus ' num2str(t(ind)) ' s, Smoothed SP8-SP9 is '
       num2str(stratsmooth_3(ind) - stratsmooth_4(ind)) ' C and Smoothed SP8-Top is '
       num2str(stratsmooth_3(ind) - stratsmooth_1(ind)) ' C, where Smoothed SP8 is '
       num2str(stratsmooth_3(ind)) ' C and Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find Max Sparger Local Relative Temperature
[y, ind] = max(stratsmooth_3 - stratsmooth_4);
% Store the Key Point
keypoints_ind(14) = ind;
outstring=['Maximum Smoothed Condensing Region SP8-SP9 delta T is ' num2str(y) ' degrees
       C at (KEY POINT #14) t plus ' num2str(t(ind)) ' s with T_SP8 = '
       num2str(stratsmooth_3(ind)) ' C and T_SP9 = ' num2str(stratsmooth_4(ind)) ' C and
       Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find Max Sparger Local Relative Temperature (top)
[y, ind] = max(stratsmooth_3 - stratsmooth_1);
outstring=['Maximum Smoothed Condensing Region SP8-Upper delta T is ' num2str(y) '
       degrees C at t plus ' num2str(t(ind)) ' s with T_SP8 = '
       num2str(stratsmooth_3(ind)) ' C and T_upper = ' num2str(stratsmooth_1(ind)) ' C
       and Pool P = ' num2str(trmdat(ind, 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end



% unsmoothed basic stratification data

% Top-Mid temps
topmid = [ (trmdat(:,60)-trmdat(:,58)), (trmdat(:,44)-trmdat(:,42)), (trmdat(:,28)-
       trmdat(:,26))];
topmidno4 = [ t*0, (trmdat(:,44)-trmdat(:,42)), (trmdat(:,28)-trmdat(:,26))];

% Top-Lower temps
toplow = [ (trmdat(:,60)-trmdat(:,56)), (trmdat(:,44)-trmdat(:,40)), (trmdat(:,28)-
       trmdat(:,24))];

% Mid-Lower temps
midlow = [ (trmdat(:,58)-trmdat(:,56)), (trmdat(:,42)-trmdat(:,40)), (trmdat(:,26)-
       trmdat(:,24))];
midlowno4 = [ t*0, (trmdat(:,42)-trmdat(:,40)), (trmdat(:,26)-trmdat(:,24))];
```

```
% Upper-Outlet temps
upout = [ (trmdat(:,60)-trmdat(:,74)), (trmdat(:,44)-trmdat(:,74)), (trmdat(:,28)-
        trmdat(:,74))];

% Mid-outlet temps
midout = [ (trmdat(:,58)-trmdat(:,74)), (trmdat(:,42)-trmdat(:,74)), (trmdat(:,26)-
        trmdat(:,74))];
midoutno4 = [ t*0, (trmdat(:,42)-trmdat(:,74)), (trmdat(:,26)-trmdat(:,74))];

% Lower-outlet temps
lowout = [ (trmdat(:,56)-trmdat(:,74)), (trmdat(:,40)-trmdat(:,74)), (trmdat(:,24)-
        trmdat(:,74))];

% Find Max Top-Mid stratification
[temps, inds] = max(topmidno4);
[y, ind] = max(temps);
% get T values
if ind == 1
    % rear set
    tempsc = [trmdat(inds(ind), 60), trmdat(inds(ind), 58)];
elseif ind == 2
    % middle set
    tempsc = [trmdat(inds(ind), 44), trmdat(inds(ind), 42)];
elseif ind == 3
    % front set
    tempsc = [trmdat(inds(ind), 28), trmdat(inds(ind), 26)];
else
    % oops
    tempsc = [0, 0];
end
% Store the Key Point
keypoints_ind(4) = inds(ind);
outstring=['Maximum Top-Mid delta T is ' num2str(temps(ind)) ' degrees C at (KEY POINT #4)
        t plus ' num2str(t(inds(ind))) ' s ignoring SP 4, with temperatures of '
        num2str(tempsc(1)) ' and ' num2str(tempsc(2)) ' C, respectively, at Set # '
        num2str(ind)  ', where Pool P = ' num2str(trmdat(inds(ind), 97)) ' psia and
        T_outlet = ' num2str(trmdat(inds(ind), 74)) ' C'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find the Top-Mid Reconvergence Point
RP = length(t);
PV = temps(ind);
foundreconverge = 0;
for n = inds(ind):(RP-600)
    dtvals = MTMDeltaT(n:n+600);
    % look at t throug t plus 1 minute, and check for reconvergence for the
    % entire minute in the smoothed mid-axis data
    % reconvergence is delta T less than 1 degree OR less than 1/3 of the
    % Peak Difference
    if (sum(dtvals > (PV/3)) == 0) || (sum(dtvals > (1)) == 0)
        % found it!
        foundreconverge = 1;
        break
    end
end
if foundreconverge == 0
    % if the standard method did not find reconvergence, check the tail end
    for n = RP-600 : RP
        dtvals = MTMDeltaT(n:RP);
        % look at t through the end, and check for reconvergence for the
        % entire period (< 1 min) in the smoothed mid-axis data
        % reconvergence is delta T less than 1 degree OR less than 1/3 of the
        % Peak Difference
        if (sum(dtvals > (PV/3)) == 0) || (sum(dtvals > (1)) == 0)
```

```
            % found it!
            foundreconverge = 1;
            break
        end
    end
end
if foundreconverge == 1
    outstring = ['Top-Mid Reconvergence Detected at (KEY POINT #5) t plus ' num2str(t(n))
        ' s with a Smoothed Mid-Axis Top-Mid Delta T of ' num2str(MTMDeltaT(n)) ' C and a
        raw SP12 Reading of ' num2str(trmdat(n,42)) ' C. '];
else
    n = RP;
    outstring = ['Top-Mid Reconvergence NOT Detected, setting t to (KEY POINT #5) t plus
        ' num2str(t(n)) ' s with a Smoothed Mid-Axis Top-Mid Delta T of '
        num2str(MTMDeltaT(n)) ' C and a raw SP12 Reading of ' num2str(trmdat(n,42)) ' C.
        '];
end
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
keypoints_ind(5) = n;

% Find Max Top-Lower stratification
[temps, inds] = max(toplow);
[y, ind] = max(temps);
% get T values
if ind == 1
    % rear set
    tempsc = [trmdat(inds(ind), 60), trmdat(inds(ind), 56)];
elseif ind == 2
    % middle set
    tempsc = [trmdat(inds(ind), 44), trmdat(inds(ind), 40)];
elseif ind == 3
    % front set
    tempsc = [trmdat(inds(ind), 28), trmdat(inds(ind), 24)];
else
    % oops
    tempsc = [0, 0];
end
outstring=['Maximum Top-Lower delta T is ' num2str(temps(ind)) ' degrees C at t plus '
        num2str(t(inds(ind))) ' s, with temperatures of ' num2str(tempsc(1)) ' and '
        num2str(tempsc(2)) ' C, respectively, at Set # ' num2str(ind)   ', where Pool P =
        ' num2str(trmdat(inds(ind), 97)) ' psia and T_outlet = ' num2str(trmdat(inds(ind),
        74)) ' C'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find Max Mid-Lower stratification
[temps, inds] = max(midlowno4);
[y, ind] = max(temps);
% get T values
if ind == 1
    % rear set
    tempsc = [trmdat(inds(ind), 58), trmdat(inds(ind), 56)];
elseif ind == 2
    % middle set
    tempsc = [trmdat(inds(ind), 42), trmdat(inds(ind), 40)];
elseif ind == 3
    % front set
    tempsc = [trmdat(inds(ind), 26), trmdat(inds(ind), 24)];
else
    % oops
    tempsc = [0, 0];
end
```

```
% Store the Key Point
keypoints_ind(6) = inds(ind);
outstring=['Maximum Mid-Low delta T is ' num2str(temps(ind)) ' degrees C at (KEY POINT #6)
       t plus ' num2str(t(inds(ind))) ' s ignoring SP 4, with temperatures of '
       num2str(tempsc(1)) ' and ' num2str(tempsc(2)) ' C, respectively, at Set # '
       num2str(ind)   ', where Pool P = ' num2str(trmdat(inds(ind), 97)) ' psia and
       T_outlet = ' num2str(trmdat(inds(ind), 74)) ' C'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find the Mid-Low Reconvergence Point
RP = length(t);
PV = temps(ind);
foundreconverge = 0;
for n = inds(ind):(RP-600)
    dtvals = MMLDeltaT(n:n+600);
    % look at t through t plus 1 minute, and check for reconvergence for the
    % entire minute in the smoothed mid-axis data
    % reconvergence is delta T less than 1 degree OR less than 1/3 of the
    % Peak Difference
    if (sum(dtvals > (PV/3)) == 0) || (sum(dtvals > (1)) == 0)
        % found it!
        foundreconverge = 1;
        break
    end
end
if foundreconverge == 0
    % if the standard method did not find reconvergence, check the tail end
    for n = RP-600 : RP
        dtvals = MMLDeltaT(n:RP);
        % look at t through the end, and check for reconvergence for the
        % entire period (< 1 min) in the smoothed mid-axis data
        % reconvergence is delta T less than 1 degree OR less than 1/3 of the
        % Peak Difference
        if (sum(dtvals > (PV/3)) == 0) || (sum(dtvals > (1)) == 0)
            % found it!
            foundreconverge = 1;
            break
        end
    end
end
if foundreconverge == 1
    outstring = ['Mid-Low Reconvergence Detected at (KEY POINT #7) t plus ' num2str(t(n))
        ' s with a Smoothed Mid-Axis Mid-Low Delta T of ' num2str(MMLDeltaT(n)) ' C and a
        raw SP12 Reading of ' num2str(trmdat(n,42)) ' C. '];
else
    n = RP;
    outstring = ['Mid-Low Reconvergence NOT Detected, setting t to (KEY POINT #7) t plus
        ' num2str(t(n)) ' s with a Smoothed Mid-Axis Mid-Low Delta T of '
        num2str(MMLDeltaT(n)) ' C and a raw SP12 Reading of ' num2str(trmdat(n,42)) ' C.
        '];
end
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
keypoints_ind(7) = n;

% Find Max Top-Outlet stratification
[temps, inds] = max(upout);
[y, ind] = max(temps);
% get T values
if ind == 1
    % rear set
    tempsc = [trmdat(inds(ind), 60), trmdat(inds(ind), 74)];
```

```
elseif ind == 2
    % middle set
    tempsc = [trmdat(inds(ind), 44), trmdat(inds(ind), 74)];
elseif ind == 3
    % front set
    tempsc = [trmdat(inds(ind), 28), trmdat(inds(ind), 74)];
else
    % oops
    tempsc = [0, 0];
end
outstring=['Maximum Top-Outlet delta T is ' num2str(temps(ind)) ' degrees C at t plus '
       num2str(t(inds(ind))) ' s, with temperatures of ' num2str(tempsc(1)) ' and '
       num2str(tempsc(2)) ' C, respectively, at Set # ' num2str(ind)   ', where Pool P =
       ' num2str(trmdat(inds(ind), 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find Max Mid-Outlet stratification
[temps, inds] = max(midoutno4);
[y, ind] = max(temps);
% get T values
if ind == 1
    % rear set
    tempsc = [trmdat(inds(ind), 58), trmdat(inds(ind), 74)];
elseif ind == 2
    % middle set
    tempsc = [trmdat(inds(ind), 42), trmdat(inds(ind), 74)];
elseif ind == 3
    % front set
    tempsc = [trmdat(inds(ind), 26), trmdat(inds(ind), 74)];
else
    % oops
    tempsc = [0, 0];
end
outstring=['Maximum Mid-Outlet delta T is ' num2str(temps(ind)) ' degrees C at t plus '
       num2str(t(inds(ind))) ' s ignoring SP 4, with temperatures of ' num2str(tempsc(1))
       ' and ' num2str(tempsc(2)) ' C, respectively, at Set # ' num2str(ind)   ', where
       Pool P = ' num2str(trmdat(inds(ind), 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find Max Lower-Outlet stratification
[temps, inds] = max(lowout);
[y, ind] = max(temps);
% get T values
if ind == 1
    % rear set
    tempsc = [trmdat(inds(ind), 56), trmdat(inds(ind), 74)];
elseif ind == 2
    % middle set
    tempsc = [trmdat(inds(ind), 40), trmdat(inds(ind), 74)];
elseif ind == 3
    % front set
    tempsc = [trmdat(inds(ind), 24), trmdat(inds(ind), 74)];
else
    % oops
    tempsc = [0 0];
end
% Store the Key Point
keypoints_ind(8) = inds(ind);
outstring=['Maximum Lower-Outlet delta T is ' num2str(temps(ind)) ' degrees C at (KEY
       POINT #8) t plus ' num2str(t(inds(ind))) ' s, with temperatures of '
```

```
        num2str(tempsc(1)) ' and ' num2str(tempsc(2)) ' C, respectively, at Set # '
        num2str(ind)   ', where Pool P = ' num2str(trmdat(inds(ind), 97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Find the Lower-Outlet Reconvergence Point
RP = length(t);
PV = temps(ind);
foundreconverge = 0;
for n = inds(ind):(RP-600)
    dtvals = MLODeltaT(n:n+600);
    % look at t through t plus 1 minute, and check for reconvergence for the
    % entire minute in the smoothed mid-axis data
    % reconvergence is delta T less than 1 degree OR less than 1/3 of the
    % Peak Difference
    if (sum(dtvals > (PV/3)) == 0) || (sum(dtvals > (1)) == 0)
        % found it!
        foundreconverge = 1;
        break
    end
end
if foundreconverge == 0
    % if the standard method did not find reconvergence, check the tail end
    for n = RP-600 : RP
        dtvals = MLODeltaT(n:RP);
        % look at t through the end, and check for reconvergence for the
        % entire period (< 1 min) in the smoothed mid-axis data
        % reconvergence is delta T less than 1 degree OR less than 1/3 of the
        % Peak Difference
        if (sum(dtvals > (PV/3)) == 0) || (sum(dtvals > (1)) == 0)
            % found it!
            foundreconverge = 1;
            break
        end
    end
end
if foundreconverge == 1
    outstring = ['Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus '
        num2str(t(n)) ' s with a Smoothed Mid-Axis Low-Outlet Delta T of '
        num2str(MLODeltaT(n)) ' C and a raw SP12 Reading of ' num2str(trmdat(n,42)) ' C.
        '];
else
    n = RP;
    outstring = ['Low-Outlet Reconvergence NOT Detected, setting t to (KEY POINT #10) t
        plus ' num2str(t(n)) ' s with a Smoothed Mid-Axis Low-Outlet Delta T of '
        num2str(MLODeltaT(n)) ' C and a raw SP12 Reading of ' num2str(trmdat(n,42)) ' C.
        '];
end
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
keypoints_ind(10) = n;

% SP Pressures
% Min
[y, ind] = min(trmdat(:,97));
outstring=['Minimum SP Pressure is ' num2str(y) ' psia at t plus ' num2str(t(ind)) ' s'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Max
[y, ind] = max(trmdat(:,97));
outstring=['Maximum SP Pressure is ' num2str(y) ' psia at t plus ' num2str(t(ind)) ' s'];
```

```
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Beginning
outstring=['Beginning SP Pressure is ' num2str(trmdat(1,97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% End
outstring=['Ending SP Pressure is ' num2str(trmdat(end,97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Mean
y = mean(trmdat(:,97));
ind = std(trmdat(:,97));
outstring=['Time-Average SP Pressure is ' num2str(y) ' +/- ' num2str(ind) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end




% SP Levels
outstring='SP Levels are fully corrected and compensated';
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Initial, Pre-start
outstring=['Pre-Start SP Level is ' num2str(coldlevelprestart) ' cm (cold) / '
       num2str(hotlevelprestart) ' cm (hot) at ' num2str(data(1,97)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Beginning
outstring=['Beginning Smoothed SP Level is ' num2str(coldlevels(1)) ' cm (cold) / '
       num2str(hotdepth(1)) ' cm (hot) at ' num2str(smoothedP(1)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Ending
outstring=['Ending Smoothed SP Level is ' num2str(coldlevels(end)) ' cm (cold) / '
       num2str(hotdepth(end)) ' cm (hot) at ' num2str(smoothedP(end)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Min
[y, ind] = min(coldlevels);
outstring=['Minimum Smoothed Cold SP Level is ' num2str(y) ' cm at t plus '
       num2str(t(ind)) ' s and ' num2str(smoothedP(ind)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
[y, ind] = min(hotdepth);
outstring=['Minimum Smoothed Hot SP Level is ' num2str(y) ' cm at t plus ' num2str(t(ind))
       ' s and ' num2str(smoothedP(ind)) ' psia'];
disp(outstring)
```

```
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
% Max
[y, ind] = max(coldlevels);
outstring=['Maximum Smoothed Cold SP Level is ' num2str(y) ' cm at t plus '
        num2str(t(ind)) ' s and ' num2str(smoothedP(ind)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
[y, ind] = max(hotdepth);
outstring=['Maximum Smoothed Hot SP Level is ' num2str(y) ' cm at t plus ' num2str(t(ind))
        ' s and ' num2str(smoothedP(ind)) ' psia'];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Temperatures
outstring=['SP 12 Temperature at the beginning is ' num2str(trmdat(1,42)) ' C, and at the
        end is ' num2str(trmdat(end,42)) ' C' ];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

% Mixing Number
outstring=['At plume detection, the Mixing Number is '
        num2str(testrelationship(plume_ind)) ' ' ];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end

[y1, ind1] = min(testrelationship);
[y2, ind2] = max(testrelationship);
outstring = ['The Mixing Number ranges from a minimum of ' num2str(y1) ' at (KEY POINT
        #12) t plus ' num2str(t(ind1)) ' s to a maximum of ' num2str(y2) ' at (KEY POINT
        #13) t plus ' num2str(t(ind2)) ' s; it had a mean value of '
        num2str(mean(testrelationship)) ' +/- ' num2str(std(testrelationship)) ' over the
        test period. '];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
keypoints_ind(12) = ind1;
keypoints_ind(13) = ind2;

% Key Point Data Dumps
outstring=['Key Points have Data Dumps of the following for each Key Point:  '
        steampropsdesc];
disp(outstring)
if save_em == 1
    fprintf(filehandle, '%s\r\n', outstring);
end
for n=1:length(keypoints_ind)
    outstring=['KEY POINT #' num2str(n) ' (t plus ' num2str(t(keypoints_ind(n))) ' s with
        a Mixing Number of ' num2str(testrelationship(keypoints_ind(n))) '):  '
        num2str(steamprops(keypoints_ind(n), :)) ' '];
    disp(outstring)
    if save_em == 1
        fprintf(filehandle, '%s\r\n', outstring);
    end
end
```

```
%
% =======================
% PLOT GENERATION SECTION
% =======================
%


disp(' ')
disp('Generating Plots for the Loaded & Computed Data')

% Smoothed Pool Temperatures
% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the smoothed rear pool temperatures.'];
disp(text)

% set up plot
x1 = stratsmooth_0;
y1 = stratsmooth_1;
x2 = stratsmooth_0;
y2 = stratsmooth_3;
x3 = stratsmooth_0;
y3 = stratsmooth_4;
x4 = stratsmooth_0;
y4 = stratsmooth_2;
x5 = stratsmooth_0;
y5 = stratsmooth_5;
x6 = t;
y6 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
```

```
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d', x4(1), y4(1),
       'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'c-', x3, y3, 'r-', x4, y4, 'g-', x5, y5, 'k-', x6,
       y6, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p, y5p,
       'ko', x6p, y6p, 'k*');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'c');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'c');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'r');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerFaceColor', 'r');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerFaceColor', 'g');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerSize', 10);
set(ploth3(4), 'MarkerFaceColor', 'g');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerSize', 10);
set(ploth1(5), 'MarkerFaceColor', 'k');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerSize', 5);
set(ploth3(5), 'MarkerFaceColor', 'k');
set(ploth3(5), 'MarkerEdgeColor', 'w');
set(ploth3(5), 'MarkerSize', 5);
set(ploth1(6), 'MarkerSize', 10);
set(ploth3(6), 'MarkerSize', 10);
xlabel('Time, s');
ylabel('Temperature, C');
if showtitles == 1
    title('Smoothed Near-Sparger-End Pool Temperatures');
end
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
```

```
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
figname = [testname '_pool_back_smoothed_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
legendhandle = legend('A - Upper', 'B - Near Sparger (Middle)', 'C - Further from Sparger
        (Middle)', 'D - Lower', 'E - Outlet', 'F - Saturation', 'Location', 'NorthWest');
set(legendhandle, 'Color', 'none');
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Enthalpies

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the smoothed rear pool enthalpies.'];
disp(text)

% set up plot
x1 = t;
y1 = htop;
x2 = t;
y2 = hcondensing;
x3 = t;
y3 = hmid;
x4 = t;
y4 = hlow;
x5 = t;
y5 = hout;
x6 = t;
y6 = AdjustedEnth_DS;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
```

```
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d', x4(1), y4(1),
       'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k:*');
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'c-', x3, y3, 'r-', x4, y4, 'g-', x5, y5, 'k-', x6,
       y6, 'k:');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p, y5p,
       'ko', x6p, y6p, 'k*');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'c');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'c');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'r');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerFaceColor', 'r');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerFaceColor', 'g');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerSize', 10);
set(ploth3(4), 'MarkerFaceColor', 'g');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerSize', 10);
set(ploth1(5), 'MarkerFaceColor', 'k');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerSize', 5);
set(ploth3(5), 'MarkerFaceColor', 'k');
```

```
set(ploth3(5), 'MarkerEdgeColor', 'w');
set(ploth3(5), 'MarkerSize', 5);
set(ploth1(6), 'MarkerSize', 10);
set(ploth3(6), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
        0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
if showtitles == 1
    title('Smoothed Near-Sparger End Pool Enthalpies');
end
xlabel('Time, s');
ylabel('Enthalpy, kJ/kg');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
figname = [testname '_pool_back_smoothed_enthalpies'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
legendhandle = legend('A - Upper', 'B - Near Sparger (Middle)', 'C - Further from Sparger
        (Middle)', 'D - Lower', 'E - Outlet', 'F - Steam In', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end


% Delta T

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Local Delta T'];
disp(text)

% set up plot
x1 = t;
y1 = stratsmooth_3-stratsmooth_4;
x2 = t;
y2 = stratsmooth_3-stratsmooth_1;
x3 = t;
y3 = poolsat-stratsmooth_3;
x1pdist = floor(x1(end)/5);
x2pdist = floor(x2(end)/6);
x3pdist = floor(x3(end)/7);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
```

```
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end

[ax,h1,h2] = plotyy(x1, [y1, y2], x3, y3);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'g-p');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'gp');
ploth3a = plot(ax(2), x3(1), y3(1), 'r-d');
ploth3b = plot(ax(2), x3p, y3p, 'rd');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(2), 'YColor', 'r')
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'g');
set(h2, 'Color', 'r');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth3a, 'MarkerEdgeColor', 'k');
set(ploth3b, 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'g');
set(ploth2a(2), 'MarkerSize', 10);
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'g');
set(ploth2b(2), 'MarkerSize', 10);
set(ploth3a, 'MarkerFaceColor', 'r');
set(ploth3b, 'MarkerFaceColor', 'r');
xlabel('Time, s');
if showtitles == 1
    title('Condensing Region Delta T');
end
set(get(ax(1),'Ylabel'),'String','Delta T, C');
set(get(ax(2),'Ylabel'),'String','Saturation - Pool Condensing Delta T, C');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
figname = [testname '_delta_T'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
legendhandle = legend([ploth2a', ploth3a], 'A - Condensing - SP9', 'B - Condensing -
       Upper', 'C - Saturation - Condensing', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
```

```
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Delta h, cooling

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Local Condensing Enthalpy'];
disp(text)

% set up plot
x1 = t;
y1 = AdjustedEnth_DS - hsatL(:,2);
x2 = t;
y2 = AdjustedEnth_DS - hcondensing;
x3 = t;
y3 = mdcondinj;
x4 = t;
if use_turbine == 1
    y4 = mdcondinjcool;
else
    y4 = 0*mdcondinjcool;
end
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
```

```
    end
end
[ax, h1, h2] = plotyy(x1, [y1, y2], x3, [y3, y4]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'g-p');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'gp');
ploth3a = plot(ax(2), x3(1), y3(1), 'r-d', x4(1), y4(1), 'm-v');
ploth3b = plot(ax(2), x3p, y3p, 'rd', x4p, y4p, 'mv');
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'g');
set(h2(1), 'Color', 'r');
set(h2(2), 'Color', 'm');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3a(2), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth3b(2), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'g');
set(ploth2a(2), 'MarkerSize', 10);
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'g');
set(ploth2b(2), 'MarkerSize', 10);
set(ploth3a(1), 'MarkerFaceColor', 'r');
set(ploth3a(2), 'MarkerFaceColor', 'm');
set(ploth3b(1), 'MarkerFaceColor', 'r');
set(ploth3b(2), 'MarkerFaceColor', 'm');
xlabel('Time, s');
set(get(ax(1),'Ylabel'),'String','Steam Delta h, kJ/kg');
set(get(ax(2),'Ylabel'),'String','Water mdot, kg/s');
if showtitles == 1
    title('Condensing Region Enthalpy and Massflows');
end
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
rtlims = get(ax(2), 'YLim');
if rtlims(1) < 0
    rtlims(1) = 0;
    % keep chart above zero
end
if use_turbine == 1
    if rtlims(2) > 1.25 * max(mdcondinjcool(stratstartind:stratendind))
        % too high
        rtlims(2) = ceil(1.25 * max(mdcondinjcool(stratstartind:stratendind)));
    end
    if rtlims(2) > 10 * max(mdcondinj)
        rtlims(2) = 10 * max(mdcondinj);
    end
else
    if rtlims(2) > 1.25 * max(mdcondinj)
        % too high
        rtlims(2) = ceil(1.25 * max(mdcondinj));
    end
end
set(ax(2), 'YLim', rtlims);
```

```
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
figname = [testname '_delta_h'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
legendhandle = legend([ploth2a', ploth3a'], 'A - Condensing', 'B - Condensing & Cooling',
       'C - mdot - Condensing', 'D - mdot - Condensing & Cooling', 'Location',
       'NorthWest');
set(legendhandle, 'Color', 'none');
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Pool Temperatures - Outlet End

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Outlet End Pool Temperature.'];
disp(text)

% SP 18 is in Column 30
% SP 19 is in Column 28
% SP 20 is in Column 26
% SP 21 is in Column 24
% SP 22 is in Column 22
% SP 23 is in Column 20
% SP Top Flange is in Column 14
% SP Outlet is in Column 74

% set up plot
x1 = t;
y1 = trmdat(:,28);
x2 = t;
y2 = trmdat(:,26);
x3 = t;
y3 = trmdat(:,24);
x4 = t;
y4 = trmdat(:,22);
x5 = t;
y5 = trmdat(:,20);
x6 = t;
y6 = trmdat(:,74);
x7 = t;
y7 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/13);
x7pdist = floor(x6(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
```

```
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
        'c-^', x5(1), y5(1), 'm-v', x6(1), y6(1), 'k-o', x7(1), y7(1), 'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'c-', x5, y5, 'm-', x6,
        y6, 'k-', x7, y7, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'c^', x5p, y5p,
        'mv', x6p, y6p, 'ko', x7p, y7p, 'k*');
set(ploth1(1), 'MarkerFaceColor', 'b');
```

```
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerFaceColor', 'c');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerFaceColor', 'c');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerFaceColor', 'm');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth3(5), 'MarkerFaceColor', 'm');
set(ploth3(5), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerFaceColor', 'k');
set(ploth1(6), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerSize', 5);
set(ploth3(6), 'MarkerFaceColor', 'k');
set(ploth3(6), 'MarkerEdgeColor', 'w');
set(ploth3(6), 'MarkerSize', 5);
set(ploth1(7), 'MarkerSize', 10);
set(ploth3(7), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
if showtitles == 1
    title('Outlet End Pool Temperatures, Facing Away from the Sparger End');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('A - Upper', 'B - Middle', 'C - Lower', 'D - Left', 'E - Right', 'F
       - Bottom Outlet', 'G - Saturation', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_front_temps'];
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% T & x

% create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the steam temperature and quality.'];
disp(text)
```

```
% set up plot
x1 = t;
y1 = AdjustedQuality(:,1);
x2 = t;
if use_turbine == 1
    y2 = AdjustedQuality(:,2);
else
    y2 = 0*AdjustedQuality(:,2);
end
x3 = t;
y3 = trmdat(:,76);
x4 = t;
y4 = trmdat(:,68);
x5 = t;
y5 = trmdat(:, 66);
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1, y2], x3, [y3, y4, y5]);
```

```
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'g-p');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'gp');
ploth3a = plot(ax(2), x3(1), y3(1), 'r-d', x4(1), y4(1), 'm-v', x5(1), y5(1), 'c-^');
ploth3b = plot(ax(2), x3p, y3p, 'rd', x4p, y4p, 'mv', x5p, y5p, 'c^');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
ylvals = get(ax(1), 'YLim');
ylvals(2) = 0.1 * ceil(10*ylvals(2));
if ylvals(1) > 0
    ylvals(1) = 0;
end
set(ax(1), 'YLim', ylvals);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'g');
set(h2(1), 'Color', 'r');
set(h2(2), 'Color', 'm');
set(h2(3), 'Color', 'c');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3a(2), 'MarkerEdgeColor', 'k');
set(ploth3a(3), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth3b(2), 'MarkerEdgeColor', 'k');
set(ploth3b(3), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'g');
set(ploth2a(2), 'MarkerSize', 10);
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'g');
set(ploth2b(2), 'MarkerSize', 10);
set(ploth3a(1), 'MarkerFaceColor', 'r');
set(ploth3a(2), 'MarkerFaceColor', 'm');
set(ploth3a(3), 'MarkerFaceColor', 'c');
set(ploth3b(1), 'MarkerFaceColor', 'r');
set(ploth3b(2), 'MarkerFaceColor', 'm');
set(ploth3b(3), 'MarkerFaceColor', 'c');
xlabel('Time, s');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Quality');
set(get(ax(2),'Ylabel'),'String','Temperature, C');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('Steam Quality');
end
legendhandle = legend([ploth2a', ploth3a'], 'Estimated Smoothed Steam Quality', 'Turbine
       Outlet Smoothed Quality', 'Pre-Injection T', 'Post-Injection T', 'Turbine Outlet
       T', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_steam_quality'];
```

```
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the steam flowpath temperature.'];
disp(text)

% Steam Path Temperature Plot

% Steam Generator void temperature is in Column 4
% Vortex Flowmeter Steam Temperature is in Column 82
% Steam Line upstream of Water Injection Temperature is in Column 76
% Steam Line Downstream of Water Injection Temperature in in Column 68
% RCIC Turbine Outlet Temperature is in Column 66
% SP 1 Temperature is in Column 64

% set up plot
x1 = t;
y1 = trmdat(:, 4);
x2 = t;
y2 = trmdat(:, 82);
x3 = t;
y3 = trmdat(:, 76);
x4 = t;
y4 = trmdat(:, 68);
x5 = t;
y5 = trmdat(:, 66);
x6 = t;
y6 = trmdat(:, 64);
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/13);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
```

```
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end

ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
       'c-^', x5(1), y5(1), 'm-v', x6(1), y6(1), 'k-o');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'c-', x5, y5, 'm-', x6,
       y6, 'k-');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'c^', x5p, y5p,
       'mv', x6p, y6p, 'ko');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerFaceColor', 'c');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerFaceColor', 'c');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerFaceColor', 'm');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth3(5), 'MarkerFaceColor', 'm');
set(ploth3(5), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerFaceColor', 'k');
set(ploth1(6), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerSize', 5);
set(ploth3(6), 'MarkerFaceColor', 'k');
```

```
set(ploth3(6), 'MarkerEdgeColor', 'w');
set(ploth3(6), 'MarkerSize', 5);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Steam Path Temperatures');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('Steam Generator Outlet', 'Main Steam Line at Flowmeter', 'Main
       Steam Line Upstream of Water Injection', 'Main Steam Line Downstream of Water
       Injection', 'Turbine Outlet', 'SP1 - RCIC Sparger Outlet', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_steam_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Water Flowpath Temperature Plot

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the water flowpath temperature.'];
disp(text)

% SP Outlet Temperature is in Column 74
% RCIC Pump Inlet Temperature is in Column 70
% RCIC Pump Outlet Temperature in in Column 72
% Return Water Flowmeter Temperature is in Column 84
% Steam Generator Water Injection Temperature is in Column 12
% Water Injection to Steam Line is the average of two temperatures
%      Upstream is in Column 78
%      Downstream is in Column 80

% set up plot
x1 = t;
y1 = trmdat(:, 74);
x2 = t;
y2 = trmdat(:, 70);
x3 = t;
y3 = trmdat(:, 72);
x4 = t;
y4 = trmdat(:, 84);
x5 = t;
y5 = trmdat(:, 12);
x6 = t;
y6 = (0.5*(trmdat(:,78)+trmdat(:,80)));
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
```

```
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/13);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end

ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
        'c-^', x5(1), y5(1), 'm-v', x6(1), y6(1), 'k-o');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'c-', x5, y5, 'm-', x6,
        y6, 'k-');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'c^', x5p, y5p,
        'mv', x6p, y6p, 'ko');
```

```
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerFaceColor', 'c');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerFaceColor', 'c');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerFaceColor', 'm');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth3(5), 'MarkerFaceColor', 'm');
set(ploth3(5), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerFaceColor', 'k');
set(ploth1(6), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerSize', 5);
set(ploth3(6), 'MarkerFaceColor', 'k');
set(ploth3(6), 'MarkerEdgeColor', 'w');
set(ploth3(6), 'MarkerSize', 5);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Water Flowath Temperatures');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('Suppression Pool Outlet', 'RCIC Pump Inlet', 'RCIC Pump Outlet',
       'Water to Steam Generator Flowmeter', 'Steam Generator Injection Point', 'Avg.
       Water Injection to Steam Line (US & DS)', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_water_flow_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Pool Temperatures - Upper Horizontal

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the axial upper-level pool temperature.'];
disp(text)
```

```
% SP 19 is in Column 28
% SP 11 is in Column 44
% SP 3 is in Column 60

% set up plot
x1 = t;
y1 = trmdat(:,28);
x2 = t;
y2 = trmdat(:,44);
x3 = t;
y3 = trmdat(:,60);
x4 = t;
y4 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
       'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'k*');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
```

```
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerSize', 10);
set(ploth3(4), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
        0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Suppression Pool Upper-Level Axial Temperatures');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('Upper Front', 'Upper Middle', 'Upper Rear', 'Saturation',
        'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_upper_horiz_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Pool Temperatures - Middle Horizontal

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the axial mid-level pool temperature.'];
disp(text)

% SP 4 is in Column 58
% SP 8 is in Column 50
% SP 9 is in Column 48
% SP 10 is in Column 46
% SP 12 is in Column 42
% SP 16 is in Column 34
% SP 17 is in Column 32
% SP 20 is in Column 26
% SP 24 is in Column 18

% set up plot
x1 = t;
y1 = trmdat(:,50);
x2 = t;
y2 = trmdat(:,48);
x3 = t;
y3 = trmdat(:,46);
x4 = t;
```

```
y4 = trmdat(:,42);
x5 = t;
y5 = trmdat(:,34);
x6 = t;
y6 = trmdat(:,32);
x7 = t;
y7 = trmdat(:,26);
x8 = t;
y8 = trmdat(:,18);
x9 = t;
y9 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/13);
x7pdist = floor(x7(end)/(17/2));
x8pdist = floor(x8(end)/(19/2));
x9pdist = floor(x9(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
```

```
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
x8p = x8(1);
y8p = y8(1);
for ind = 2:length(x8)
    if x8p(end) + x8pdist <= x8(ind)
        % append the point to the array
        x8p = [x8p x8(ind)];
        y8p = [y8p y8(ind)];
    end
end
x9p = x9(1);
y9p = y9(1);
for ind = 2:length(x9)
    if x9p(end) + x9pdist <= x9(ind)
        % append the point to the array
        x9p = [x9p x9(ind)];
        y9p = [y9p y9(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
       'c-^', x5(1), y5(1), 'm-v', x6(1), y6(1), 'k-o', x7(1), y7(1), 'y->', x8(1),
       y8(1), 'y-<', x9(1), y9(1), 'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'c-', x5, y5, 'm-', x6,
       y6, 'k-', x7, y7, 'y-', x8, y8, 'y-', x9, y9, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'c^', x5p, y5p,
       'mv', x6p, y6p, 'ko', x7p, y7p, 'y>', x8p, y8p, 'y<', x9p, y9p, 'k*');
set(ploth1(7) , 'Color', [1, 155/255, 0]);
set(ploth2(7) , 'Color', [1, 155/255, 0]);
set(ploth3(7) , 'Color', [1, 155/255, 0]);
set(ploth1(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth2(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth3(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'w');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'w');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerFaceColor', 'c');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerFaceColor', 'c');
set(ploth3(4), 'MarkerEdgeColor', 'k');
```

```
set(ploth1(5), 'MarkerFaceColor', 'm');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth3(5), 'MarkerFaceColor', 'm');
set(ploth3(5), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerFaceColor', 'k');
set(ploth1(6), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerSize', 5);
set(ploth3(6), 'MarkerFaceColor', 'k');
set(ploth3(6), 'MarkerEdgeColor', 'w');
set(ploth3(6), 'MarkerSize', 5);
set(ploth1(7), 'MarkerFaceColor', [1, 155/255, 0]);
set(ploth1(7), 'MarkerEdgeColor', 'k');
set(ploth3(7), 'MarkerFaceColor', [1, 155/255, 0]);
set(ploth3(7), 'MarkerEdgeColor', 'k');
set(ploth1(8), 'MarkerFaceColor', [139/255, 115/255, 85/255]);
set(ploth1(8), 'MarkerEdgeColor', 'k');
set(ploth3(8), 'MarkerFaceColor', [139/255, 115/255, 85/255]);
set(ploth3(8), 'MarkerEdgeColor', 'k');
set(ploth1(9), 'MarkerSize', 10);
set(ploth3(9), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Suppression Pool Mid-Level Axial Temperatures');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('A - Near-Sparger (0.63 m)', 'B - 0.94 m', 'C - 1.24 m', 'D - 1.55
       m', 'E - 1.85 m', 'F - 2.16 m', 'G - 2.46 m', 'H - Front (2.77 m)', 'J -
       Saturation', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_mid_horiz_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Pool Temperatures - Lower Horizontal

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the axial lower-level pool temperature.'];
disp(text)

% SP 21 is in Column 24
% SP 13 is in Column 40
% SP 5 is in Column 56

% set up plot
x1 = t;
```

```
y1 = trmdat(:,24);
x2 = t;
y2 = trmdat(:,40);
x3 = t;
y3 = trmdat(:,56);
x4 = t;
y4 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
       'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'k*');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
```

```
set(ploth1(4), 'MarkerSize', 10);
set(ploth3(4), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Suppression Pool Lower-Level Axial Temperatures');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('Lower Front', 'Lower Middle', 'Lower Rear', 'Saturation',
        'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_lower_horiz_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Pool Temperatures - Sparger End

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Sparger End Pool Temperature.'];
disp(text)

% SP 2 is in Column 62
% SP 3 is in Column 60
% SP 4 is in Column 58
% SP 5 is in Column 56
% SP 6 is in Column 54
% SP 7 is in Column 52

% set up plot
x1 = t;
y1 = trmdat(:, 60);
x2 = t;
y2 = trmdat(:, 58);
x3 = t;
y3 = trmdat(:, 56);
x4 = t;
y4 = trmdat(:, 54);
x5 = t;
y5 = trmdat(:, 52);
x6 = t;
y6 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
```

```
x6pdist = floor(x6(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d', x4(1), y4(1),
       'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'c-', x3, y3, 'r-', x4, y4, 'g-', x5, y5, 'k-', x6,
       y6, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p, y5p,
       'ko', x6p, y6p, 'k*');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
```

```
set(ploth1(2), 'MarkerFaceColor', 'c');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'c');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'r');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerFaceColor', 'r');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerFaceColor', 'g');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerSize', 10);
set(ploth3(4), 'MarkerFaceColor', 'g');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerSize', 10);
set(ploth1(5), 'MarkerFaceColor', 'k');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerSize', 5);
set(ploth3(5), 'MarkerFaceColor', 'k');
set(ploth3(5), 'MarkerEdgeColor', 'w');
set(ploth3(5), 'MarkerSize', 5);
set(ploth1(6), 'MarkerSize', 10);
set(ploth3(6), 'MarkerSize', 10);
rtlims = get(get(fighandle, 'CurrentAxes'), 'YLim');
if rtlims(2) > 1.2 * max(poolsat)
    rtlims(2) = 10 * ceil(1.2*max(poolsat/10));
end
set(get(fighandle, 'CurrentAxes'), 'YLim', rtlims);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
        0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Sparger End Pool Temperatures, Facing Outlet End');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('A - Upper', 'B - Middle (bad)', 'C - Lower', 'D - Left', 'E -
        Right', 'F - Saturation', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_back_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Pool Temperatures - Middle

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Mid-Axis Pool Temperature.'];
disp(text)
```

```
% SP 11 is in Column 44
% SP 12 is in Column 42
% SP 13 is in Column 40
% SP 14 is in Column 38
% SP 15 is in Column 36

% set up plot
x1 = t;
y1 = trmdat(:, 44);
x2 = t;
y2 = trmdat(:, 42);
x3 = t;
y3 = trmdat(:, 40);
x4 = t;
y4 = trmdat(:, 38);
x5 = t;
y5 = trmdat(:, 36);
x6 = t;
y6 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
```

```
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d', x4(1), y4(1),
        'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'c-', x3, y3, 'r-', x4, y4, 'g-', x5, y5, 'k-', x6,
        y6, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p, y5p,
        'ko', x6p, y6p, 'k*');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'c');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'c');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'r');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerFaceColor', 'r');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerFaceColor', 'g');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerSize', 10);
set(ploth3(4), 'MarkerFaceColor', 'g');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerSize', 10);
set(ploth1(5), 'MarkerFaceColor', 'k');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerSize', 5);
set(ploth3(5), 'MarkerFaceColor', 'k');
set(ploth3(5), 'MarkerEdgeColor', 'w');
set(ploth3(5), 'MarkerSize', 5);
set(ploth1(6), 'MarkerSize', 10);
set(ploth3(6), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
        0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Mid-Axis Pool Temperatures, Facing Outlet End');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('A - Upper', 'B - Middle', 'C - Lower', 'D - Left', 'E - Right', 'F
        - Saturation', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_mid_temps'];
set(fighandle, 'Name', figname);
```

```
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end
```

```
% Flowrates

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Flowrate.'];
disp(text)

% Steam Flowrate  (kg/s) is in Column 107
% Water Return Flowrate (kg/s) is in Column 102
% Water Injection to Steam Line (kg/s) is in Column 127

% set up plot
x1 = t;
y1 = 1000*trmdat(:,107);
x2 = t;
y2 = 1000*trmdat(:,102);
x3 = t;
y3 = 1000*trmdat(:,127);
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'c-', x3, y3, 'r-');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
```

```
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'c');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'c');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'r');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerFaceColor', 'r');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(get(fighandle, 'CurrentAxes'), 'YLim', [0 25*ceil(mean(1000*trmdat(:,102))/18.75)]);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Mass Flow Rates');
end
xlabel('Time, s');
ylabel('Flowrate, g/s');
legendhandle = legend('Steam Flowrate', 'Water Return to Steam Generator', 'Water
       Injection to Steam Line', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_flowrates'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Pressures

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Gas Pressure.'];
disp(text)

% SG Pressure is in Column 88
% MSL Pressure is in Column 110
% SP Pressure is in Column 97

% set up plot
x1 = t;
y1 = trmdat(:,88);
x2 = t;
y2 = trmdat(:,110);
x3 = t;
y3 = trmdat(:,97);
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x1p = x1(1);
y1p = y1(1);
```

```
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'c-', x3, y3, 'r-');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'c');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'c');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'r');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerFaceColor', 'r');
set(ploth3(3), 'MarkerEdgeColor', 'k');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('System Vapor Space Pressures');
end
xlabel('Time, s');
ylabel('Pressure, psia');
legendhandle = legend('Steam Generator', 'Main Steam Line', 'Suppression Chamber',
       'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pressures'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
```

```
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end




% Turbine

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Turbine/Sparger Performance.'];
disp(text)

% Turbine Inlet Temperature is in Column 68
% Turbine Outlet Temperature is in Column 66
% Sparger Outlet Temperature in Column 64
% Sparger Delta P is in Column 113

% set up plot
x1 = t;
y1 = trmdat(:,68);
x2 = t;
y2 = trmdat(:,66);
x3 = t;
y3 = trmdat(:,64);
x4 = t;
y4 = trmdat(:,113) - spargeroffset;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
```

```
    end
end
[ax, h1, h2] = plotyy(x1, [y1, y2, y3], x4, [y4]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'g-p', x3(1), y3(1), 'r-d');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'gp', x3p, y3p, 'rd');
ploth3a = plot(ax(2), x4(1), y4(1), 'm-v');
ploth3b = plot(ax(2), x4p, y4p, 'mv');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(2), 'YColor', 'm')
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'g');
set(h1(3), 'Color', 'r');
set(h2(1), 'Color', 'm');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2a(3), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth2b(3), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'g');
set(ploth2a(2), 'MarkerSize', 10);
set(ploth2a(3), 'MarkerFaceColor', 'r');
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'g');
set(ploth2b(2), 'MarkerSize', 10);
set(ploth2b(3), 'MarkerFaceColor', 'r');
set(ploth3a(1), 'MarkerFaceColor', 'm');
set(ploth3b(1), 'MarkerFaceColor', 'm');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Temperature, C');
set(get(ax(2),'Ylabel'),'String','Sparger DP, inH2O');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('RCIC Turbine Analog/Sparger Performance');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Turbine Analog Inlet T', 'B - Turbine
       Analog Outlet T', 'C - Sparger Outlet T', 'D - Sparger DP', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_turbine'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end
```

```
% Vertical-Horizontal Pool Thermal Profile NO SP 4

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Vert-Horiz Center Thermal Profile.'];
disp(text)

% SP 3 is in Column 60
% SP 4 is in Column 58 -- bad, don't use
% SP 5 is in Column 56
% SP 11 is in Column 44
% SP 12 is in Column 42
% SP 13 is in Column 40
% SP 19 is in Column 28
% SP 20 is in Column 26
% SP 21 is in Column 24
% SP Outlet is in Column 74

% set up plot
x1 = t;
y1 = trmdat(:, 60);
x2 = t;
y2 = trmdat(:, 56);
x3 = t;
y3 = trmdat(:, 44);
x4 = t;
y4 = trmdat(:, 42);
x5 = t;
y5 = trmdat(:, 40);
x6 = t;
y6 = trmdat(:, 28);
x7 = t;
y7 = trmdat(:, 26);
x8 = t;
y8 = trmdat(:, 24);
x9 = t;
y9 = trmdat(:, 74);
x10 = t;
y10 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/13);
x7pdist = floor(x7(end)/(17/2));
x8pdist = floor(x8(end)/(19/2));
x9pdist = floor(x9(end)/(23/2));
x10pdist = floor(x10(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
```

```
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
x8p = x8(1);
y8p = y8(1);
for ind = 2:length(x8)
    if x8p(end) + x8pdist <= x8(ind)
        % append the point to the array
        x8p = [x8p x8(ind)];
        y8p = [y8p y8(ind)];
    end
end
x9p = x9(1);
y9p = y9(1);
for ind = 2:length(x9)
    if x9p(end) + x9pdist <= x9(ind)
        % append the point to the array
        x9p = [x9p x9(ind)];
        y9p = [y9p y9(ind)];
    end
end
```

```
x10p = x10(1);
y10p = y10(1);
for ind = 2:length(x10)
    if x10p(end) + x10pdist <= x10(ind)
        % append the point to the array
        x10p = [x10p x10(ind)];
        y10p = [y10p y10(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
        'c-^', x5(1), y5(1), 'm-v', x6(1), y6(1), 'k-o', x7(1), y7(1), 'y->', x8(1),
        y8(1), 'y-<', x9(1), y9(1), 'y-h', x10(1), y10(1), 'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'c-', x5, y5, 'm-', x6,
        y6, 'k-', x7, y7, 'y-', x8, y8, 'y-', x9, y9, 'y-', x10, y10, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'c^', x5p, y5p,
        'mv', x6p, y6p, 'ko', x7p, y7p, 'y>', x8p, y8p, 'y<', x9p, y9p, 'yh', x10p, y10p,
        'k*');
set(ploth1(7) , 'Color', [1, 155/255, 0]);
set(ploth2(7) , 'Color', [1, 155/255, 0]);
set(ploth3(7) , 'Color', [1, 155/255, 0]);
set(ploth1(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth2(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth3(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth1(9) , 'Color', [0/255, 0.4, 0/255]);
set(ploth2(9) , 'Color', [0/255, 0.4, 0/255]);
set(ploth3(9) , 'Color', [0/255, 0.4, 0/255]);
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'w');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'w');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerFaceColor', 'c');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerFaceColor', 'c');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerFaceColor', 'm');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth3(5), 'MarkerFaceColor', 'm');
set(ploth3(5), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerFaceColor', 'k');
set(ploth1(6), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerSize', 5);
set(ploth3(6), 'MarkerFaceColor', 'k');
set(ploth3(6), 'MarkerEdgeColor', 'w');
set(ploth3(6), 'MarkerSize', 5);
set(ploth1(7), 'MarkerFaceColor', [1, 155/255, 0]);
set(ploth1(7), 'MarkerEdgeColor', 'k');
set(ploth3(7), 'MarkerFaceColor', [1, 155/255, 0]);
set(ploth3(7), 'MarkerEdgeColor', 'k');
set(ploth1(8), 'MarkerFaceColor', [139/255, 115/255, 85/255]);
set(ploth1(8), 'MarkerEdgeColor', 'k');
set(ploth3(8), 'MarkerFaceColor', [139/255, 115/255, 85/255]);
set(ploth3(8), 'MarkerEdgeColor', 'k');
set(ploth1(9), 'MarkerFaceColor', [0/255, 0.4, 0/255]);
set(ploth1(9), 'MarkerEdgeColor', 'k');
set(ploth1(9), 'MarkerSize', 10);
```

```
set(ploth3(9), 'MarkerFaceColor', [0/255, 0.4, 0/255]);
set(ploth3(9), 'MarkerEdgeColor', 'k');
set(ploth3(9), 'MarkerSize', 10);
set(ploth1(10), 'MarkerSize', 10);
set(ploth3(10), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
        0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Horizontal & Vertical Pool Thermal Profile');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('Rear Upper', 'Rear Lower', 'Mid Upper', 'Mid Middle', 'Mid Lower',
        'Front Upper', 'Front Middle', 'Front Lower', 'Bottom Outlet', 'Saturation',
        'Location', 'NorthWest');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_vert_horiz_temps_noSP4'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Air-Vertical Middle Profile

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' is the Air-Water VertHoriz Thermal Profile.'];
disp(text)

% SP 2 is in Column 62 (rear air)
% SP 3 is in Column 60 (rear top)
% SP 11 is in Column 44 (mid-top)
% SP 12 is in Column 42 (mid-mid)
% SP 13 is in Column 40 (mid-low)
% SP 18 is in Column 30 (front air)
% SP 19 is in Column 28 (front upper)
% SP Outlet is in Column 74

% set up plot
x1 = t;
y1 = trmdat(:, 60);
x2 = t;
y2 = trmdat(:, 44);
x3 = t;
y3 = trmdat(:, 28);
x4 = t;
y4 = trmdat(:, 42);
x5 = t;
y5 = trmdat(:, 40);
x6 = t;
```

```
y6 = trmdat(:, 74);
x7 = t;
y7 = trmdat(:, 62);
x8 = t;
y8 = trmdat(:, 30);
x9 = t;
y9 = poolsat;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/13);
x7pdist = floor(x7(end)/(17/2));
x8pdist = floor(x8(end)/(19/2));
x9pdist = floor(x9(end)/3);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
```

```
        y6p = [y6p y6(ind)];
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
x8p = x8(1);
y8p = y8(1);
for ind = 2:length(x8)
    if x8p(end) + x8pdist <= x8(ind)
        % append the point to the array
        x8p = [x8p x8(ind)];
        y8p = [y8p y8(ind)];
    end
end
x9p = x9(1);
y9p = y9(1);
for ind = 2:length(x9)
    if x9p(end) + x9pdist <= x9(ind)
        % append the point to the array
        x9p = [x9p x9(ind)];
        y9p = [y9p y9(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x2(1), y2(1), 'r-d', x3(1), y3(1), 'g-p', x4(1), y4(1),
        'c-^', x5(1), y5(1), 'm-v', x6(1), y6(1), 'k-o', x7(1), y7(1), 'y->', x8(1),
        y8(1), 'y-<', x9(1), y9(1), 'k-.*');
% add data lines
hold on
ploth2 = plot(x1, y1, 'b-', x2, y2, 'r-', x3, y3, 'g-', x4, y4, 'c-', x5, y5, 'm-', x6,
        y6, 'k-', x7, y7, 'y-', x8, y8, 'y-', x9, y9, 'k-.');
ploth3 = plot(x1p, y1p, 'bs', x2p, y2p, 'rd', x3p, y3p, 'gp', x4p, y4p, 'c^', x5p, y5p,
        'mv', x6p, y6p, 'ko', x7p, y7p, 'y>', x8p, y8p, 'y<', x9p, y9p, 'k*');
set(ploth1(7) , 'Color', [1, 155/255, 0]);
set(ploth2(7) , 'Color', [1, 155/255, 0]);
set(ploth3(7) , 'Color', [1, 155/255, 0]);
set(ploth1(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth2(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth3(8) , 'Color', [139/255, 115/255, 85/255]);
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'w');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'w');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerFaceColor', 'c');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth3(4), 'MarkerFaceColor', 'c');
set(ploth3(4), 'MarkerEdgeColor', 'k');
set(ploth1(5), 'MarkerFaceColor', 'm');
set(ploth1(5), 'MarkerEdgeColor', 'k');
set(ploth3(5), 'MarkerFaceColor', 'm');
set(ploth3(5), 'MarkerEdgeColor', 'k');
```

```
set(ploth1(6), 'MarkerFaceColor', 'k');
set(ploth1(6), 'MarkerEdgeColor', 'k');
set(ploth1(6), 'MarkerSize', 5);
set(ploth3(6), 'MarkerFaceColor', 'k');
set(ploth3(6), 'MarkerEdgeColor', 'w');
set(ploth3(6), 'MarkerSize', 5);
set(ploth1(7), 'MarkerFaceColor', [1, 155/255, 0]);
set(ploth1(7), 'MarkerEdgeColor', 'k');
set(ploth3(7), 'MarkerFaceColor', [1, 155/255, 0]);
set(ploth3(7), 'MarkerEdgeColor', 'k');
set(ploth1(8), 'MarkerFaceColor', [139/255, 115/255, 85/255]);
set(ploth1(8), 'MarkerEdgeColor', 'k');
set(ploth3(8), 'MarkerFaceColor', [139/255, 115/255, 85/255]);
set(ploth3(8), 'MarkerEdgeColor', 'k');
set(ploth1(9), 'MarkerSize', 10);
set(ploth3(9), 'MarkerSize', 10);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
if showtitles == 1
    title('Suppression Pool Axial Air & Water Temperatures');
end
xlabel('Time, s');
ylabel('Temperature, C');
legendhandle = legend('A - Rear Upper', 'B - Mid Upper', 'C - Front Upper', 'D - Mid
       Middle', 'E - Mid Lower', 'F - Outlet', 'G - Rear Airspace', 'H - Front Airspace',
       'J - Saturation', 'Location', 'NorthWest');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_axial_air_water_temps'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Slopes (Temperature changerates)

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the 5-minute Rear Temperature
       Changerates.'];
disp(text)

% set up plot
x1 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y1 = 60*vsmooth_top(sindex(1):sindex(3)-inclusionlen, 1);
x2 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y2 = 60*vsmooth_hot(sindex(1):sindex(3)-inclusionlen, 1);
x3 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y3 = 60*vsmooth_mid(sindex(1):sindex(3)-inclusionlen, 1);
x4 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y4 = 60*vsmooth_low(sindex(1):sindex(3)-inclusionlen, 1);
```

```
x5 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y5 = 60*vsmooth_out(sindex(1):sindex(3)-inclusionlen, 1);
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
ploth1 = plot(x1(1), y1(1), 'b-s', x3(1), y3(1), 'r-d', x4(1), y4(1), 'g-p', x5(1), y5(1),
       'k-o');
hold on
ploth2 = plot(x1, y1, 'b-', x3, y3, 'r-', x4, y4, 'g-', x5, y5, 'k-');
ploth3 = plot(x1p, y1p, 'bs', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p, y5p, 'ko');
set(ploth1(1), 'MarkerFaceColor', 'b');
set(ploth1(1), 'MarkerEdgeColor', 'k');
set(ploth3(1), 'MarkerFaceColor', 'b');
set(ploth3(1), 'MarkerEdgeColor', 'k');
set(ploth1(2), 'MarkerFaceColor', 'r');
set(ploth1(2), 'MarkerEdgeColor', 'k');
set(ploth3(2), 'MarkerFaceColor', 'r');
set(ploth3(2), 'MarkerEdgeColor', 'k');
set(ploth1(3), 'MarkerFaceColor', 'g');
set(ploth1(3), 'MarkerEdgeColor', 'k');
```

```
set(ploth1(3), 'MarkerSize', 10);
set(ploth3(3), 'MarkerFaceColor', 'g');
set(ploth3(3), 'MarkerEdgeColor', 'k');
set(ploth3(3), 'MarkerSize', 10);
set(ploth1(4), 'MarkerFaceColor', 'k');
set(ploth1(4), 'MarkerEdgeColor', 'k');
set(ploth1(4), 'MarkerSize', 5);
set(ploth3(4), 'MarkerFaceColor', 'k');
set(ploth3(4), 'MarkerEdgeColor', 'w');
set(ploth3(4), 'MarkerSize', 5);
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold off
if showtitles == 1
    title('Smoothed Rear Temperature Changerates');
end
xlabel('Time, s');
ylabel('Smoothed Changerate, degrees/min');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
figname = [testname '_pool_back_smoothed_changerates'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
legendhandle = legend('A - Upper', 'C - 12 in. from Sparger (Middle)', 'D - Lower', 'E -
       Outlet', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Slope Differences:  Top-Middle (Temperature changerates)

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the 5-minute Top-Mid Rear Temperature
       Changerate Differences.'];
disp(text)

% set up plot
x1 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y1 = (vsmooth_top(sindex(1):sindex(3)-inclusionlen, 2) - vsmooth_mid(sindex(1):sindex(3)-
       inclusionlen,2));
x2 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y2 = 60*stopmid;
x1pdist = floor(x1(end)/9);
x2pdist = floor(x1(end)/11);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
```

```
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1], x2, [y2]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s');
ploth2b = plot(ax(1), x1p, y1p, 'bs');
ploth3a = plot(ax(2), x2(1), y2(1), 'r-d');
ploth3b = plot(ax(2), x2p, y2p, 'rd');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(1), 'YColor', 'b')
set(ax(2), 'YColor', 'r')
set(h1(1), 'Color', 'b');
set(h2(1), 'Color', 'r');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth3a(1), 'MarkerFaceColor', 'r');
set(ploth3b(1), 'MarkerFaceColor', 'r');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Smoothed Temperature Difference, C');
set(get(ax(2),'Ylabel'),'String','Smoothed dT/dt Difference, Degrees/min');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('5-Minute Smoothed Rear Temperature & Changerate Differences');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Rear Top-Middle T(t) Difference', 'B -
       Rear Top-Middle dT/dt Difference', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_back_smoothed_changerate_difference_topmid'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end
```

```
% Slope Differences:  Mid-Low (Temperature changerates)

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the 5-minute Mid-Low Rear Temperature
       Changerate Differences.'];
disp(text)

% set up plot
x1 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y1 = (vsmooth_mid(sindex(1):sindex(3)-inclusionlen, 2) - vsmooth_low(sindex(1):sindex(3)-
       inclusionlen,2));
x2 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y2 = 60*smidlow;
x1pdist = floor(x1(end)/9);
x2pdist = floor(x1(end)/11);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1], x2, [y2]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s');
ploth2b = plot(ax(1), x1p, y1p, 'bs');
ploth3a = plot(ax(2), x2(1), y2(1), 'r-d');
ploth3b = plot(ax(2), x2p, y2p, 'rd');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(1), 'YColor', 'b')
set(ax(2), 'YColor', 'r')
set(h1(1), 'Color', 'b');
set(h2(1), 'Color', 'r');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth3a(1), 'MarkerFaceColor', 'r');
set(ploth3b(1), 'MarkerFaceColor', 'r');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Smoothed Temperature Difference, C');
```

```
set(get(ax(2),'Ylabel'),'String','Smoothed dT/dt Difference, Degrees/min');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('5-Minute Smoothed Rear Temperature & Changerate Differences');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Rear Middle-Low T(t) Difference', 'B -
       Rear Middle-Low dT/dt Difference', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_back_smoothed_changerate_difference_midlow'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Slope Differences:  Low-Out (Temperature changerates)

% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the 5-minute Low-Out Rear Temperature
       Changerate Differences.'];
disp(text)

% set up plot
x1 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y1 = (vsmooth_low(sindex(1):sindex(3)-inclusionlen, 2) - vsmooth_out(sindex(1):sindex(3)-
       inclusionlen,2));
x2 = data(sindex(1):sindex(3)-inclusionlen, 1) - data(sindex(1), 1);
y2 = 60*slowout;
x1pdist = floor(x1(end)/9);
x2pdist = floor(x1(end)/11);
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1], x2, [y2]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s');
ploth2b = plot(ax(1), x1p, y1p, 'bs');
ploth3a = plot(ax(2), x2(1), y2(1), 'r-d');
ploth3b = plot(ax(2), x2p, y2p, 'rd');
```

```
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(1), 'YColor', 'b')
set(ax(2), 'YColor', 'r')
set(h1(1), 'Color', 'b');
set(h2(1), 'Color', 'r');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth3a(1), 'MarkerFaceColor', 'r');
set(ploth3b(1), 'MarkerFaceColor', 'r');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Smoothed Temperature Difference, C');
set(get(ax(2),'Ylabel'),'String','Smoothed dT/dt Difference, Degrees/min');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('5-Minute Smoothed Rear Temperature & Changerate Differences');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Rear Lower-Outlet T(t) Difference', 'B -
       Rear Lower-Outlet dT/dt Difference', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_pool_back_smoothed_changerate_difference_lowout'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Mixing Number

% Smoothed Pool Temperatures
% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the smoothed rear pool temperatures and
       the Mixing Number (Type 1).'];
disp(text)

% set up plot
x1 = stratsmooth_0;
y1 = stratsmooth_1;
x2 = stratsmooth_0;
y2 = stratsmooth_3;
x3 = stratsmooth_0;
y3 = stratsmooth_4;
```

```
x4 = stratsmooth_0;
y4 = stratsmooth_2;
x5 = stratsmooth_0;
y5 = stratsmooth_5;
x6 = t;
y6 = poolsat;
x7 = t;
y7 = testrelationship;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/3);
x7pdist = floor(x7(end)/(13));
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
```

```
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1, y2, y3, y4, y5, y6], x7, [y7]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d',
       x4(1), y4(1), 'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k-.*');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p,
       y5p, 'ko', x6p, y6p, 'k*');
ploth3a = plot(ax(2), x7(1), y7(1), 'm-v');
ploth3b = plot(ax(2), x7p, y7p, 'mv');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(2), 'YColor', 'm')
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'c');
set(h1(3), 'Color', 'r');
set(h1(4), 'Color', 'g');
set(h1(5), 'Color', 'k');
set(h1(6), 'Color', 'k');
set(h1(6), 'LineStyle', '-.');
set(h2(1), 'Color', 'm');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2a(3), 'MarkerEdgeColor', 'k');
set(ploth2a(4), 'MarkerEdgeColor', 'k');
set(ploth2a(5), 'MarkerEdgeColor', 'k');
set(ploth2a(6), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth2b(3), 'MarkerEdgeColor', 'k');
set(ploth2b(4), 'MarkerEdgeColor', 'k');
set(ploth2b(5), 'MarkerEdgeColor', 'w');
set(ploth2b(6), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'c');
set(ploth2a(3), 'MarkerFaceColor', 'r');
set(ploth2a(4), 'MarkerFaceColor', 'g');
set(ploth2a(4), 'MarkerSize', 10);
set(ploth2a(5), 'MarkerFaceColor', 'k');
set(ploth2a(5), 'MarkerSize', 5);
set(ploth2a(6), 'MarkerFaceColor', 'k');
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'c');
set(ploth2b(3), 'MarkerFaceColor', 'r');
set(ploth2b(4), 'MarkerFaceColor', 'g');
set(ploth2b(4), 'MarkerSize', 10);
set(ploth2b(5), 'MarkerFaceColor', 'k');
set(ploth2b(5), 'MarkerSize', 5);
set(ploth2b(6), 'MarkerFaceColor', 'k');
```

```
set(ploth3a(1), 'MarkerFaceColor', 'm');
set(ploth3b(1), 'MarkerFaceColor', 'm');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Temperature, C');
set(get(ax(2),'Ylabel'),'String','Mixing Number (nondimensional)');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('Smoothed Rear Pool Temperatures and the Mixing Number (Type 1)');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Upper', 'B - Near Sparger (Middle)', 'C
       - Further from Sparger (Middle)', 'D - Lower', 'E - Outlet', 'F - Saturation', 'G
       - Mixing Number 1', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_crazynumber_t1'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end


% Smoothed Pool Temperatures
% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the smoothed rear pool temperatures and
       the Mixing Number (Type 2).'];
disp(text)

% set up plot
x1 = stratsmooth_0;
y1 = stratsmooth_1;
x2 = stratsmooth_0;
y2 = stratsmooth_3;
x3 = stratsmooth_0;
y3 = stratsmooth_4;
x4 = stratsmooth_0;
y4 = stratsmooth_2;
x5 = stratsmooth_0;
y5 = stratsmooth_5;
x6 = t;
y6 = poolsat;
x7 = t;
y7 = testrelationship2;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/3);
x7pdist = floor(x7(end)/(13));
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
```

```
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1, y2, y3, y4, y5, y6], x7, [y7]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d',
       x4(1), y4(1), 'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k-.*');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p,
       y5p, 'ko', x6p, y6p, 'k*');
ploth3a = plot(ax(2), x7(1), y7(1), 'm-v');
ploth3b = plot(ax(2), x7p, y7p, 'mv');
set(ax(1), 'YLimMode', 'auto');
```

```
set(ax(2), 'YLimMode', 'auto');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(2), 'YColor', 'm')
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'c');
set(h1(3), 'Color', 'r');
set(h1(4), 'Color', 'g');
set(h1(5), 'Color', 'k');
set(h1(6), 'Color', 'k');
set(h1(6), 'LineStyle', '-.');
set(h2(1), 'Color', 'm');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2a(3), 'MarkerEdgeColor', 'k');
set(ploth2a(4), 'MarkerEdgeColor', 'k');
set(ploth2a(5), 'MarkerEdgeColor', 'k');
set(ploth2a(6), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth2b(3), 'MarkerEdgeColor', 'k');
set(ploth2b(4), 'MarkerEdgeColor', 'k');
set(ploth2b(5), 'MarkerEdgeColor', 'w');
set(ploth2b(6), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'c');
set(ploth2a(3), 'MarkerFaceColor', 'r');
set(ploth2a(4), 'MarkerFaceColor', 'g');
set(ploth2a(4), 'MarkerSize', 10);
set(ploth2a(5), 'MarkerFaceColor', 'k');
set(ploth2a(5), 'MarkerSize', 5);
set(ploth2a(6), 'MarkerFaceColor', 'k');
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'c');
set(ploth2b(3), 'MarkerFaceColor', 'r');
set(ploth2b(4), 'MarkerFaceColor', 'g');
set(ploth2b(4), 'MarkerSize', 10);
set(ploth2b(5), 'MarkerFaceColor', 'k');
set(ploth2b(5), 'MarkerSize', 5);
set(ploth2b(6), 'MarkerFaceColor', 'k');
set(ploth3a(1), 'MarkerFaceColor', 'm');
set(ploth3b(1), 'MarkerFaceColor', 'm');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Temperature, C');
set(get(ax(2),'Ylabel'),'String','Mixing Number (nondimensional)');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('Smoothed Rear Pool Temperatures and the Mixing Number (Type 2)');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Upper', 'B - Near Sparger (Middle)', 'C
       - Further from Sparger (Middle)', 'D - Lower', 'E - Outlet', 'F - Saturation', 'G
       - Mixing Number 2', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_crazynumber_t2'];
```

```
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Smoothed Pool Temperatures
% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the smoothed rear pool temperatures and
       the Mixing Number (Type 3).'];
disp(text)

% set up plot
x1 = stratsmooth_0;
y1 = stratsmooth_1;
x2 = stratsmooth_0;
y2 = stratsmooth_3;
x3 = stratsmooth_0;
y3 = stratsmooth_4;
x4 = stratsmooth_0;
y4 = stratsmooth_2;
x5 = stratsmooth_0;
y5 = stratsmooth_5;
x6 = t;
y6 = poolsat;
x7 = t;
y7 = testrelationship3;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/3);
x7pdist = floor(x7(end)/(13));
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
```

```
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1, y2, y3, y4, y5, y6], x7, [y7]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d',
       x4(1), y4(1), 'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k-.*');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p,
       y5p, 'ko', x6p, y6p, 'k*');
ploth3a = plot(ax(2), x7(1), y7(1), 'm-v');
ploth3b = plot(ax(2), x7p, y7p, 'mv');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(2), 'YColor', 'm')
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'c');
set(h1(3), 'Color', 'r');
set(h1(4), 'Color', 'g');
set(h1(5), 'Color', 'k');
set(h1(6), 'Color', 'k');
set(h1(6), 'LineStyle', '-.');
set(h2(1), 'Color', 'm');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2a(3), 'MarkerEdgeColor', 'k');
```

```
set(ploth2a(4), 'MarkerEdgeColor', 'k');
set(ploth2a(5), 'MarkerEdgeColor', 'k');
set(ploth2a(6), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth2b(3), 'MarkerEdgeColor', 'k');
set(ploth2b(4), 'MarkerEdgeColor', 'k');
set(ploth2b(5), 'MarkerEdgeColor', 'w');
set(ploth2b(6), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'c');
set(ploth2a(3), 'MarkerFaceColor', 'r');
set(ploth2a(4), 'MarkerFaceColor', 'g');
set(ploth2a(4), 'MarkerSize', 10);
set(ploth2a(5), 'MarkerFaceColor', 'k');
set(ploth2a(5), 'MarkerSize', 5);
set(ploth2a(6), 'MarkerFaceColor', 'k');
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'c');
set(ploth2b(3), 'MarkerFaceColor', 'r');
set(ploth2b(4), 'MarkerFaceColor', 'g');
set(ploth2b(4), 'MarkerSize', 10);
set(ploth2b(5), 'MarkerFaceColor', 'k');
set(ploth2b(5), 'MarkerSize', 5);
set(ploth2b(6), 'MarkerFaceColor', 'k');
set(ploth3a(1), 'MarkerFaceColor', 'm');
set(ploth3b(1), 'MarkerFaceColor', 'm');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Temperature, C');
set(get(ax(2),'Ylabel'),'String','Mixing Number (nondimensional)');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('Smoothed Rear Pool Temperatures and the Mixing Number (Type 3)');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Upper', 'B - Near Sparger (Middle)', 'C
       - Further from Sparger (Middle)', 'D - Lower', 'E - Outlet', 'F - Saturation', 'G
       - Mixing Number 3', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_crazynumber_t3'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end



% Smoothed Pool Temperatures
% Create a new figure
fighandle=figure;
text=['Figure', ' ', num2str(fighandle), ' has the smoothed rear pool temperatures and
       the Mixing Number (Type 4).'];
disp(text)
```

```
% set up plot
x1 = stratsmooth_0;
y1 = stratsmooth_1;
x2 = stratsmooth_0;
y2 = stratsmooth_3;
x3 = stratsmooth_0;
y3 = stratsmooth_4;
x4 = stratsmooth_0;
y4 = stratsmooth_2;
x5 = stratsmooth_0;
y5 = stratsmooth_5;
x6 = t;
y6 = poolsat;
x7 = t;
y7 = testrelationship4;
x1pdist = floor(x1(end)/4);
x2pdist = floor(x2(end)/5);
x3pdist = floor(x3(end)/7);
x4pdist = floor(x4(end)/9);
x5pdist = floor(x5(end)/11);
x6pdist = floor(x6(end)/3);
x7pdist = floor(x7(end)/(13));
x1p = x1(1);
y1p = y1(1);
for ind = 2:length(x1)
    if x1p(end) + x1pdist <= x1(ind)
        % append the point to the array
        x1p = [x1p x1(ind)];
        y1p = [y1p y1(ind)];
    end
end
x2p = x2(1);
y2p = y2(1);
for ind = 2:length(x2)
    if x2p(end) + x2pdist <= x2(ind)
        % append the point to the array
        x2p = [x2p x2(ind)];
        y2p = [y2p y2(ind)];
    end
end
x3p = x3(1);
y3p = y3(1);
for ind = 2:length(x3)
    if x3p(end) + x3pdist <= x3(ind)
        % append the point to the array
        x3p = [x3p x3(ind)];
        y3p = [y3p y3(ind)];
    end
end
x4p = x4(1);
y4p = y4(1);
for ind = 2:length(x4)
    if x4p(end) + x4pdist <= x4(ind)
        % append the point to the array
        x4p = [x4p x4(ind)];
        y4p = [y4p y4(ind)];
    end
end
x5p = x5(1);
y5p = y5(1);
for ind = 2:length(x5)
    if x5p(end) + x5pdist <= x5(ind)
        % append the point to the array
        x5p = [x5p x5(ind)];
        y5p = [y5p y5(ind)];
    end
```

```
end
x6p = x6(1);
y6p = y6(1);
for ind = 2:length(x6)
    if x6p(end) + x6pdist <= x6(ind)
        % append the point to the array
        x6p = [x6p x6(ind)];
        y6p = [y6p y6(ind)];
    end
end
x7p = x7(1);
y7p = y7(1);
for ind = 2:length(x7)
    if x7p(end) + x7pdist <= x7(ind)
        % append the point to the array
        x7p = [x7p x7(ind)];
        y7p = [y7p y7(ind)];
    end
end
[ax, h1, h2] = plotyy(x1, [y1, y2, y3, y4, y5, y6], x7, [y7]);
hold(ax(1), 'on');
hold(ax(2), 'on');
ploth2a = plot(ax(1), x1(1), y1(1), 'b-s', x2(1), y2(1), 'c-^', x3(1), y3(1), 'r-d',
       x4(1), y4(1), 'g-p', x5(1), y5(1), 'k-o', x6(1), y6(1), 'k-.*');
ploth2b = plot(ax(1), x1p, y1p, 'bs', x2p, y2p, 'c^', x3p, y3p, 'rd', x4p, y4p, 'gp', x5p,
       y5p, 'ko', x6p, y6p, 'k*');
ploth3a = plot(ax(2), x7(1), y7(1), 'm-v');
ploth3b = plot(ax(2), x7p, y7p, 'mv');
set(ax(1), 'YLimMode', 'auto');
set(ax(2), 'YLimMode', 'auto');
line([t(plume_ind), t(plume_ind)], ylim, 'LineStyle', '--', 'Color', [0.75, 0.75, 0.0]);
line([t(stratstartind), t(stratstartind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7,
       0.7]);
line([t(stratendind), t(stratendind)], ylim, 'LineStyle', '-', 'Color', [0.7, 0.7, 0.7]);
hold(ax(1), 'off');
hold(ax(2), 'off');
set(ax(2), 'YColor', 'm')
set(h1(1), 'Color', 'b');
set(h1(2), 'Color', 'c');
set(h1(3), 'Color', 'r');
set(h1(4), 'Color', 'g');
set(h1(5), 'Color', 'k');
set(h1(6), 'Color', 'k');
set(h1(6), 'LineStyle', '-.');
set(h2(1), 'Color', 'm');
set(ploth2a(1), 'MarkerEdgeColor', 'k');
set(ploth2a(2), 'MarkerEdgeColor', 'k');
set(ploth2a(3), 'MarkerEdgeColor', 'k');
set(ploth2a(4), 'MarkerEdgeColor', 'k');
set(ploth2a(5), 'MarkerEdgeColor', 'k');
set(ploth2a(6), 'MarkerEdgeColor', 'k');
set(ploth2b(1), 'MarkerEdgeColor', 'k');
set(ploth2b(2), 'MarkerEdgeColor', 'k');
set(ploth2b(3), 'MarkerEdgeColor', 'k');
set(ploth2b(4), 'MarkerEdgeColor', 'k');
set(ploth2b(5), 'MarkerEdgeColor', 'w');
set(ploth2b(6), 'MarkerEdgeColor', 'k');
set(ploth3a(1), 'MarkerEdgeColor', 'k');
set(ploth3b(1), 'MarkerEdgeColor', 'k');
set(ploth2a(1), 'MarkerFaceColor', 'b');
set(ploth2a(2), 'MarkerFaceColor', 'c');
set(ploth2a(3), 'MarkerFaceColor', 'r');
set(ploth2a(4), 'MarkerFaceColor', 'g');
set(ploth2a(4), 'MarkerSize', 10);
set(ploth2a(5), 'MarkerFaceColor', 'k');
set(ploth2a(5), 'MarkerSize', 5);
set(ploth2a(6), 'MarkerFaceColor', 'k');
```

```
set(ploth2b(1), 'MarkerFaceColor', 'b');
set(ploth2b(2), 'MarkerFaceColor', 'c');
set(ploth2b(3), 'MarkerFaceColor', 'r');
set(ploth2b(4), 'MarkerFaceColor', 'g');
set(ploth2b(4), 'MarkerSize', 10);
set(ploth2b(5), 'MarkerFaceColor', 'k');
set(ploth2b(5), 'MarkerSize', 5);
set(ploth2b(6), 'MarkerFaceColor', 'k');
set(ploth3a(1), 'MarkerFaceColor', 'm');
set(ploth3b(1), 'MarkerFaceColor', 'm');
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
set(fighandle, 'Position', [48 48 960 624]);
set(fighandle, 'PaperOrientation', 'portrait');
set(fighandle, 'PaperSize', [10 6.5]);
set(fighandle, 'PaperPosition', [0 0 10 6.5]);
set(get(ax(1),'Ylabel'),'String','Temperature, C');
set(get(ax(2),'Ylabel'),'String','Mixing Number (nondimensional)');
set(ax(1), 'YTickMode', 'auto');
set(ax(2), 'YTickMode', 'auto');
xlabel('Time, s');
if showtitles == 1
    title('Smoothed Rear Pool Temperatures and the Mixing Number (Type 4)');
end
legendhandle = legend([ploth2a', ploth3a'], 'A - Upper', 'B - Near Sparger (Middle)', 'C
       - Further from Sparger (Middle)', 'D - Lower', 'E - Outlet', 'F - Saturation', 'G
       - Mixing Number 4', 'Location', 'Best');
set(legendhandle, 'Color', 'none');
figname = [testname '_crazynumber_t4'];
set(fighandle, 'Name', figname);
set(findall(fighandle,'type','axes'),'fontsize',16)
set(findall(fighandle,'type','text'),'fontSize',16)
% save to jpeg file
fileoutname = [figname '.jpg'];
if save_em == 1
    print(fighandle, '-djpeg90', '-r300', [outdir fileoutname]);
    saveas(fighandle, [mfigoutdir figname], 'fig')
end




% Close the log file
if save_em == 1
    fprintf(filehandle, '%s\r\n', 'End');
    fclose(filehandle);
    disp('Closing Output Text File')
end

save_em = 0;
clear startingtemp;
savefigs='n';
```

C.3 SOURCE – SPREADSHOUT.M

```
%spreadshout.m

tabchar = sprintf('\t');
tabchar = [' ' tabchar];
filehandle = [];
fileh2 = [];
crlf = sprintf('\r\n');
outdir = [outpath '\Export\' testname '\'];
disp(['Loading ' outdir testname '_results_rcicland.txt' ' ...']);
```

```
filehandle = fopen([outdir testname '_results_rcicland.txt'], 'r');
filetext = fscanf(filehandle,'%c',inf);
fclose(filehandle);
textdat = filetext;
disp('Removing non-numeric data ...');
for ind = 1:length(textdat)
    if isempty(str2num(textdat(ind)))
        % either decimal, -, +, e, or non-numeric, check for decimal
        if ind < length(textdat)
            if textdat(ind) == '.'
                % decimal or period, check for decimal (numbers right and
                % left)
                if ind == 1
                    % period?
                    textdat(ind) = ' ';
                elseif isempty(str2num(textdat(ind-1)))
                    % period
                    textdat(ind) = ' ';
                elseif isempty(str2num(textdat(ind+1)))
                    % period
                    textdat(ind) = ' ';
                end
            elseif textdat(ind) == '-'
                if isempty(str2num(textdat(ind+1))) && (textdat(ind+1) ~= '.')
                    % not a negative number leader
                    textdat(ind) = ' ';
                end
                elseif textdat(ind) == '+'
                if isempty(str2num(textdat(ind+1))) && (textdat(ind+1) ~= '.')
                    % not a number leader
                    textdat(ind) = ' ';
                end
            elseif (textdat(ind) == 'e') || (textdat(ind) == 'E')
                % Power indicator?
                if ind > 1
                    if isempty(str2num(textdat(ind-1)))
                        % no preceding numeric
                        textdat(ind) = ' ';
                    elseif (~isempty(str2num(textdat(ind+1)))) && (textdat(ind+1) ~= '+')
        && (textdat(ind+1) ~= '-')
                        % no succeeding numeric/+/-
                        textdat(ind) = ' ';
                    end
                else
                    % too early
                    textdat(ind) = ' ';
                end
            else
                % non-numeric
                textdat(ind) = ' ';
            end
        else
            % last character, not a decimal or -
            textdat(ind) = ' ';
        end
    elseif str2num(textdat(ind)) == 1i
        % no imaginaries
        textdat(ind) = ' ';
    end
end
disp('Converting ...')
numericdata = str2num(textdat);
outstring = '';
for ind=1:length(numericdata)
    outstring = [outstring num2str(numericdata(ind)) tabchar];
end
disp('Data:  ');
```

```
disp(outstring);

if savefigs == 'y'
    mkdir([outpath '\extracted_numerics\'] );
    fileh2 = fopen([outpath '\extracted_numerics\extracted.txt'], 'a+');
    fprintf(fileh2, '%s\r\n', ' ');
    fprintf(fileh2, '%s\r\n', date);
    fprintf(fileh2, '%s\r\n', ['Currently:  ' num2str(clock) ' ' tabchar ' in Y M D H M
       S' ]);
    fprintf(fileh2, '%s\r\n', ['Test name:  ' testname]);
    fprintf(fileh2, '%s\r\n', ['Read from:  ' outdir testname '_results_localextra.txt']);
    fprintf(fileh2, '%s\r\n', 'Reported numeric data:  ');
    fprintf(fileh2, '%s\r\n', outstring);
    fprintf(fileh2, '%s\r\n', ' ');
    fclose(fileh2);
    savefigs = 'n';
end
disp('Done!')
```

APPENDIX D

PROCESSED RESULTS

This Appendix contains the processed results produced by the Matlab data processing script for each test.

D.1 TEST #1 - T01_RCIC_STD_57KW_OLD_ORIFICE_FORCED_END_RESULTS_RCICLAND.TXT

```
Output Saved to C:\Local
       Files\RCICLAND_NOTITLES\Export\T01_RCIC_STD_57kW_old_orifice_forced_end\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 4894.684 s, and ending (KEY POINT #11) at t
       plus 15262.944 s, for a time period of 10368.26 s.
Original Data Record Time:  18000.2876 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       3366.7506 s, T_bulk = 57.9366 C and T_out = 55.3123 C
Stratification Beginning SP12 Temperature = 57.8114 C
Stratification Beginning Pressure = 18.2573 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       10338.6603 s, T_bulk = 95.2465 C and T_out = 75.2305 C
Stratification Ending SP12 Temperature = 95.0466 C
Stratification Ending Pressure = 29.6467 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 3437.0516 s.
At t = 3437.0516 s, the pool pressure is 18.3156 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 58.6463, 58.3923, 60.3963, 58.5985, and
       55.3555 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 9.9536 +/- 3.7452 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.3379 +/- 3.709 C.
Minimum Steam Quality:  0.99206 at t plus 10341.7605 s
Maximum Steam Quality:  1.0067 at t plus 4320.9661 s
Time-Averaged Steam Quality:  0.99984 +/- 0.0018699
Minimum Turbine Outlet Steam Quality:  0.99912 at t plus 10341.7605 s
Maximum Turbine Outlet Steam Quality:  1.0211 at t plus 1361.7219 s
Time-Averaged Turbine Outlet Steam Quality:  1.012 +/- 0.0034148
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 10278.2598 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.51474 degrees/min at t plus 6986.8076 s
       and 0.14389 degrees/min at t plus 6458.0983 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.42858 degrees/min at t plus
       7873.7213 s and 0.22665 degrees/min at t plus 10163.6563 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.1729 degrees/min at t
       plus 6986.8076 s and -0.17509 degrees/min at t plus 6095.0926 s, respectively
Max and min smoothed lower level changerates:  1.6104 degrees/min at t plus 9630.8498 s
       and -0.02954 degrees/min at t plus 9178.0409 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.38396 degrees/min at t
       plus 9173.4417 s and -1.3687 degrees/min at t plus 9630.8498 s, respectively
Max and min smoothed outlet level changerates:  0.42114 degrees/min at t plus 2760.2659 s
       and -0.035359 degrees/min at t plus 9570.6484 s, respectively
Max and min smoothed lower-outlet level changerate differences:  1.608 degrees/min at t
       plus 9630.7498 s and -0.26317 degrees/min at t plus 7352.7135 s, respectively
Max and min smoothed hot (SP8) level changerates:  0.8365 degrees/min at t plus 5010.7006
       s and 0.097639 degrees/min at t plus 7472.9144 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.53428 degrees/min
       at t plus 5050.9779 s and -0.28931 degrees/min at t plus 7472.9144 s,
       respectively
The mean steam flow rate was 23.4779 +/- 0.51075 g/s
The mean feedwater flow rate was 22.2345 +/- 0.93409 g/s
The mean water injection to steam flow rate was 0.0037187 +/- 0.035541 g/s
```

Mean Smoothed Condensing Region SP8-SP9 delta T is 9.8722 +/- 3.8126 C over the Stratification Period, beginning at 2.0096 C and ending at 15.2092 C
Mean Smoothed SP8-Upper Pool delta T is 9.2603 +/- 3.7694 C over the Stratification Period, beginning at 1.6629 C and ending at 14.6871 C
The stratification period begins and ends with Smoothed SP8 readings of 60.0785 and 110.3675 C, respectively
The stratification period begins and ends with condensing flows of 0.25584 and 0.48511 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 6.8018 and 0.85851 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2720.1958 +/- 0.96719 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.25584 and 6.7861 kg/s, respectively
The plume period had a mean steam enthalpy of 2720.4826 +/- 0.87007 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.4115 degrees C at t plus 5966.8922 s with T_upper = 72.5743 C and T_mid = 71.1628 C
At t plus 5966.8922 s, Smoothed SP8-SP9 is 9.8021 C and Smoothed SP8-Top is 8.3906 C, where Smoothed SP8 is 80.9649 C and Pool P = 21.0255 psia
Maximum Smoothed Top-Lower delta T is 10.2558 degrees C at t plus 9492.1469 s with T_upper = 91.9391 C and T_low = 81.6833 C
At t plus 9492.1469 s, Smoothed SP8-SP9 is 13.8539 C and Smoothed SP8-Top is 13.5498 C, where Smoothed SP8 is 105.4889 C and Pool P = 27.7777 psia
Maximum Smoothed Mid-Lower delta T is 9.9801 degrees C at t plus 9475.8459 s with T_mid = 91.5156 C and T_low = 81.5355 C
At t plus 9475.8459 s, Smoothed SP8-SP9 is 14.0551 C and Smoothed SP8-Top is 13.7811 C, where Smoothed SP8 is 105.5707 C and Pool P = 27.7365 psia
Maximum Smoothed Top-Outlet delta T is 20.6577 degrees C at t plus 10368.26 s with T_upper = 95.8454 C and T_out = 75.1878 C
At t plus 10368.26 s, Smoothed SP8-SP9 is 14.29 C and Smoothed SP8-Top is 13.7245 C, where Smoothed SP8 is 109.5699 C and Pool P = 29.6855 psia
Maximum Smoothed Mid-Outlet delta T is 20.0922 degrees C at t plus 10368.26 s with T_mid = 95.2799 C and T_out = 75.1878 C
At t plus 10368.26 s, Smoothed SP8-SP9 is 14.29 C and Smoothed SP8-Top is 13.7245 C, where Smoothed SP8 is 109.5699 C and Pool P = 29.6855 psia
Maximum Smoothed Lower-Outlet delta T is 19.2737 degrees C at t plus 10368.26 s with T_low = 94.4615 C and T_out = 75.1878 C
At t plus 10368.26 s, Smoothed SP8-SP9 is 14.29 C and Smoothed SP8-Top is 13.7245 C, where Smoothed SP8 is 109.5699 C and Pool P = 29.6855 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 15.3759 degrees C at (KEY POINT #14) t plus 10244.7579 s with T_SP8 = 110.1343 C and T_SP9 = 94.7584 C and Pool P = 29.447 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 14.8121 degrees C at t plus 10335.5601 s with T_SP8 = 110.4903 C and T_upper = 95.6782 C and Pool P = 29.6334 psia
Maximum Top-Mid delta T is 2.0598 degrees C at (KEY POINT #4) t plus 7452.6142 s ignoring SP 4, with temperatures of 80.862 and 78.8022 C, respectively, at Set # 2, where Pool P = 23.3349 psia and T_outlet = 72.3473 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 8339.1279 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99965 C and a raw SP12 Reading of 84.6904 C.
Maximum Top-Lower delta T is 11.5433 degrees C at t plus 9566.3481 s, with temperatures of 92.6406 and 81.0973 C, respectively, at Set # 1, where Pool P = 27.9386 psia and T_outlet = 75.1664 C
Maximum Mid-Low delta T is 10.7936 degrees C at (KEY POINT #6) t plus 9554.6695 s ignoring SP 4, with temperatures of 91.8716 and 81.0779 C, respectively, at Set # 2, where Pool P = 27.9107 psia and T_outlet = 75.1204 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 9806.8519 s with a Smoothed Mid-Axis Mid-Low Delta T of 3.5957 C and a raw SP12 Reading of 92.8709 C.
Maximum Top-Outlet delta T is 20.8945 degrees C at t plus 10362.0596 s, with temperatures of 96.1019 and 75.2074 C, respectively, at Set # 2, where Pool P = 29.6753 psia
Maximum Mid-Outlet delta T is 20.0585 degrees C at t plus 10361.7596 s ignoring SP 4, with temperatures of 95.2658 and 75.2073 C, respectively, at Set # 2, where Pool P = 29.677 psia
Maximum Lower-Outlet delta T is 20.7106 degrees C at (KEY POINT #8) t plus 10327.2596 s, with temperatures of 95.9922 and 75.2816 C, respectively, at Set # 1, where Pool P = 29.6197 psia

Low-Outlet Reconvergence NOT Detected, setting t to (KEY POINT #10) t plus 10368.26 s with a Smoothed Mid-Axis Low-Outlet Delta T of 19.8329 C and a raw SP12 Reading of 95.203 C.
Minimum SP Pressure is 16.1529 psia at t plus 1.5001 s
Maximum SP Pressure is 29.6911 psia at t plus 10366.3599 s
Beginning SP Pressure is 16.153 psia
Ending SP Pressure is 29.6855 psia
Time-Average SP Pressure is 21.0553 +/- 3.9107 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 70.9431 cm (cold) / 70.9765 cm (hot) at 14.7305 psia
Beginning Smoothed SP Level is 71.0841 cm (cold) / 71.2098 cm (hot) at 16.1582 psia
Ending Smoothed SP Level is 72.4754 cm (cold) / 73.2211 cm (hot) at 29.6949 psia
Minimum Smoothed Cold SP Level is 70.7834 cm at t plus 7792.5197 s and 23.9641 psia
Minimum Smoothed Hot SP Level is 71.1946 cm at t plus 232.5043 s and 16.2625 psia
Maximum Smoothed Cold SP Level is 72.4754 cm at t plus 10368.26 s and 29.6949 psia
Maximum Smoothed Hot SP Level is 73.2211 cm at t plus 10368.26 s and 29.6949 psia
SP 12 Temperature at the beginning is 39.964 C, and at the end is 95.203 C
At plume detection, the Mixing Number is 43.6834
The Mixing Number ranges from a minimum of 32.1718 at (KEY POINT #12) t plus 0 s to a maximum of 109.8003 at (KEY POINT #13) t plus 10368.26 s; it had a mean value of 58.7259 +/- 22.0058 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 32.1718): 17.2558211 0.040894
0.00925 0.3937 0.710840769 0.712097661 1.01519585
1 1 26.5357604 54155.8597 0.0695263055 0.0581485075
0.0226644245 3.40124572e-006 0.0226644245 40.4304101 120.47864
103.942449 40.595914 40.5527487 40.8388362 37.3958216
4.17851387 4.22178976 2.09371415 0.629184762 0.6792901
0.6792901 4.30050184 1.68103157 0.0382322272 992.059931
955.488355 0.681179479 0.650383122 0.000647553248 0.000270479623
1.24041639e-005 1.30301606e-005 1532.07587 1541.23736 474.246369
485.564903 1.16542603 1.11406685 1.15106685 0.0755556799
0.0762228145 2716.58504 2715.88089 169.435004 435.744383
2681.75091 266.309379 2280.84065 170.126564 169.944693
171.14321 156.760419
KEY POINT #2 (t plus 3437.0516 s with a Mixing Number of 43.6834): 17.5665799
0.040894 0.00925 0.3937 0.710374428 0.712998794
1.01382146 1 1 24.0141531 54877.4594
0.0665160113 0.057463508 0.0230725865 4.83070945e-006 0.0230725865
58.3923137 122.311476 107.449788 60.3963003 58.6463089
58.5985271 55.3554831 4.18204086 4.22665414 2.10922984
0.649274175 0.680494719 0.680494719 3.07843157 1.62188928
0.0388199629 984.04051 952.880255 0.762727525 0.731662607
0.000477935578 0.000261125479 1.25243723e-005 1.30903968e-005 1552.88038

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      1537.4255      475.972813      486.199643      1.31519342      1.26312409
      1.30012409      0.18507901      0.203145122      2718.66215      2718.08547
      244.522899      450.571129      2687.17238      206.04823      2268.09102
      252.904469      245.583697      245.386818      231.82983
KEY POINT #3 (t plus 3366.7506 s with a Mixing Number of 43.3505):  17.6386555
      0.040894      0.00925      0.3937      0.710379405      0.712990993
      1.0143673      1      1      24.2148881      55017.9869
      0.0665717272      0.0574791375      0.0231672532 6.22327102e-006      0.0231672532
      58.0688746      122.829746      107.370074      60.0784843      58.4155729
      58.1582666      55.203572      4.18191547      4.22654054      2.1088654
      0.648957099      0.680468986      0.680468986      3.09519397      1.62318692
      0.0388062484      984.203223      952.940138      0.760789947      0.728617603
      0.000480317719  0.000261331543 1.25216377e-005 1.31105338e-005      1552.65708
      1537.51605      475.934048      486.556989      1.31162174      1.25916445
      1.29616445      0.182295614      0.200183662      2719.77334      2719.18698
      243.169951      450.233948      2687.04998      207.063997      2269.53939
      251.574775      244.618403      243.545301      231.194368
KEY POINT #4 (t plus 7452.6142 s with a Mixing Number of 69.173):  18.1319328
      0.040894      0.00925      0.3937      0.707936929      0.71274093
      1.0102738      1      1      19.7776738      56281.3272
      0.0628312045      0.0561087689      0.0238151416 3.06885185e-006      0.0238151416
      79.1349402      125.069778      114.305865      90.6036668      80.2241776
      77.3846683      72.3573978      4.19465181      4.23696678      2.14273739
      0.666437906      0.682425312      0.682425312      2.25483791      1.51771554
      0.0400647576      972.369776      947.625364      0.945040919      0.91690608
      0.000358244147  0.000244450229 1.27599419e-005 1.31746584e-005      1557.3837
      1528.97781      479.222442      486.751393      1.65383151      1.60864466
      1.64564466      0.457781062      0.718068767      2720.72883      2720.33768
      331.41299      479.608684      2697.55098      148.195694      2241.12015
      379.58001      335.981106      324.0739      303.006611
KEY POINT #5 (t plus 8339.1279 s with a Mixing Number of 80.5104):  18.3093169
      0.040894      0.00925      0.3937      0.708762907      0.71422025
      1.00887905      1      1      18.6384739      56766.7416
      0.0617746777      0.0556834012      0.0240481243 5.88887413e-006      0.0240481243
      84.8695651      125.657033      116.437483      97.3228528      85.5268849
      79.916849      74.7938285      4.1997156      4.24039598      2.15406253
      0.670130489      0.682912903      0.682912903      2.09251742      1.48811062
      0.0404791787      968.74203      945.949806      1.00840711      0.982580472
      0.000333893971  0.000239659208 1.28333106e-005 1.31897866e-005      1555.56445
      1526.09206      480.197977      486.693789      1.77260774      1.72896679
      1.76596679      0.575721569      0.921043594      2720.70377      2720.35638
      355.491465      488.652396      2700.71537      133.16093      2232.05138
      407.871983      358.250896      334.704092      313.225851
KEY POINT #6 (t plus 9554.6695 s with a Mixing Number of 99.3881):  18.3895432
      0.040894      0.00925      0.3937      0.718371455      0.725035608
      1.00701982      1      1      16.890259      56866.2239
      0.0604458649      0.0550331683      0.0241534965 3.72002901e-006      0.0241534965
      91.9633418      126.865082      119.677305      106.124497      92.3536258
      83.3681791      75.1373421      4.20692153      4.24581678      2.17214005
      0.674101689      0.683553123      0.683553123      1.91911998      1.44540672
      0.041135305      964.032568      943.365551      1.11125998      1.0889339
      0.000307512753  0.000232702522  1.2944914e-005 1.32244051e-005      1551.70731
      1521.47813      481.648204      486.772365      1.96643602      1.92452031
      1.96152031      0.755809157      1.25684188      2721.21549      2720.93021
      385.323449      502.412953      2705.46519      117.089504      2218.80254
      445.018453      386.964121      349.203963      314.681405
KEY POINT #7 (t plus 9806.8519 s with a Mixing Number of 102.572):  18.407053
      0.040894      0.00925      0.3937      0.720701084      0.72763533
      1.00635676      1      1      16.5674133      56943.5922
      0.0602536952      0.0549071003      0.0241764945 9.66189958e-006      0.0241764945
      92.9788172      126.790955      120.302892      106.517533      93.5908866
      89.0284098      75.1883188      4.20803739      4.246893      2.17575328
      0.674617652      0.683662825      0.683662825      1.89646538      1.43746483
      0.041265737      963.339163      942.861345      1.13206278      1.11148367
      0.000304034613  0.000231402408 1.29664749e-005  1.3219012e-005      1551.01828
      1520.55602      481.923665      486.565893      2.00578542      1.9639646
      2.0009646      0.785060525      1.27391976      2720.64147      2720.36699
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      389.59907      505.072181      2706.37385      115.473111      2215.56929
      446.681888      392.17359      372.98551      314.898252
KEY POINT #8 (t plus 10327.2596 s with a Mixing Number of 109.2173):  18.58154
      0.040894         0.00925          0.3937     0.724506992      0.73192618
      1.00623696              1               1      16.1290073      57325.8322
      0.0598498501    0.0546630386     0.024405672  5.4998842e-006     0.024405672
      95.1045834      127.847475      121.511683      110.105122      95.6966334
      94.4333493      75.2535103      4.21044538      4.24899995      2.18284911
      0.675655022     0.683862103     0.683862103      1.85063812      1.42238708
      0.0415212623     961.871625      941.882333      1.17314987      1.15231688
      0.000296974031  0.000228928367  1.3008145e-005 1.32553417e-005       1549.4661
      1518.74605      482.451697      486.997925      2.08364016      2.04194878
      2.07894878     0.849351508      1.43882957      2722.09007      2721.82992
      398.552879      510.212511      2708.12165      111.659632      2211.87756
      461.854986      401.044584      395.728321      315.177788
KEY POINT #9 (t plus 10338.6603 s with a Mixing Number of 109.4056):  18.5721544
      0.040894         0.00925          0.3937     0.724568522     0.732003484
      1.00627554              1               1      16.1114471      57286.8215
      0.0598396197    0.0546583968    0.0243933447 5.06130544e-006    0.0243933447
      95.1582909      127.909408      121.534644      110.36749       95.6804195
      94.4714337      75.2521771      4.21050758      4.24904033      2.18298536
      0.675680464     0.683865727     0.683865727      1.84950751      1.42210405
      0.0415261608     961.834251      941.863676      1.1739418       1.15296955
      0.000296799393  0.000228881853 1.30089366e-005 1.32576684e-005       1549.4249
      1518.71131      482.461672      487.035396      2.0851425       2.04345378
      2.08045378     0.851030785      1.45154757      2722.20699      2721.94741
      398.779128      510.310176      2708.15475      111.531048      2211.89681
      462.965059      400.97642       395.888759      315.172321
KEY POINT #10 (t plus 10368.26 s with a Mixing Number of 109.8003):  18.5700451
      0.040894         0.00925          0.3937      0.72475433     0.732210997
      1.00632765              1               1      16.0858766      57262.5274
      0.0598164465    0.0546463309    0.0243905742 8.33388687e-006    0.0243905742
      95.2799187      128.021027      121.594322      109.569922      95.8454466
      94.4614741      75.1877502      4.21064853      4.24914532      2.18333974
      0.675737975     0.683875117     0.683875117      1.8469519        1.421369
      0.0415389009     961.749585      941.815174      1.17600216       1.1548261
      0.000296404587  0.000228761037 1.30109942e-005 1.32617867e-005      1549.33137
      1518.62095      482.487591      487.098213      2.08905148      2.04739441
      2.08439441     0.854843934      1.41317028      2722.40565      2722.14689
      399.291552      510.564029      2708.24075      111.272477      2211.84162
      459.591503      401.671685      395.847133      314.902596
KEY POINT #11 (t plus 10368.26 s with a Mixing Number of 109.8003):  18.5700451
      0.040894         0.00925          0.3937      0.72475433     0.732210997
      1.00632765              1               1      16.0858766      57262.5274
      0.0598164465    0.0546463309    0.0243905742 8.33388687e-006    0.0243905742
      95.2799187      128.021027      121.594322      109.569922      95.8454466
      94.4614741      75.1877502      4.21064853      4.24914532      2.18333974
      0.675737975     0.683875117     0.683875117      1.8469519        1.421369
      0.0415389009     961.749585      941.815174      1.17600216       1.1548261
      0.000296404587  0.000228761037 1.30109942e-005 1.32617867e-005      1549.33137
      1518.62095      482.487591      487.098213      2.08905148      2.04739441
      2.08439441     0.854843934      1.41317028      2722.40565      2722.14689
      399.291552      510.564029      2708.24075      111.272477      2211.84162
      459.591503      401.671685      395.847133      314.902596
KEY POINT #12 (t plus 0 s with a Mixing Number of 32.1718):  17.2558211        0.040894
      0.00925          0.3937     0.710840769     0.712097661      1.01519585
      1              1      26.5357604      54155.8597    0.0695263055    0.0581485075
      0.0226644245 3.40124572e-006    0.0226644245      40.4304101       120.47864
      103.942449       40.595914      40.5527487      40.8388362      37.3958216
      4.17851387      4.22178976      2.09371415     0.629184762       0.6792901
      0.6792901       4.30050184      1.68103157    0.0382322272      992.059931
      955.488355     0.681179479     0.650383122  0.000647553248  0.000270479623
      1.24041639e-005 1.30301606e-005      1532.07587      1541.23736      474.246369
      485.564903      1.16542603      1.11406685      1.15106685    0.0755556799
      0.0762228145      2716.58504      2715.88089      169.435004      435.744383
      2681.75091      266.309379      2280.84065      170.126564      169.944693
      171.14321       156.760419
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KEY POINT #13 (t plus 10368.26 s with a Mixing Number of 109.8003):  18.5700451
       0.040894         0.00925          0.3937       0.72475433     0.732210997
       1.00632765              1               1      16.0858766      57262.5274
       0.0598164465    0.0546463309    0.0243905742 8.33388687e-006    0.0243905742
       95.2799187      128.021027      121.594322      109.569922      95.8454466
       94.4614741      75.1877502      4.21064853      4.24914532      2.18333974
       0.675737975     0.683875117     0.683875117       1.8469519        1.421369
       0.0415389009      961.749585      941.815174      1.17600216       1.1548261
       0.000296404587  0.000228761037 1.30109942e-005 1.32617867e-005      1549.33137
       1518.62095      482.487591      487.098213      2.08905148      2.04739441
       2.08439441     0.854843934      1.41317028      2722.40565      2722.14689
       399.291552      510.564029      2708.24075      111.272477      2211.84162
       459.591503      401.671685      395.847133      314.902596
KEY POINT #14 (t plus 10244.7579 s with a Mixing Number of 108.1998):  18.5266147
       0.040894         0.00925          0.3937       0.72401168     0.731375443
       1.00596487              1               1      16.1562722      57230.2374
       0.0599157545    0.0546999129    0.0243335312 6.68839932e-006    0.0243335312
       94.7584316      127.390561      121.329246      110.134312      95.4699985
       93.2670483      75.2146423      4.21004651      4.24867963      2.18176849
       0.67549005     0.683833097     0.683833097      1.85795679      1.42464035
       0.0414823999      962.112078      942.030492      1.16687283      1.14702864
       0.000298103909  0.000229298584 1.30018552e-005 1.32382359e-005      1549.72897
       1519.02159      482.372361      486.724635      2.07173444      2.03006904
       2.06706904     0.838594252      1.44023996      2721.23287      2720.97184
       397.094589      509.436532      2707.85854      112.341944      2211.79634
       461.977606      400.089318      390.818449      315.013916
End
```

D.2 TEST #2 - T02_RCIC_STD_57KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T02_RCIC_STD_57kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2098.241 s, and ending (KEY POINT #11) at t
       plus 14976.2446 s, for a time period of 12878.0036 s.
Original Data Record Time:  17235.4818 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       3929.9628 s, T_bulk = 59.101 C and T_out = 56.673 C
Stratification Beginning SP12 Temperature = 58.8905 C
Stratification Beginning Pressure = 17.1325 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       12176.6925 s, T_bulk = 96.9752 C and T_out = 75.692 C
Stratification Ending SP12 Temperature = 96.8511 C
Stratification Ending Pressure = 29.2965 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 3545.8568 s.
At t = 3545.8568 s, the pool pressure is 16.8474 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 57.6073, 57.5885, 59.5907, 57.7115, and
       55.3163 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 10.3245 +/- 3.9134 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.8447 +/- 3.796 C.
Minimum Steam Quality:  0.99468 at t plus 12849.403 s
Maximum Steam Quality:  1.0128 at t plus 1017.4172 s
Time-Averaged Steam Quality:  1.005 +/- 0.0022442
Minimum Turbine Outlet Steam Quality:  0.99783 at t plus 12849.403 s
Maximum Turbine Outlet Steam Quality:  1.0229 at t plus 623.0106 s
Time-Averaged Turbine Outlet Steam Quality:  1.0118 +/- 0.0039172
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 12788.0044 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.40631 degrees/min at t plus 8035.0266 s
       and 0.16646 degrees/min at t plus 11923.091 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.37305 degrees/min at t plus 320.1063
       s and 0.17868 degrees/min at t plus 11868.3888 s, respectively
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Max and min smoothed upper-mid level changerate differences: 0.12699 degrees/min at t plus 5053.08 s and -0.12147 degrees/min at t plus 5259.9839 s, respectively
Max and min smoothed lower level changerates: 1.2298 degrees/min at t plus 10380.1647 s and 0.017432 degrees/min at t plus 9885.4564 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.30459 degrees/min at t plus 9885.1564 s and -0.99422 degrees/min at t plus 10380.1647 s, respectively
Max and min smoothed outlet level changerates: 2.9767 degrees/min at t plus 12566.1988 s and -0.036845 degrees/min at t plus 10665.47 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.2078 degrees/min at t plus 10380.0647 s and -2.7451 degrees/min at t plus 12566.0988 s, respectively
Max and min smoothed hot (SP8) level changerates: 0.75677 degrees/min at t plus 5506.2869 s and -0.6814 degrees/min at t plus 12788.0044 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.46131 degrees/min at t plus 5506.2869 s and -0.97449 degrees/min at t plus 12788.0044 s, respectively
The mean steam flow rate was 23.4613 +/- 1.079 g/s
The mean feedwater flow rate was 25.0392 +/- 2.212 g/s
The mean water injection to steam flow rate was 0.003927 +/- 0.035595 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 10.6969 +/- 3.5926 C over the Stratification Period, beginning at 2.278 C and ending at 15.3024 C
Mean Smoothed SP8-Upper Pool delta T is 10.1997 +/- 3.4994 C over the Stratification Period, beginning at 2.0959 C and ending at 14.5742 C
The stratification period begins and ends with Smoothed SP8 readings of 61.5964 and 112.478 C, respectively
The stratification period begins and ends with condensing flows of 0.26707 and 0.52925 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 5.8361 and 0.84231 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2718.9485 +/- 1.3255 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.25821 and 6.6148 kg/s, respectively
The plume period had a mean steam enthalpy of 2719.0269 +/- 1.3145 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.1552 degrees C at t plus 12463.8209 s with T_upper = 99.3145 C and T_mid = 98.1594 C
At t plus 12463.8209 s, Smoothed SP8-SP9 is 14.0873 C and Smoothed SP8-Top is 12.9321 C, where Smoothed SP8 is 112.2467 C and Pool P = 29.8925 psia
Maximum Smoothed Top-Lower delta T is 8.5506 degrees C at t plus 10131.7605 s with T_upper = 89.665 C and T_low = 81.1145 C
At t plus 10131.7605 s, Smoothed SP8-SP9 is 14.2503 C and Smoothed SP8-Top is 13.8028 C, where Smoothed SP8 is 103.4678 C and Pool P = 25.3731 psia
Maximum Smoothed Mid-Lower delta T is 8.1068 degrees C at t plus 10129.9604 s with T_mid = 89.2103 C and T_low = 81.1035 C
At t plus 10129.9604 s, Smoothed SP8-SP9 is 14.2595 C and Smoothed SP8-Top is 13.819 C, where Smoothed SP8 is 103.4699 C and Pool P = 25.3717 psia
Maximum Smoothed Top-Outlet delta T is 22.158 degrees C at t plus 12166.1939 s with T_upper = 97.8491 C and T_out = 75.6912 C
At t plus 12166.1939 s, Smoothed SP8-SP9 is 15.1393 C and Smoothed SP8-Top is 14.4672 C, where Smoothed SP8 is 112.3164 C and Pool P = 29.2696 psia
Maximum Smoothed Mid-Outlet delta T is 21.5082 degrees C at t plus 12157.9924 s with T_mid = 97.1573 C and T_out = 75.6491 C
At t plus 12157.9924 s, Smoothed SP8-SP9 is 14.8815 C and Smoothed SP8-Top is 14.2554 C, where Smoothed SP8 is 112.0388 C and Pool P = 29.2534 psia
Maximum Smoothed Lower-Outlet delta T is 21.7369 degrees C at t plus 12062.891 s with T_low = 97.2259 C and T_out = 75.489 C
At t plus 12062.891 s, Smoothed SP8-SP9 is 14.4427 C and Smoothed SP8-Top is 13.7744 C, where Smoothed SP8 is 111.0992 C and Pool P = 29.0656 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 15.3957 degrees C at (KEY POINT #14) t plus 12173.3923 s with T_SP8 = 112.5654 C and T_SP9 = 97.1696 C and Pool P = 29.2841 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 14.6746 degrees C at t plus 12173.3923 s with T_SP8 = 112.5654 C and T_upper = 97.8907 C and Pool P = 29.2841 psia
Maximum Top-Mid delta T is 1.4105 degrees C at (KEY POINT #4) t plus 6366.4011 s ignoring SP 4, with temperatures of 71.0791 and 69.6686 C, respectively, at Set # 2, where Pool P = 19.4128 psia and T_outlet = 65.9976 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 6366.4011 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99578 C and a raw SP12 Reading of 69.6686 C.

Maximum Top-Lower delta T is 9.8872 degrees C at t plus 10389.4643 s, with temperatures of 90.814 and 80.9268 C, respectively, at Set # 2, where Pool P = 25.8877 psia and T_outlet = 75.1347 C

Maximum Mid-Low delta T is 9.2559 degrees C at (KEY POINT #6) t plus 10389.5643 s ignoring SP 4, with temperatures of 90.1813 and 80.9254 C, respectively, at Set # 2, where Pool P = 25.8871 psia and T_outlet = 75.1374 C

Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 10476.3662 s with a Smoothed Mid-Axis Mid-Low Delta T of 3.0829 C and a raw SP12 Reading of 90.5594 C.

Maximum Top-Outlet delta T is 22.4053 degrees C at t plus 12180.4927 s, with temperatures of 98.0775 and 75.6723 C, respectively, at Set # 1, where Pool P = 29.2976 psia

Maximum Mid-Outlet delta T is 21.3857 degrees C at t plus 12172.8923 s ignoring SP 4, with temperatures of 97.0182 and 75.6325 C, respectively, at Set # 2, where Pool P = 29.283 psia

Maximum Lower-Outlet delta T is 22.5979 degrees C at (KEY POINT #8) t plus 12150.792 s, with temperatures of 98.1573 and 75.5594 C, respectively, at Set # 1, where Pool P = 29.2292 psia

Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 12655.0008 s with a Smoothed Mid-Axis Low-Outlet Delta T of 7.5317 C and a raw SP12 Reading of 98.9045 C.

Minimum SP Pressure is 15.021 psia at t plus 14.6008 s

Maximum SP Pressure is 30.8387 psia at t plus 12878.0036 s

Beginning SP Pressure is 15.028 psia

Ending SP Pressure is 30.8387 psia

Time-Average SP Pressure is 20.7374 +/- 4.6514 psia

SP Levels are fully corrected and compensated

Pre-Start SP Level is 78.062 cm (cold) / 78.2033 cm (hot) at 14.6198 psia

Beginning Smoothed SP Level is 77.9323 cm (cold) / 78.1145 cm (hot) at 15.0245 psia

Ending Smoothed SP Level is 77.8519 cm (cold) / 78.9101 cm (hot) at 30.8374 psia

Minimum Smoothed Cold SP Level is 76.6822 cm at t plus 9807.555 s and 24.7146 psia

Minimum Smoothed Hot SP Level is 77.4352 cm at t plus 9285.7471 s and 23.679 psia

Maximum Smoothed Cold SP Level is 77.9323 cm at t plus 1.9001 s and 15.0252 psia

Maximum Smoothed Hot SP Level is 78.9101 cm at t plus 12878.0036 s and 30.8374 psia

SP 12 Temperature at the beginning is 40.0277 C, and at the end is 99.8193 C

At plume detection, the Mixing Number is 45.0613

The Mixing Number ranges from a minimum of 33.3326 at (KEY POINT #12) t plus 0 s to a maximum of 138.0096 at (KEY POINT #13) t plus 12878.0036 s; it had a mean value of 68.9277 +/- 29.4538 over the test period.

Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11

KEY POINT #1 (t plus 0 s with a Mixing Number of 33.3326): 20.4407065 0.040894
0.00925 0.3937 0.779323037 0.78114485 1.01583551
1 1 33.4106111 64315.6065 0.0695239701 0.0584969002
0.0268475692 2.89403617e-006 0.0268475692 40.4447578 119.481328
102.147658 40.4779476 40.3956775 40.3300343 38.0154017
4.17853301 4.21940564 2.08617393 0.629198854 0.678615984
0.678615984 4.29928124 1.71298998 0.0379435701 992.051354

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      956.80174     0.642282317     0.611868784  0.000647380988  0.000275503822
      1.23427452e-005 1.29968805e-005      1532.08722      1543.04963      473.346672
      485.184939      1.09441404      1.03590518      1.07290518     0.0756133143
      0.0757467822      2715.70744      2714.59117      169.488037      428.164019
      2678.94885      258.675982      2287.54342      169.626721      169.281448
      169.010255      159.342433
KEY POINT #2 (t plus 3545.8568 s with a Mixing Number of 45.0613):  17.0980732
      0.040894         0.00925          0.3937     0.774251536      0.77782142
      1.01437511               1               1      25.1543862      53625.4588
      0.0666543777    0.0578988016    0.0224572327 3.30255128e-006    0.0224572327
      57.5884917      120.796019      105.224264      59.5907247      57.6073494
      57.7115322      55.3163089      4.18175389      4.22353585      2.09926281
      0.64847851     0.679747572     0.679747572      3.12040063      1.65892247
      0.0384433414      984.439928      954.541528        0.710116     0.679825282
      0.000483890924  0.000266991582 1.24480689e-005 1.30387436e-005      1552.30037
      1539.88533      474.882234      485.568719      1.21843599       1.1617673
      1.1987673     0.178227526     0.195710166      2716.61079      2715.97805
      241.152843      441.160976      2683.74072      200.008133      2275.44982
      249.526468      241.230265      241.668892      231.657426
KEY POINT #3 (t plus 3929.9628 s with a Mixing Number of 46.6199):  17.2182201
      0.040894         0.00925          0.3937     0.773909323     0.777684851
      1.01448632               1               1      24.9655168      53919.1583
      0.0663561845    0.0578091447     0.022615038 4.16771383e-006     0.022615038
      59.3183846      121.355029      105.683579      61.5963731      59.5004877
      59.6213177      56.7012398      4.18243309      4.22417038      2.10128489
      0.650168455     0.679906659     0.679906659      3.03129404      1.65114079
      0.0385200139      983.567396      954.200467     0.720724989       0.6898072
      0.000471221349  0.000265761443 1.24638092e-005 1.30588443e-005      1553.47546
      1539.38928      475.108716      485.863188      1.23790854      1.18084268
      1.21784268     0.193249648     0.214666293      2717.54356      2716.92028
      248.389013      443.102493      2684.45138      194.713479      2274.44107
      257.917658      249.149224      249.657542      237.449675
KEY POINT #4 (t plus 6366.4011 s with a Mixing Number of 59.5309):  17.6517064
      0.040894         0.00925          0.3937     0.771597097     0.776836182
      1.01265051               1               1      22.7900364      55110.1103
      0.0644064815     0.057132581    0.0231843947 5.53168716e-006    0.0231843947
      70.4163904      122.649972      109.134231      79.1966002      71.0299707
      70.5403739      65.9699288      4.18828341      4.22908818      2.11706265
      0.659962259     0.681020711     0.681020711      2.54874932      1.59495301
      0.0391137419      977.557622      951.608309     0.804617413     0.774720923
      0.000401615219  0.000256839297 1.25821823e-005 1.30983023e-005      1557.70958
      1535.47034      476.786755      486.127572       1.3925608      1.33857323
      1.37557323     0.317668188     0.458931685      2718.50573      2717.98634
      294.848815      457.698387      2689.74975      162.849572      2260.80734
      331.650093      297.417399      295.369567      276.237069
KEY POINT #5 (t plus 6366.4011 s with a Mixing Number of 59.5309):  17.6517064
      0.040894         0.00925          0.3937     0.771597097     0.776836182
      1.01265051               1               1      22.7900364      55110.1103
      0.0644064815     0.057132581    0.0231843947 5.53168716e-006    0.0231843947
      70.4163904      122.649972      109.134231      79.1966002      71.0299707
      70.5403739      65.9699288      4.18828341      4.22908818      2.11706265
      0.659962259     0.681020711     0.681020711      2.54874932      1.59495301
      0.0391137419      977.557622      951.608309     0.804617413     0.774720923
      0.000401615219  0.000256839297 1.25821823e-005 1.30983023e-005      1557.70958
      1535.47034      476.786755      486.127572       1.3925608      1.33857323
      1.37557323     0.317668188     0.458931685      2718.50573      2717.98634
      294.848815      457.698387      2689.74975      162.849572      2260.80734
      331.650093      297.417399      295.369567      276.237069
KEY POINT #6 (t plus 10389.5643 s with a Mixing Number of 101.2825):  18.1662026
      0.040894         0.00925          0.3937     0.766980885     0.775200659
      1.00781491               1               1      17.8698105      56358.6549
      0.0607506161    0.0554773728    0.0238601528 4.62477143e-006    0.0238601528
      90.3476697      125.541221      117.466444      104.312626      90.9430938
      85.1550588      75.0186114      4.20520845      4.24209009      2.15968964
      0.673249347     0.683129374     0.683129374      1.95623718      1.47425568
      0.0406840861      965.122498      945.133956      1.04020118      1.01678324
      0.000313191468  0.000237408291 1.28687445e-005 1.31814482e-005      1552.71808
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     1524.65623      480.662839      486.381443       1.8323919      1.78456563
     1.82156563     0.711141829      1.18053541      2719.81591      2719.49658
     378.517041      493.020714       2702.2318      114.503673       2226.7952
     437.355907      381.019801      356.696271      314.172469
KEY POINT #7 (t plus 10476.3662 s with a Mixing Number of 102.1378):  18.2451682
     0.040894         0.00925          0.3937     0.767048816     0.775341886
     1.00800428               1               1      17.8537151      56543.0263
     0.0606872241    0.0554392316    0.0239638691 3.46070345e-006    0.0239638691
     90.6842878       125.92333      117.656684      104.964976      91.1503275
     87.199227       75.0508422      4.20556484      4.24240609      2.16074159
     0.673428715     0.683168053     0.683168053      1.94839641      1.47172436
     0.0407223221      964.895693      944.982617      1.04616726      1.02207316
     0.000311992833  0.000236996423 1.28752969e-005 1.31955779e-005      1552.51115
     1524.38774      480.748352      486.600797      1.84362374      1.79577757
     1.83277757      0.720261872      1.20755557      2720.50904      2720.19028
     379.933517      493.828557      2702.51137       113.89504      2226.68048
     440.111337      381.892283      365.284616      314.308464
KEY POINT #8 (t plus 12150.792 s with a Mixing Number of 124.9287):  18.3967156
     0.040894         0.00925          0.3937     0.774506634     0.784257862
     1.00595646               1               1      16.1029805      56849.8624
     0.0594655753    0.0547267846     0.024162917 2.60579392e-006     0.024162917
     97.1171366      127.252007      121.196254      112.099614      97.7386992
     97.0049835      75.6274089      4.21283709      4.24844665      2.18098291
     0.676578993     0.683811712     0.683811712      1.80916264      1.42628789
     0.041454137      960.458396      942.138406      1.16231414      1.14256485
     0.000290550384  0.000229569169 1.29972703e-005 1.32333704e-005      1547.84291
     1519.22193      482.314448      486.661696      2.06309051      2.01590208
     2.05290208      0.914190784      1.53784957      2721.02293      2720.76362
     407.027036      508.870904      2707.66659      101.843868      2212.15202
     470.293543      409.644526      406.555925      316.742934
KEY POINT #9 (t plus 12176.6925 s with a Mixing Number of 125.0643):  18.4266372
     0.040894         0.00925          0.3937     0.774688595     0.784459429
     1.00600526               1               1      16.1033029      56925.3987
     0.059454396     0.0547150309     0.024202217 1.92789535e-006     0.024202217
     97.1755392      127.358866       121.25443      112.477966      97.9037866
     97.1450586      75.7681241      4.21290677      4.24854851      2.18132633
     0.676605296     0.683821092     0.683821092      1.80798517      1.42556668
     0.0414664932      960.417304       942.09121       1.1643065      1.14436802
     0.00029036777   0.000229450732 1.29992759e-005 1.32373056e-005      1547.79481
     1519.13435       482.33979      486.721667      2.06686804      2.01967949
     2.05667949      0.916131977      1.55725035      2721.21325      2720.95394
     407.273365      509.118326      2707.75057      101.844961      2212.09493
     471.895644      410.340439      407.146317      317.333092
KEY POINT #10 (t plus 12655.0008 s with a Mixing Number of 133.4362):  18.3302025
     0.040894         0.00925          0.3937     0.777489783     0.787815423
     1.00497512               1               1      15.4795526      56647.8362
     0.0590909045    0.0544990916    0.0240755563 3.85227378e-006    0.0240755563
     99.0700238       127.35117      122.321983      112.031872      100.022111
     99.8606177      91.2361347      4.21521885      4.25043273      2.18769058
     0.677432515     0.683986349     0.683986349      1.77057858      1.41247365
     0.0416951577      959.073343      941.222556       1.2013598      1.18434531
     0.000284551655  0.000227297492 1.30360843e-005 1.32325496e-005      1546.16608
     1517.51205      482.802522      486.435734      2.13719639      2.09022054
     2.12722054      0.980981298      1.53439702      2720.45046      2720.21085
     415.262156       513.65979      2709.28734      98.3976337      2206.79067
     470.012139      419.274702      418.596425      382.282066
KEY POINT #11 (t plus 12878.0036 s with a Mixing Number of 138.0096):  18.3550464
     0.040894         0.00925          0.3937     0.778519357     0.789100504
     1.00510617               1               1      15.3131202      56639.7123
     0.0589014853    0.0544122981    0.0241081871 3.98772412e-006    0.0241081871
     100.053871      127.904521      122.750407      113.305965      101.032183
     100.851041      96.3918084      4.21645048      4.25119695      2.19027808
     0.677844433      0.68404902      0.68404902      1.75173411      1.40729389
     0.0417879538      958.368397      940.872581      1.21649476      1.19884663
     0.000281612039  0.000226443991 1.30508583e-005 1.32523849e-005       1545.2763
     1516.85292      482.986991      486.711946       2.1659633      2.12616504
     2.16316504      1.01613104      1.60040925       2721.3413      2721.10681
```

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       419.412594      515.482946      2709.90173      96.0703515      2205.85835
       475.40958      423.536934      422.775575      403.984819
KEY POINT #12 (t plus 0 s with a Mixing Number of 33.3326):  20.4407065        0.040894
       0.00925          0.3937      0.779323037      0.78114485      1.01583551
       1               1      33.4106111      64315.6065    0.0695239701    0.0584969002
       0.0268475692 2.89403617e-006    0.0268475692      40.4447578      119.481328
       102.147658      40.4779476      40.3956775      40.3300343      38.0154017
       4.17853301      4.21940564      2.08617393     0.629198854     0.678615984
       0.678615984      4.29928124      1.71298998    0.0379435701      992.051354
       956.80174     0.642282317     0.611868784  0.000647380988  0.000275503822
       1.23427452e-005 1.29968805e-005      1532.08722      1543.04963      473.346672
       485.184939      1.09441404      1.03590518      1.07290518    0.0756133143
       0.0757467822      2715.70744      2714.59117      169.488037      428.164019
       2678.94885      258.675982      2287.54342      169.626721      169.281448
       169.010255      159.342433
KEY POINT #13 (t plus 12878.0036 s with a Mixing Number of 138.0096):  18.3550464
       0.040894         0.00925          0.3937     0.778519357     0.789100504
       1.00510617              1               1      15.3131202      56639.7123
       0.0589014853    0.0544122981    0.0241081871 3.98772412e-006    0.0241081871
       100.053871      127.904521      122.750407      113.305965      101.032183
       100.851041      96.3918084      4.21645048      4.25119695      2.19027808
       0.677844433      0.68404902      0.68404902      1.75173411      1.40729389
       0.0417879538      958.368397      940.872581      1.21649476      1.19884663
       0.000281612039  0.000226443991 1.30508583e-005 1.32523849e-005      1545.2763
       1516.85292      482.986991      486.711946      2.1659633      2.12616504
       2.16316504      1.01613104      1.60040925      2721.3413      2721.10681
       419.412594      515.482946      2709.90173      96.0703515      2205.85835
       475.40958      423.536934      422.775575      403.984819
KEY POINT #14 (t plus 12173.3923 s with a Mixing Number of 125.0495):  18.4248759
       0.040894         0.00925          0.3937     0.774667349     0.784433846
       1.00600622              1               1      16.1052489      56920.8484
       0.0594555237     0.054716488    0.0241999037 1.95006229e-006    0.0241999037
       97.1696482      127.352804      121.247218      112.565384      97.8907387
       97.1195014      75.7433818      4.21289976      4.24853588      2.18128374
       0.67660264     0.683819931     0.683819931      1.80810388      1.42565604
       0.0414649609      960.421446      942.097061      1.16405937      1.14412144
       0.000290386178  0.000229465407 1.29990272e-005 1.32370985e-005      1547.79965
       1519.14521      482.336649      486.719271      2.06639947      2.01921538
       2.05621538     0.915936017      1.56176135      2721.20514      2720.94576
       407.248512      509.087655      2707.74016      101.839143      2212.11748
       472.265744      410.285423      407.038613      317.229338
End
```

D.3 TEST #3 - T03_RCIC_STD_157KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T03_RCIC_STD_157kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1869.6379 s, and ending (KEY POINT #11) at t
       plus 8547.2479 s, for a time period of 6677.6099 s.
Original Data Record Time:  10624.0827 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2445.4389 s, T_bulk = 72.3374 C and T_out = 69.2204 C
Stratification Beginning SP12 Temperature = 71.8924 C
Stratification Beginning Pressure = 19.2092 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       6176.2003 s, T_bulk = 122.185 C and T_out = 80.2982 C
Stratification Ending SP12 Temperature = 121.8844 C
Stratification Ending Pressure = 48.0791 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1087.8182 s.
At t = 1087.8182 s, the pool pressure is 16.2342 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 54.6606, 54.7606, 56.7615, 54.3952, and
       51.9724 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 9.5434 +/- 2.5003 C.
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Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 8.7138 +/- 2.0978 C.
Minimum Steam Quality: 0.99337 at t plus 176.1021 s
Maximum Steam Quality: 1.0011 at t plus 2569.341 s
Time-Averaged Steam Quality: 0.99782 +/- 0.0010239
Minimum Turbine Outlet Steam Quality: 1.003 at t plus 6615.9084 s
Maximum Turbine Outlet Steam Quality: 1.0276 at t plus 2379.1381 s
Time-Averaged Turbine Outlet Steam Quality: 1.019 +/- 0.0066167
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 6587.6078 s; using 300 s smoothing
Max and min smoothed upper level changerates: 1.0663 degrees/min at t plus 3189.1514 s and 0.50493 degrees/min at t plus 2875.2465 s, respectively
Max and min smoothed mid (SP9) level changerates: 1.0573 degrees/min at t plus 3237.3522 s and 0.62261 degrees/min at t plus 6283.4024 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.19443 degrees/min at t plus 1985.7866 s and -0.241 degrees/min at t plus 2875.5455 s, respectively
Max and min smoothed lower level changerates: 1.4786 degrees/min at t plus 3815.9613 s and 0.094281 degrees/min at t plus 3327.9543 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.86976 degrees/min at t plus 3327.4533 s and -0.60293 degrees/min at t plus 3815.7623 s, respectively
Max and min smoothed outlet level changerates: 7.0042 degrees/min at t plus 6468.1059 s and -0.17395 degrees/min at t plus 3795.5621 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.6313 degrees/min at t plus 3815.3622 s and -6.3115 degrees/min at t plus 6468.705 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.553 degrees/min at t plus 1559.0252 s and 0.13839 degrees/min at t plus 2936.648 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.82583 degrees/min at t plus 1648.1263 s and -0.59259 degrees/min at t plus 2936.648 s, respectively
The mean steam flow rate was 65.8486 +/- 3.0439 g/s
The mean feedwater flow rate was 65.8823 +/- 9.1956 g/s
The mean water injection to steam flow rate was 0.0031783 +/- 0.036458 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 10.6358 +/- 0.8358 C over the Stratification Period, beginning at 11.8855 C and ending at 11.4474 C
Mean Smoothed SP8-Upper Pool delta T is 9.6111 +/- 0.73211 C over the Stratification Period, beginning at 10.6821 C and ending at 10.2441 C
The stratification period begins and ends with Smoothed SP8 readings of 84.4036 and 133.5181 C, respectively
The stratification period begins and ends with condensing flows of 1.035 and 2.1936 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 3.2797 and 2.9542 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2744.5577 +/- 1.5748 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.6876 and 18.3343 kg/s, respectively
The plume period had a mean steam enthalpy of 2745.8367 +/- 1.6447 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.6781 degrees C at t plus 2725.6439 s with T_upper = 77.9279 C and T_mid = 76.2498 C
At t plus 2725.6439 s, Smoothed SP8-SP9 is 12.7747 C and Smoothed SP8-Top is 11.0966 C, where Smoothed SP8 is 89.0245 C and Pool P = 20.1329 psia
Maximum Smoothed Top-Lower delta T is 6.7008 degrees C at t plus 3678.7604 s with T_upper = 90.9028 C and T_low = 84.202 C
At t plus 3678.7604 s, Smoothed SP8-SP9 is 10.1671 C and Smoothed SP8-Top is 9.1887 C, where Smoothed SP8 is 100.0914 C and Pool P = 24.992 psia
Maximum Smoothed Mid-Lower delta T is 5.7477 degrees C at t plus 3694.3553 s with T_mid = 90.1508 C and T_low = 84.4031 C
At t plus 3694.3553 s, Smoothed SP8-SP9 is 10.2035 C and Smoothed SP8-Top is 9.2788 C, where Smoothed SP8 is 100.3543 C and Pool P = 25.0879 psia
Maximum Smoothed Top-Outlet delta T is 43.0534 degrees C at t plus 6052.1992 s with T_upper = 122.2823 C and T_out = 79.2289 C
At t plus 6052.1992 s, Smoothed SP8-SP9 is 11.3286 C and Smoothed SP8-Top is 9.7474 C, where Smoothed SP8 is 132.0297 C and Pool P = 46.6739 psia
Maximum Smoothed Mid-Outlet delta T is 41.9165 degrees C at t plus 6135.4999 s with T_mid = 121.6639 C and T_out = 79.7474 C
At t plus 6135.4999 s, Smoothed SP8-SP9 is 10.9465 C and Smoothed SP8-Top is 9.9234 C, where Smoothed SP8 is 132.6104 C and Pool P = 47.6132 psia
Maximum Smoothed Lower-Outlet delta T is 41.9804 degrees C at t plus 6154.501 s with T_low = 121.9601 C and T_out = 79.9796 C

At t plus 6154.501 s, Smoothed SP8-SP9 is 11.1521 C and Smoothed SP8-Top is 10.0929 C, where Smoothed SP8 is 133.0235 C and Pool P = 47.8228 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 12.9716 degrees C at (KEY POINT #14) t plus 2669.2437 s with T_SP8 = 88.4751 C and T_SP9 = 75.5035 C and Pool P = 19.9292 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 11.8308 degrees C at t plus 2641.4711 s with T_SP8 = 87.9551 C and T_upper = 76.1242 C and Pool P = 19.8345 psia
Maximum Top-Mid delta T is 2.1445 degrees C at (KEY POINT #4) t plus 3106.8497 s ignoring SP 4, with temperatures of 82.8674 and 80.7229 C, respectively, at Set # 2, where Pool P = 21.7754 psia and T_outlet = 75.3324 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 3449.5553 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99976 C and a raw SP12 Reading of 86.4684 C.
Maximum Top-Lower delta T is 8.9259 degrees C at t plus 5260.3849 s, with temperatures of 113.4904 and 104.5645 C, respectively, at Set # 1, where Pool P = 38.2723 psia and T_outlet = 78.1327 C
Maximum Mid-Low delta T is 5.4803 degrees C at (KEY POINT #6) t plus 3805.0606 s ignoring SP 4, with temperatures of 91.8564 and 86.3762 C, respectively, at Set # 2, where Pool P = 25.7943 psia and T_outlet = 77.0472 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 5005.9813 s with a Smoothed Mid-Axis Mid-Low Delta T of 1.8263 C and a raw SP12 Reading of 108.6931 C.
Maximum Top-Outlet delta T is 43.7645 degrees C at t plus 6121.9001 s, with temperatures of 123.3603 and 79.5958 C, respectively, at Set # 1, where Pool P = 47.4626 psia
Maximum Mid-Outlet delta T is 41.9691 degrees C at t plus 6141.7003 s ignoring SP 4, with temperatures of 121.7249 and 79.7558 C, respectively, at Set # 2, where Pool P = 47.6681 psia
Maximum Lower-Outlet delta T is 43.1039 degrees C at (KEY POINT #8) t plus 6128.2005 s, with temperatures of 122.7634 and 79.6595 C, respectively, at Set # 1, where Pool P = 47.5188 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 6541.2061 s with a Smoothed Mid-Axis Low-Outlet Delta T of 14.3615 C and a raw SP12 Reading of 125.7854 C.
Minimum SP Pressure is 15.1197 psia at t plus 3.0012 s
Maximum SP Pressure is 54.3209 psia at t plus 6677.6099 s
Beginning SP Pressure is 15.1236 psia
Ending SP Pressure is 54.3209 psia
Time-Average SP Pressure is 27.2369 +/- 11.5335 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.4803 cm (cold) / 76.6011 cm (hot) at 14.6614 psia
Beginning Smoothed SP Level is 76.4544 cm (cold) / 76.6249 cm (hot) at 15.1256 psia
Ending Smoothed SP Level is 75.3066 cm (cold) / 76.8603 cm (hot) at 54.2807 psia
Minimum Smoothed Cold SP Level is 75.23 cm at t plus 6461.2076 s and 51.4663 psia
Minimum Smoothed Hot SP Level is 76.3754 cm at t plus 1119.518 s and 16.2771 psia
Maximum Smoothed Cold SP Level is 76.4544 cm at t plus 0 s and 15.1256 psia
Maximum Smoothed Hot SP Level is 76.8603 cm at t plus 6677.6099 s and 54.2807 psia
SP 12 Temperature at the beginning is 40.3721 C, and at the end is 127.344 C
At plume detection, the Mixing Number is 39.3712
The Mixing Number ranges from a minimum of 32.8326 at (KEY POINT #12) t plus 0 s to a maximum of 244.6429 at (KEY POINT #13) t plus 6677.6099 s; it had a mean value of 94.5084 +/- 60.4538 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool

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      Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
      Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
      Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
      Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
      Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
      Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 32.8326):  44.45715697        0.040894
      0.00925         0.3937     0.7645444334     0.7662493128      1.021496738
      1               1      71.42501977      136985.6705    0.06949097261
      0.05829777189    0.05839165072 -3.35227866e-007    0.05839165072      40.64740562
      126.727252      103.1744119      41.27567523      40.56635291      40.4214568
      37.64528885      4.178530783      4.220760891      2.090455176      0.629455079
      0.6790064352     0.6790064352      4.281386266      1.694561878    0.03810772194
      991.975184      956.0521556     0.6643062258     0.6224275734  0.0006449492585
      0.0002726092404 1.237787288e-005 1.327168726e-005      1532.426014
      1542.024491      473.8626944      489.753328      1.134586311      1.042875723
      1.079875723     0.0764314079    0.07901649333      2733.981454      2728.87992
      170.3354241      432.4999959      2680.554091      262.1645718      2301.481458
      172.9606689      169.9952384      169.3928835      157.7964957
KEY POINT #2 (t plus 1087.8182 s with a Mixing Number of 39.3712):  46.74300179
      0.040894         0.00925           0.3937     0.7610310003     0.7640678527
      1.023245013              1                1      70.28150504      142449.6568
      0.06713847375    0.05787353564    0.06139396264 2.001334565e-006    0.06139396264
      54.7605962      130.6875257      105.3537514      56.76149746      54.66055371
      54.39519899      51.97239649      4.180783563      4.223714257      2.09983104
      0.6456174127     0.6797926789     0.6797926789      3.275806228      1.656721278
      0.03846490139      985.8291053      954.4454734     0.7130938784     0.6651042191
      0.0005058663071   0.000266643747 1.245250587e-005 1.341883412e-005
      1550.057317      1539.746104      474.9461558      491.9930651      1.223899817
      1.119360808      1.156360808     0.1558150762     0.1714054988      2741.001413
      2736.061923      229.3251009      441.7082851      2683.94119      212.3831841
      2299.293128      237.6910933      228.9053987      227.7990104      217.6748042
KEY POINT #3 (t plus 2445.4389 s with a Mixing Number of 53.0731):  52.09388404
      0.040894         0.00925           0.3937     0.7616601133     0.7669129859
      1.023440139              1                1      67.98616653      156945.1232
      0.06403021805    0.0570059269    0.06842200646 4.754216195e-006    0.06842200646
      72.51803594      134.9852449      109.7772262      84.40355148      73.72149447
      72.83068442      69.28191302      4.189691092      4.230034258      2.12011983
      0.6616155537     0.6812125693     0.6812125693      2.47205555      1.584909902
      0.03922791118      976.342914      951.1194777     0.8210921042     0.7662956507
      0.0003903749382  0.0002552368328 1.260426217e-005 1.357370813e-005
      1557.897218      1534.703064      477.0948152      494.0944985      1.42306412
      1.324876319      1.361876319     0.3475885813     0.5652740411      2747.62984
      2743.007721      303.6514488      460.4201973      2690.728973      156.7687485
      2287.209643      353.5026752      308.692698      304.962844      290.1017527
KEY POINT #4 (t plus 3106.8497 s with a Mixing Number of 63.688):  50.68421931
      0.040894         0.00925           0.3937      0.757742679     0.7643108011
      1.021069599              1                1      59.34988308      152621.8533
      0.06253380263    0.0563658121    0.06657050141 2.881790241e-006    0.06657050141
      80.75799554      135.4007651      113.0129727      90.95896909      81.89980702
      80.70057296      75.2567058      4.196046508      4.23493907      2.13608295
      0.6675201431     0.6821037115     0.6821037115      2.206703835      1.536286421
      0.03981988967      971.3556753      948.6320332     0.9082054852     0.8540271818
      0.0003510493169  0.0002474431515 1.271546807e-005 1.358049597e-005
      1556.965813      1530.669102      478.6226023      493.8360496      1.585026419
      1.501499681      1.538499681     0.4888888945     0.7277758718      2745.945225
      2742.422817      338.2137397      474.1271125      2695.616917      135.9133729
      2271.818113      381.0660413      343.004056      337.9742229      315.1476092
KEY POINT #5 (t plus 3449.5553 s with a Mixing Number of 72.8553):  51.26459703
      0.040894         0.00925           0.3937     0.7566944695      0.764012636
      1.019897568              1                1      55.73736589      154064.7752
      0.0614855568    0.05590914161    0.06733279067 3.494004896e-006    0.06733279067
      86.42398186      136.2711778      115.3074648      96.56036014      87.3247286
      81.85379728      76.34362366      4.201236062      4.238564662      2.148003469
      0.6710489928     0.6826610134     0.6826610134      2.052149185      1.503650593
      0.04025780879      967.7266249      946.8405085     0.9744009555     0.9198005039
      0.0003277827342  0.0002421771801 1.279440976e-005 1.360735722e-005
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1554.840513 1527.636849 479.6829172 493.9993607 1.70880165
1.627899042 1.664899042 0.6117455533 0.8958553255 2746.225107
2743.118453 362.0128331 483.857161 2699.04167 121.8443279
2262.367946 404.6521669 365.7961584 342.8237309 319.7141489
KEY POINT #6 (t plus 3805.0606 s with a Mixing Number of 83.6055): 51.74712805
0.040894 0.00925 0.3937 0.756182663 0.7643272184
1.018613016 1 1 51.83232013 155151.5716
0.0604770775 0.05539388775 0.0679665645 4.350520548e-006 0.0679665645
91.79816411 137.3012319 117.882749 102.1521825 92.71302772
86.63746248 77.09783897 4.206773389 4.242782747 2.161996349
0.6740089052 0.6832134732 0.6832134732 1.922886109 1.468728513
0.040767902 964.1406186 944.8025745 1.05329277 0.9984202952
0.0003080846628 0.000236508718 1.28830837e-005 1.36392241e-005
1551.788744 1524.067462 480.8497907 494.1923263 1.857043868
1.778706343 1.815706343 0.7511380511 1.094588445 2746.628407
2743.941818 384.6173511 494.7886103 2702.843262 110.1712592
2251.839797 428.2369226 388.4651306 362.9229256 322.8884428
KEY POINT #7 (t plus 5005.9813 s with a Mixing Number of 135.5389): 52.18186199
0.040894 0.00925 0.3937 0.75621858 0.7675074262
1.013265484 1 1 38.44184736 155173.285
0.05723678458 0.05337413688 0.06853755991 4.893649213e-006 0.06853755991
108.6045161 141.1156567 127.8461739 118.5916717 109.6351462
107.1182444 78.05024085 4.22805103 4.260647399 2.222545719
0.6809253282 0.6846352846 0.6846352846 1.603271374 1.348806503
0.04293800339 952.0625002 936.6497795 1.408606361 1.357520291
0.0002582059864 0.0002167371381 1.322666703e-005 1.375188432e-005
1536.330998 1508.664187 485.126383 494.5436371 2.532994133
2.464610446 2.501610446 1.367837446 1.89964743 2747.499215
2746.02144 455.5394377 537.1951244 2717.103894 81.65568671
2210.304091 497.8423634 459.8965295 449.2583392 326.9370637
KEY POINT #8 (t plus 6128.2005 s with a Mixing Number of 203.6331): 50.39769459
0.040894 0.00925 0.3937 0.7540170605 0.7679887075
1.007481314 1 1 28.1878444 148946.7363
0.0546520603 0.05144079316 0.0661941694 5.168097216e-006 0.0661941694
121.5659852 144.3413081 137.2018108 132.5030047 122.592497
121.4549084 79.69085632 4.248797605 4.279819496 2.289129878
0.6839457009 0.6849587875 0.6849587875 1.421672689 1.254896261
0.04528298518 941.8926339 928.6091816 1.824580727 1.788062566
0.0002288522575 0.0002008384284 1.354968057e-005 1.383691495e-005
1518.929367 1492.0062 488.7861368 494.1055377 3.337826103
3.277281869 3.314281869 2.087194627 2.911151264 2746.69063
2745.896076 510.5292251 577.1977965 2729.791845 66.66857145
2169.492834 557.1100532 514.8904025 510.0585537 333.8829227
KEY POINT #9 (t plus 6176.2003 s with a Mixing Number of 207.0519): 50.22912624
0.040894 0.00925 0.3937 0.7537674572 0.7678566839
1.007014383 1 1 27.75994153 148499.7704
0.05454996775 0.05135835995 0.06597276558 4.081462731e-006 0.06597276558
122.0706752 144.2738438 137.5970359 133.5180795 123.2739319
122.2137843 80.42524476 4.249686933 4.28068411 2.292155225
0.6840240722 0.6849513055 0.6849513055 1.415486782 1.251274108
0.04538900002 941.482039 928.2613227 1.844110315 1.809522317
0.0002278349083 0.0002002160896 1.356332873e-005 1.383214184e-005
1518.163507 1491.257558 488.932975 493.9253971 3.375900397
3.315763064 3.352763064 2.120467653 2.999359788 2746.173291
2745.402677 512.6764514 578.8919549 2730.311794 66.21550345
2167.281337 561.4478286 517.7900127 513.2858903 336.9667753
KEY POINT #10 (t plus 6541.2061 s with a Mixing Number of 232.705): 50.0122673
0.040894 0.00925 0.3937 0.7525180501 0.767565761
1.005101376 1 1 25.36292152 147551.3269
0.05377488114 0.05072604026 0.06568793515 4.399974615e-006 0.06568793515
125.8853462 145.3914209 140.6191354 136.2002259 127.3316562
126.4962125 111.2730171 4.256617391 4.28744909 2.315861033
0.6845228969 0.684838091 0.684838091 1.370605422 1.224422746
0.04621890652 938.3434337 925.5794557 1.999059671 1.971997478
0.0002204122916 0.000195578144 1.366768871e-005 1.386095064e-005
1512.169001 1485.4154 490.0347414 493.6782601 3.678778217
3.620489487 3.657489487 2.386209555 3.242888959 2745.815148

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       2745.17187      528.9217242     591.8584595     2734.242761     62.93673532
       2153.956689     572.9333599     535.0789017     531.523521      466.9155592
KEY POINT #11 (t plus 6677.6099 s with a Mixing Number of 244.6429):  50.67704985
       0.040894        0.00925         0.3937     0.7530662534    0.7686028714
       1.004590928             1               1       24.89705353     149301.2138
       0.05345042976   0.05048464587   0.06656108479 5.784484202e-006    0.06656108479
       127.4734669     146.035546      141.7684685     137.6157713     128.8423165
       128.093888      122.3372651     4.2596166       4.290094498     2.325142272
       0.6846814085    0.6847691413    0.6847691413     1.352854629     1.214591517
       0.04654356902    937.0178074     924.5493162     2.060659443     2.035640638
       0.0002174548792   0.000193868641 1.370737618e-005 1.388057889e-005
       1509.564724     1483.139371     490.4439584     493.7257911     3.799557658
       3.742524598     3.779524598     2.504543433     3.377713952     2746.156124
       2745.53626      535.6924421     596.7954643     2735.716628     61.10302216
       2149.360659     578.9985853     541.5238442     538.3367807     513.8435572
KEY POINT #12 (t plus 0 s with a Mixing Number of 32.8326):  44.45715697         0.040894
       0.00925         0.3937     0.7645444334    0.7662493128    1.021496738
       1               1       71.42501977     136985.6705    0.06949097261
       0.05829777189   0.05839165072 -3.35227866e-007   0.05839165072    40.64740562
       126.727252      103.1744119     41.27567523     40.56635291     40.4214568
       37.64528885     4.178530783     4.220760891     2.090455176     0.629455079
       0.6790064352    0.6790064352    4.281386266     1.694561878    0.03810772194
       991.975184      956.0521556     0.6643062258     0.6224275734  0.0006449492585
       0.0002726092404 1.237787288e-005 1.327168726e-005      1532.426014
       1542.024491     473.8626944     489.753328      1.134586311     1.042875723
       1.079875723     0.0764314079    0.07901649333     2733.981454     2728.87992
       170.3354241     432.4999959     2680.554091     262.1645718     2301.481458
       172.9606689     169.9952384     169.3928835     157.7964957
KEY POINT #13 (t plus 6677.6099 s with a Mixing Number of 244.6429):  50.67704985
       0.040894        0.00925         0.3937     0.7530662534    0.7686028714
       1.004590928             1               1       24.89705353     149301.2138
       0.05345042976   0.05048464587   0.06656108479 5.784484202e-006    0.06656108479
       127.4734669     146.035546      141.7684685     137.6157713     128.8423165
       128.093888      122.3372651     4.2596166       4.290094498     2.325142272
       0.6846814085    0.6847691413    0.6847691413     1.352854629     1.214591517
       0.04654356902    937.0178074     924.5493162     2.060659443     2.035640638
       0.0002174548792   0.000193868641 1.370737618e-005 1.388057889e-005
       1509.564724     1483.139371     490.4439584     493.7257911     3.799557658
       3.742524598     3.779524598     2.504543433     3.377713952     2746.156124
       2745.53626      535.6924421     596.7954643     2735.716628     61.10302216
       2149.360659     578.9985853     541.5238442     538.3367807     513.8435572
KEY POINT #14 (t plus 2669.2437 s with a Mixing Number of 56.6651):  50.57188974
       0.040894        0.00925         0.3937     0.7600253188    0.7656385249
       1.022610007             1               1       64.03448581     152428.8767
       0.0634919205    0.0568324002    0.06642296367 2.277784566e-006    0.06642296367
       75.50352556     134.8908344     110.6566877     88.47510171     76.81459209
       75.64341276     70.99070421     4.191833765     4.231343531     2.124362354
       0.6638617744    0.681467031     0.681467031     2.369719358     1.571381752
       0.03938590761    974.5760457     950.4479358     0.8440676863     0.7897873048
       0.0003752930546  0.0002530744311  1.26344724e-005 1.356755297e-005
       1557.865356     1533.635061     477.5137842     493.8951837     1.465673045
       1.374448755     1.411448755     0.3941569399    0.6621467603    2746.537814
       2742.437399     316.1668913     464.1440213     2692.064109      147.97713
       2282.393793     370.6124693     321.6619546     316.7547323     297.2623747
End
```

D.4 TEST #4 - T04_RCIC_STD_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T04_RCIC_STD_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1721.1344 s, and ending (KEY POINT #11) at t
       plus 10637.7904 s, for a time period of 8916.656 s.
Original Data Record Time:  11590.724 s
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Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2678.6462 s, T_bulk = 65.2079 C and T_out = 62.5368 C
Stratification Beginning SP12 Temperature = 65.1796 C
Stratification Beginning Pressure = 17.4645 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       8051.2415 s, T_bulk = 115.4315 C and T_out = 73.8345 C
Stratification Ending SP12 Temperature = 115.3675 C
Stratification Ending Pressure = 41.4152 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 2016.8354 s.
At t = 2016.8354 s, the pool pressure is 16.4355 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 59.297, 59.4284, 61.4291, 59.2957, and 56.321
       C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 10.7153 +/- 2.4439 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.846 +/- 2.2417 C.
Minimum Steam Quality:  0.99488 at t plus 6.3004 s
Maximum Steam Quality:  1.0059 at t plus 1243.5221 s
Time-Averaged Steam Quality:  1.0015 +/- 0.0014775
Minimum Turbine Outlet Steam Quality:  1.0003 at t plus 8888.9555 s
Maximum Turbine Outlet Steam Quality:  1.0269 at t plus 1243.5221 s
Time-Averaged Turbine Outlet Steam Quality:  1.0166 +/- 0.0065728
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 8826.6569 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.82359 degrees/min at t plus 3634.1629 s
       and 0.33562 degrees/min at t plus 7201.9259 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.8436 degrees/min at t plus 3856.9686
       s and 0.39538 degrees/min at t plus 7744.1359 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.39545 degrees/min at t
       plus 3586.0621 s and -0.21489 degrees/min at t plus 3849.6672 s, respectively
Max and min smoothed lower level changerates:  3.3758 degrees/min at t plus 6273.3088 s
       and -0.010467 degrees/min at t plus 5121.79 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.69735 degrees/min at t
       plus 5121.3899 s and -2.8874 degrees/min at t plus 6284.5115 s, respectively
Max and min smoothed outlet level changerates:  8.0358 degrees/min at t plus 8357.8461 s
       and -0.024187 degrees/min at t plus 5361.5937 s, respectively
Max and min smoothed lower-outlet level changerate differences:  3.3129 degrees/min at t
       plus 6273.3088 s and -7.5257 degrees/min at t plus 8355.1469 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.2931 degrees/min at t plus 2402.0414
       s and 0.071089 degrees/min at t plus 8268.3439 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.76384 degrees/min
       at t plus 2402.5414 s and -0.4205 degrees/min at t plus 3756.0658 s, respectively
The mean steam flow rate was 45.3195 +/- 1.2552 g/s
The mean feedwater flow rate was 45.1489 +/- 3.8097 g/s
The mean water injection to steam flow rate was 0.0092897 +/- 0.036998 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.4647 +/- 1.1155 C over the
       Stratification Period, beginning at 7.5605 C and ending at 12.0327 C
Mean Smoothed SP8-Upper Pool delta T is 10.5088 +/- 1.1639 C over the Stratification
       Period, beginning at 7.2295 C and ending at 10.8785 C
The stratification period begins and ends with Smoothed SP8 readings of 73.2543 and
       127.6498 C, respectively
The stratification period begins and ends with condensing flows of 0.62296 and 1.4225
       kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 3.5097 and
       1.9911 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2736.939 +/- 0.89115 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.56225 and 13.574
       kg/s, respectively
The plume period had a mean steam enthalpy of 2737.8397 +/- 0.44888 kJ/kg.
Maximum Smoothed Top-Mid delta T is 2.4105 degrees C at t plus 3711.2643 s with T_upper =
       76.8628 C and T_mid = 74.4523 C
At t plus 3711.2643 s, Smoothed SP8-SP9 is 11.1711 C and Smoothed SP8-Top is 8.7606 C,
       where Smoothed SP8 is 85.6234 C and Pool P = 19.9646 psia
Maximum Smoothed Top-Lower delta T is 19.6247 degrees C at t plus 6010.7408 s with
       T_upper = 101.2917 C and T_low = 81.667 C
At t plus 6010.7408 s, Smoothed SP8-SP9 is 12.2069 C and Smoothed SP8-Top is 11.3904 C,
       where Smoothed SP8 is 112.6821 C and Pool P = 29.9824 psia
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Maximum Smoothed Mid-Lower delta T is 18.9971 degrees C at t plus 6044.5067 s with T_mid = 100.8166 C and T_low = 81.8195 C
At t plus 6044.5067 s, Smoothed SP8-SP9 is 11.9788 C and Smoothed SP8-Top is 11.3634 C, where Smoothed SP8 is 112.7954 C and Pool P = 30.1686 psia
Maximum Smoothed Top-Outlet delta T is 43.1262 degrees C at t plus 7969.5398 s with T_upper = 116.1395 C and T_out = 73.0133 C
At t plus 7969.5398 s, Smoothed SP8-SP9 is 12.1539 C and Smoothed SP8-Top is 11.0212 C, where Smoothed SP8 is 127.1607 C and Pool P = 40.9125 psia
Maximum Smoothed Mid-Outlet delta T is 42.061 degrees C at t plus 8017.2396 s with T_mid = 115.4865 C and T_out = 73.4255 C
At t plus 8017.2396 s, Smoothed SP8-SP9 is 11.9442 C and Smoothed SP8-Top is 10.9914 C, where Smoothed SP8 is 127.4307 C and Pool P = 41.1992 psia
Maximum Smoothed Lower-Outlet delta T is 42.2788 degrees C at t plus 8003.6398 s with T_low = 115.5709 C and T_out = 73.2921 C
At t plus 8003.6398 s, Smoothed SP8-SP9 is 12.0048 C and Smoothed SP8-Top is 10.9919 C, where Smoothed SP8 is 127.3376 C and Pool P = 41.1173 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 13.5417 degrees C at (KEY POINT #14) t plus 7113.6249 s with T_SP8 = 122.4688 C and T_SP9 = 108.9271 C and Pool P = 35.9401 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 12.5963 degrees C at t plus 7113.6249 s with T_SP8 = 122.4688 C and T_upper = 109.8725 C and Pool P = 35.9401 psia
Maximum Top-Mid delta T is 3.0644 degrees C at (KEY POINT #4) t plus 3624.5643 s ignoring SP 4, with temperatures of 76.5882 and 73.5238 C, respectively, at Set # 2, where Pool P = 19.7049 psia and T_outlet = 67.3603 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 4645.2817 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.0212 C and a raw SP12 Reading of 85.7181 C.
Maximum Top-Lower delta T is 22.445 degrees C at t plus 6218.5097 s, with temperatures of 102.8387 and 80.3937 C, respectively, at Set # 1, where Pool P = 31.1223 psia and T_outlet = 71.9789 C
Maximum Mid-Low delta T is 20.9285 degrees C at (KEY POINT #6) t plus 6229.0083 s ignoring SP 4, with temperatures of 102.3057 and 81.3772 C, respectively, at Set # 2, where Pool P = 31.1883 psia and T_outlet = 71.8474 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6370.8124 s with a Smoothed Mid-Axis Mid-Low Delta T of 6.9655 C and a raw SP12 Reading of 103.5519 C.
Maximum Top-Outlet delta T is 43.5091 degrees C at t plus 7968.3398 s, with temperatures of 116.4668 and 72.9576 C, respectively, at Set # 1, where Pool P = 40.8988 psia
Maximum Mid-Outlet delta T is 41.9109 degrees C at t plus 7975.5402 s ignoring SP 4, with temperatures of 114.86 and 72.9491 C, respectively, at Set # 2, where Pool P = 40.951 psia
Maximum Lower-Outlet delta T is 43.2682 degrees C at (KEY POINT #8) t plus 7991.5401 s, with temperatures of 116.4709 and 73.2027 C, respectively, at Set # 1, where Pool P = 41.0478 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 8405.2458 s with a Smoothed Mid-Axis Low-Outlet Delta T of 14.4199 C and a raw SP12 Reading of 117.9138 C.
Minimum SP Pressure is 14.7156 psia at t plus 15.7999 s
Maximum SP Pressure is 47.7972 psia at t plus 8916.656 s
Beginning SP Pressure is 14.7258 psia
Ending SP Pressure is 47.7972 psia
Time-Average SP Pressure is 25.6377 +/- 9.8652 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 75.149 cm (cold) / 75.2718 cm (hot) at 14.5991 psia
Beginning Smoothed SP Level is 75.2222 cm (cold) / 75.3836 cm (hot) at 14.7188 psia
Ending Smoothed SP Level is 84.1863 cm (cold) / 86.1615 cm (hot) at 47.7888 psia
Minimum Smoothed Cold SP Level is 75.1096 cm at t plus 629.01 s and 15.0644 psia
Minimum Smoothed Hot SP Level is 75.3114 cm at t plus 442.3073 s and 14.9476 psia
Maximum Smoothed Cold SP Level is 85.8062 cm at t plus 7085.2243 s and 35.7837 psia
Maximum Smoothed Hot SP Level is 87.4819 cm at t plus 7264.1275 s and 36.7636 psia
SP 12 Temperature at the beginning is 40.2491 C, and at the end is 122.0172 C
At plume detection, the Mixing Number is 43.1669
The Mixing Number ranges from a minimum of 32.2572 at (KEY POINT #12) t plus 0 s to a maximum of 255.7515 at (KEY POINT #13) t plus 8916.656 s; it had a mean value of 101.7014 +/- 65.3588 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1,

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        Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat
        Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,
        Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
        Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
        Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
        (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
        Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
        Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 32.2572):  34.40181538         0.040894
        0.00925          0.3937     0.7522216526     0.7538356888      1.020556529
        1                1      57.27315231      106633.2441    0.06952701765
        0.05852122721    0.04518459849 1.063212153e-005    0.04518459849      40.4260351
        124.6067033      102.0220533      41.00954586      40.42534979      40.22789524
        37.81728715      4.178538293      4.219241431      2.085656058     0.6291740867
        0.6785673353     0.6785673353       4.3009858      1.715271477    0.03792366743
        992.0584844      956.8931131     0.6396294303     0.6008034983   0.000647611347
        0.0002758617193  1.23384495e-005 1.319314487e-005       1532.05248
        1543.172896      473.2833033      488.5448809      1.089581454      1.014824369
        1.051824369    0.07553811317    0.07791241071      2728.307459      2725.027245
        169.4079371      427.6336913      2678.752065      258.2257542      2300.673768
        171.846159      169.4035685      168.5815964      158.5127097
KEY POINT #2 (t plus 2016.8354 s with a Mixing Number of 43.1669):  34.92123307
        0.040894         0.00925           0.3937     0.7637198724     0.7673177211
        1.022370601                1                1      52.60794133      106754.6615
        0.06633717182    0.05789917199    0.04586682062 1.036059291e-005    0.04586682062
        59.4283765      129.5986662      105.2223657      61.42908483      59.29701925
        59.29567379      56.32095298      4.182489254      4.223533235      2.099254486
        0.6502718707     0.6797469092     0.6797469092      3.025813938      1.658954783
        0.03844302561      983.5106873      954.5429359      0.710072415     0.6639514938
        0.0004704379545  0.0002669966882 1.244800381e-005 1.337711052e-005
        1553.536947      1539.88737      474.8812965      491.3118292      1.218356035
        1.133565949      1.170565949     0.1942402031     0.2130276744      2736.673344
        2733.905748      248.8450726      441.1529516      2683.737778      192.307879
        2295.520392      257.2138703      248.2942457      248.2915633      235.8555574
KEY POINT #3 (t plus 2678.6462 s with a Mixing Number of 48.9515):  34.83387524
        0.040894         0.00925           0.3937     0.7746214971      0.779223643
        1.022198815                1                1      50.21642406      106192.7673
        0.06524385091    0.05763756962    0.04575208167 7.243594906e-006    0.04575208167
        65.69376493      130.6504106      106.5612187      73.25431464      66.02483043
        65.63601417      62.49393146      4.185492826      4.225395863      2.105198932
        0.6560097956     0.6802035598     0.6802035598      2.736992128      1.636473814
        0.03866803798      980.1983043      953.5461753     0.7413546004     0.6937847703
        0.0004289802231  0.0002634392965 1.249389627e-005 1.341425156e-005
        1556.572572      1538.424595      475.5394436      491.7930094      1.275829729
        1.203945501      1.240945501     0.2582847625     0.3586180176      2738.030475
        2735.508786      275.0648305      446.8131219        2685.8058      171.7482914
        2291.217353      306.7266148      276.4491276      274.8246053      261.6799004
KEY POINT #4 (t plus 3624.5643 s with a Mixing Number of 59.493):  34.93264592
        0.040894         0.00925           0.3937     0.7953994066     0.8020127387
        1.020257726                1                1       45.2137879      106306.2565
        0.06378198893    0.05701084426    0.04588181068 6.512104765e-006    0.04588181068
        73.89781827      131.489335      109.7522791      85.99930331      75.47625293
        72.97017505      67.4294238      4.190655797      4.229997376      2.120000517
        0.6626696478     0.6812052172     0.6812052172      2.423793664       1.58529714
        0.03922346051      975.5308972      951.1384773     0.8204478518     0.7727201283
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      0.0003832752131  0.0002552986649 1.260340539e-005 1.343792614e-005
      1557.929276      1534.733048      477.0828903      491.8396249      1.421870485
      1.359230226      1.396230226      0.3684980549     0.6017214731     2737.917671
      2735.873384      309.4357568      460.3145838      2690.691029      150.8788269
      2277.603087      360.2077192      316.0499732      305.5500901      282.3482331
KEY POINT #5 (t plus 4645.2817 s with a Mixing Number of 81.2408):  34.92112247
      0.040894         0.00925          0.3937     0.8190119211      0.828250966
      1.017594645            1                1      38.90008026      105956.2387
      0.06163749197    0.05610772163    0.04586667536 9.802100608e-006    0.04586667536
      85.60790257      132.8739297      114.3111256      96.74004667       86.472661
      78.17109105      70.81145043      4.200450543      4.236975112      2.142764793
      0.6705661017     0.6824265802     0.6824265802     2.073171896      1.517640948
      0.04006576376     968.2571846      947.621253     0.9451932205     0.8979052274
      0.0003309642103  0.0002444381887 1.276012292e-005 1.347786974e-005
      1555.214835      1528.970836      479.2248698      491.9560525      1.65411637
      1.594827843      1.631827843      0.5926048434     0.9017390056      2738.0957
      2736.582484      358.5820237      479.6309925      2697.558831      121.0489688
      2258.464708      405.4065633      362.2134334      327.3706936      296.5295385
KEY POINT #6 (t plus 6229.0083 s with a Mixing Number of 137.9235):  34.75329138
      0.040894         0.00925          0.3937     0.8545270816     0.8689713752
      1.012140227            1                1      29.08765306      104850.0376
      0.05842805582    0.05429689137    0.04564623988 7.521363545e-006    0.04564623988
      102.5029149      135.6590304      123.3194877      115.0044135      103.133534
      89.09535659      71.88475847      4.219623583      4.252219229      2.19374485
      0.678814136     0.6841290414     0.6841290414      1.706503443      1.400478648
      0.04191213469     956.5931569     940.4064904      1.236836165      1.194974987
      0.0002745265394  0.0002253195482 1.307048472e-005 1.355460741e-005
      1542.920027      1515.970295      483.2309269      491.9364943      2.204662026
      2.150553579      2.187553579      1.108178404      1.692013842      2738.183049
      2737.336957      429.7445418      517.9051974      2710.715739      88.16065558
      2220.277851      482.6069751      432.4045148      373.2814169      301.0706533
KEY POINT #7 (t plus 6370.8124 s with a Mixing Number of 142.763):  34.55550981
      0.040894         0.00925          0.3937     0.8555736982     0.8704090631
      1.01163804             1                1      28.25422642      104215.0657
      0.05822015396    0.05414374541    0.04538646636 8.958663403e-006    0.04538646636
      103.5739645      135.8623059      124.0736408      116.1709322      104.367005
      97.51265443      72.0393395       4.2210432       4.253586647      2.198391619
      0.6792173666     0.6842294283     0.6842294283      1.68743126      1.391559939
      0.04207832679     955.8097495     939.7866875      1.264214688      1.223262321
      0.0002715282839  0.0002238455075 1.309649711e-005 1.355958477e-005
      1541.8416      1514.788173      483.5522627      491.8948769      2.256812451
      2.203031053      2.240031053      1.150544667      1.75738407      2738.08423
      2737.285928      434.2686266      521.1161509      2711.790771      86.84752438
      2216.968079      487.5554721      437.6152482      408.7089062      301.722479
KEY POINT #8 (t plus 7991.5401 s with a Mixing Number of 205.3155):  35.25266162
      0.040894         0.00925          0.3937     0.8545491691     0.8726889905
      1.00686591             1                1      22.60800895      105675.7284
      0.05592699423    0.0524881249     0.04630213096 1.068039694e-005    0.04630213096
      115.2179803      138.8443543      132.1546108      127.3980117      116.2705098
      115.3695778      73.19203933      4.238144568      4.269173936      2.252014138
      0.6827102144     0.6849042168     0.6849042168      1.504842452      1.303536968
      0.04397926731     946.9628101     932.9931443      1.589453642      1.559659382
      0.0002424106344   0.000209126632  1.33753981e-005 1.364194377e-005
      1528.005266      1501.249046      486.8553624      491.7737341      2.881365416
      2.829725527      2.866725527      1.703830436      2.498815276      2738.428411
      2737.917289      483.5606425      555.5935966      2723.035826      72.03295414
      2182.834815      535.3086623      488.0210915      484.2044374      306.6025861
KEY POINT #9 (t plus 8051.2415 s with a Mixing Number of 207.827):  35.20540065
      0.040894         0.00925          0.3937     0.8540015799     0.8721979013
      1.00671896             1                1      22.37746022      105498.2817
      0.05584735139    0.05242481555    0.04624005668   1.0692646e-005    0.04624005668
      115.6170491      138.9976133      132.4610877      127.6497742      116.771276
      115.8657729      73.75350182      4.238785684      4.269799808      2.254187739
      0.6828016163     0.6849155093     0.6849155093      1.499305715      1.300452701
      0.0440558161      946.6491522     932.7300266      1.602996852      1.573616544
      0.0002415145379  0.0002086046804 1.338597988e-005 1.364656969e-005
      1527.465631      1500.704762      486.9755299      491.7888471      2.907554438
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    2.85602991      2.89302991      1.726092028     2.517969354     2738.5098
    2738.00905      485.2539555     556.90385       2723.4521       71.6498945
    2181.60595      536.3829494     490.1463423     486.3095733     308.9572528
KEY POINT #10 (t plus 8405.2458 s with a Mixing Number of 225.698):  34.94308821
    0.040894        0.00925         0.3937      0.849664637     0.8685311569
    1.005289487             1               1       21.01984588     104657.0783
    0.05533662492   0.05204083332   0.04589552596 9.229719687e-006  0.04589552596
    118.1680825     139.4084348     134.3160722     129.2548024     119.3937725
    118.7195412     103.3680065     4.242976403     4.273644077     2.267564464
    0.6833415888    0.6849617792    0.6849617792    1.464914922     1.282152795
    0.04452629745    944.6273076     931.1289622     1.686962751     1.662719868
    0.0002359280832  0.0002054980818 1.345003082e-005 1.365376019e-005
    1523.914819     1497.363362     487.694802      491.4921922     3.070212789
    3.019526207     3.056526207     1.874096352     2.642904076     2737.828183
    2737.386349     496.0841327     564.8386593     2725.955152     68.7545266
    2172.989524     543.2342437     501.2847667     498.4254787     433.4646691
KEY POINT #11 (t plus 8916.656 s with a Mixing Number of 255.7515):  35.04922075
    0.040894        0.00925         0.3937      0.8418626439    0.8616154854
    1.003650211             1               1       19.37441085     104691.1598
    0.05452979159   0.05142895909   0.04603492431 9.012404901e-006  0.04603492431
    122.1703529     140.7152566     137.258567      132.6789999     123.6338255
    123.2272372     118.978596      4.249870726     4.279943377     2.289563268
    0.6840375006    0.6849578175    0.6849578175    1.414269088     1.254374494
    0.04529817388    941.3986284     928.5592682     1.827375008      1.80940121
    0.000227633534  0.0002007488277 1.355164051e-005 1.369077233e-005
    1518.004914     1491.898912     488.8072625     491.4340818     3.343272323
    3.29491943      3.33191943      2.127090052     2.926292478     2738.09877
    2737.723402     513.0986043     577.4410635     2729.866594     64.34245921
    2160.657707     557.8627244     519.3188957     517.5924596     499.5475351
KEY POINT #12 (t plus 0 s with a Mixing Number of 32.2572):  34.40181538        0.040894
    0.00925         0.3937     0.7522216526    0.7538356888    1.020556529
    1               1      57.27315231     106633.2441    0.06952701765
    0.05852122721   0.04518459849 1.063212153e-005    0.04518459849     40.4260351
    124.6067033     102.0220533     41.00954586     40.42534979     40.22789524
    37.81728715     4.178538293     4.219241431     2.085656058     0.6291740867
    0.6785673353    0.6785673353      4.3009858     1.715271477    0.03792366743
    992.0584844     956.8931131     0.6396294303    0.6008034983   0.000647611347
    0.0002758617193  1.23384495e-005 1.319314487e-005       1532.05248
    1543.172896     473.2833033     488.5448809     1.089581454     1.014824369
    1.051824369    0.07553811317   0.07791241071    2728.307459     2725.027245
    169.4079371     427.6336913     2678.752065     258.2257542     2300.673768
    171.846159      169.4035685     168.5815964     158.5127097
KEY POINT #13 (t plus 8916.656 s with a Mixing Number of 255.7515):  35.04922075
    0.040894        0.00925         0.3937      0.8418626439    0.8616154854
    1.003650211             1               1       19.37441085     104691.1598
    0.05452979159   0.05142895909   0.04603492431 9.012404901e-006  0.04603492431
    122.1703529     140.7152566     137.258567      132.6789999     123.6338255
    123.2272372     118.978596      4.249870726     4.279943377     2.289563268
    0.6840375006    0.6849578175    0.6849578175    1.414269088     1.254374494
    0.04529817388    941.3986284     928.5592682     1.827375008      1.80940121
    0.000227633534  0.0002007488277 1.355164051e-005 1.369077233e-005
    1518.004914     1491.898912     488.8072625     491.4340818     3.343272323
    3.29491943      3.33191943      2.127090052     2.926292478     2738.09877
    2737.723402     513.0986043     577.4410635     2729.866594     64.34245921
    2160.657707     557.8627244     519.3188957     517.5924596     499.5475351
KEY POINT #14 (t plus 7113.6249 s with a Mixing Number of 168.4359):  34.79428343
    0.040894        0.00925         0.3937      0.8580402853    0.8745200367
    1.009412978             1               1       25.38457855     104653.0809
    0.05717334687   0.05338016654   0.04570008033 6.330933059e-006  0.04570008033
    108.9270743     137.1877066     127.8167278     122.4687829     109.8724974
    107.4931699     72.25716339     4.228520776     4.260590843     2.222351265
    0.6810242178    0.6846327354    0.6846327354    1.598156455     1.349128592
    0.04293110763    951.8171674     936.6744992     1.407430088     1.370875765
    0.0002573910139  0.0002167909646 1.322565074e-005  1.35961351e-005
    1535.952154     1508.713333     485.1143128     491.8531995     2.530736843
    2.477954732     2.514954732     1.382848779     2.147018096     2738.227453
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       2737.583076       456.9042782       537.0695117       2717.062847       80.16523352
       2201.157941        514.310077       460.9014351       450.8438134       302.6573393
End
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D.5 TEST #5 - T05_SRV_STD_157KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T05_SRV_STD_157kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2283.0426 s, and ending (KEY POINT #11) at t
       plus 6993.515 s, for a time period of 4710.4724 s.
Original Data Record Time:  9615.556 s
No Bulk Pool to Outlet Thermal Stratification Detected (KEY POINT #3), 0 0 0 0 0 0.
No Bulk Pool to Outlet Destratification Detected (KEY POINT #9), 0 0 0 0 0 0.
No Plume detected, setting t_plume (KEY POINT #2) to the end at 4710.4724 s.
At t = 4710.4724 s, the pool pressure is 32.5391 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 105.7249, 106.8742, 106.4698, 105.2811, and
       102.8122 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were -0.40439 +/- 0 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 0.74496 +/- 0 C.
Minimum Steam Quality:  1.0089 at t plus 4709.8724 s
Maximum Steam Quality:  1.0217 at t plus 664.11 s
Time-Averaged Steam Quality:  1.017 +/- 0.0028703
SRV Alignment, no RCIC Turbine 0 0 0 0 0 0
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 4620.4713 s; using 300 s smoothing
Max and min smoothed upper level changerates:  1.1176 degrees/min at t plus 3715.9565 s
       and 0.69649 degrees/min at t plus 4138.4627 s, respectively
Max and min smoothed mid (SP9) level changerates:  1.3449 degrees/min at t plus 3650.9568
       s and 0.53674 degrees/min at t plus 4342.9674 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.25342 degrees/min at t
       plus 4343.6675 s and -0.30281 degrees/min at t plus 3565.5539 s, respectively
Max and min smoothed lower level changerates:  1.0132 degrees/min at t plus 384.807 s and
       0.58094 degrees/min at t plus 552.9086 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.63315 degrees/min at t
       plus 3650.9568 s and -0.38044 degrees/min at t plus 4505.9687 s, respectively
Max and min smoothed outlet level changerates:  1.0635 degrees/min at t plus 1267.9205 s
       and 0.7041 degrees/min at t plus 213.8042 s, respectively
Max and min smoothed lower-outlet level changerate differences:  0.2568 degrees/min at t
       plus 2236.8339 s and -0.22594 degrees/min at t plus 1358.9207 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.1427 degrees/min at t plus 3712.9564
       s and 0.663 degrees/min at t plus 4102.6637 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.45887 degrees/min
       at t plus 4342.9674 s and -0.33179 degrees/min at t plus 3945.0606 s,
       respectively
The mean steam flow rate was 66.4143 +/- 2.0659 g/s
The mean feedwater flow rate was 65.5882 +/- 3.517 g/s
The mean water injection to steam flow rate was 0.0027372 +/- 0.03749 g/s
No stratification; 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.
At plume detection, the condensing and condensing+cooling flows are 2.0687 and -93.0779
       kg/s, respectively
The plume period had a mean steam enthalpy of 2740.5797 +/- 0 kJ/kg.
Maximum Smoothed Top-Mid delta T is 0.78185 degrees C at t plus 3541.8546 s with T_upper
       = 89.7499 C and T_mid = 88.9681 C
At t plus 3541.8546 s, Smoothed SP8-SP9 is 0.83515 C and Smoothed SP8-Top is 0.053292 C,
       where Smoothed SP8 is 89.8032 C and Pool P = 24.2712 psia
Maximum Smoothed Top-Lower delta T is 1.6622 degrees C at t plus 4130.3633 s with T_upper
       = 98.4533 C and T_low = 96.7911 C
At t plus 4130.3633 s, Smoothed SP8-SP9 is -1.7152 C and Smoothed SP8-Top is -0.20891 C,
       where Smoothed SP8 is 98.2444 C and Pool P = 28.0202 psia
Maximum Smoothed Mid-Lower delta T is 3.1906 degrees C at t plus 4222.5665 s with T_mid =
       101.2668 C and T_low = 98.0762 C
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At t plus 4222.5665 s, Smoothed SP8-SP9 is -2.2607 C and Smoothed SP8-Top is -0.32095 C, where Smoothed SP8 is 99.0062 C and Pool P = 28.6706 psia
Maximum Smoothed Top-Outlet delta T is 3.6183 degrees C at t plus 3791.1588 s with T_upper = 94.1787 C and T_out = 90.5604 C
At t plus 3791.1588 s, Smoothed SP8-SP9 is -0.5268 C and Smoothed SP8-Top is -0.21835 C, where Smoothed SP8 is 93.9603 C and Pool P = 25.7636 psia
Maximum Smoothed Mid-Outlet delta T is 4.9228 degrees C at t plus 4128.0641 s with T_mid = 99.9653 C and T_out = 95.0425 C
At t plus 4128.0641 s, Smoothed SP8-SP9 is -1.7364 C and Smoothed SP8-Top is -0.19411 C, where Smoothed SP8 is 98.2288 C and Pool P = 27.9945 psia
Maximum Smoothed Lower-Outlet delta T is 3.7321 degrees C at t plus 2357.2368 s with T_low = 74.0511 C and T_out = 70.319 C
At t plus 2357.2368 s, Smoothed SP8-SP9 is -0.19088 C and Smoothed SP8-Top is -0.072027 C, where Smoothed SP8 is 72.8295 C and Pool P = 19.1811 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 0.83709 degrees C at (KEY POINT #14) t plus 3541.4546 s with T_SP8 = 89.8009 C and T_SP9 = 88.9638 C and Pool P = 24.2743 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 0.84595 degrees C at t plus 4681.9728 s with T_SP8 = 106.0622 C and T_upper = 105.2162 C and Pool P = 32.2835 psia
Maximum Top-Mid delta T is 2.5727 degrees C at (KEY POINT #4) t plus 4140.8628 s ignoring SP 4, with temperatures of 98.4093 and 95.8366 C, respectively, at Set # 2, where Pool P = 28.086 psia and T_outlet = 95.0966 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 4631.3719 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99936 C and a raw SP12 Reading of 102.7251 C.
Maximum Top-Lower delta T is 2.7721 degrees C at t plus 3907.5615 s, with temperatures of 96.4098 and 93.6377 C, respectively, at Set # 1, where Pool P = 26.4991 psia and T_outlet = 92.3452 C
Maximum Mid-Low delta T is 2.3395 degrees C at (KEY POINT #6) t plus 3943.0615 s ignoring SP 4, with temperatures of 95.6497 and 93.3102 C, respectively, at Set # 2, where Pool P = 26.7444 psia and T_outlet = 92.5376 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 3943.0615 s with a Smoothed Mid-Axis Mid-Low Delta T of 0.79846 C and a raw SP12 Reading of 95.6497 C.
Maximum Top-Outlet delta T is 4.5212 degrees C at t plus 3799.0583 s, with temperatures of 95.0318 and 90.5106 C, respectively, at Set # 1, where Pool P = 25.818 psia
Maximum Mid-Outlet delta T is 3.4159 degrees C at t plus 3206.2514 s ignoring SP 4, with temperatures of 85.5874 and 82.1715 C, respectively, at Set # 2, where Pool P = 22.5307 psia
Maximum Lower-Outlet delta T is 5.0378 degrees C at (KEY POINT #8) t plus 2533.0399 s, with temperatures of 77.6333 and 72.5955 C, respectively, at Set # 1, where Pool P = 19.7508 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 3342.0522 s with a Smoothed Mid-Axis Low-Outlet Delta T of 1.6785 C and a raw SP12 Reading of 86.378 C.
Minimum SP Pressure is 15.0498 psia at t plus 6.0014 s
Maximum SP Pressure is 32.5412 psia at t plus 4710.3724 s
Beginning SP Pressure is 15.053 psia
Ending SP Pressure is 32.5391 psia
Time-Average SP Pressure is 20.7278 +/- 4.9594 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 74.671 cm (cold) / 74.7459 cm (hot) at 14.7681 psia
Beginning Smoothed SP Level is 75.0613 cm (cold) / 75.2106 cm (hot) at 15.056 psia
Ending Smoothed SP Level is 82.5067 cm (cold) / 83.8763 cm (hot) at 32.5357 psia
Minimum Smoothed Cold SP Level is 75.0613 cm at t plus 0 s and 15.056 psia
Minimum Smoothed Hot SP Level is 75.2106 cm at t plus 0 s and 15.056 psia
Maximum Smoothed Cold SP Level is 82.5067 cm at t plus 4710.4724 s and 32.5357 psia
Maximum Smoothed Hot SP Level is 83.8763 cm at t plus 4710.4724 s and 32.5357 psia
SP 12 Temperature at the beginning is 40.3181 C, and at the end is 103.7826 C
At plume detection, the Mixing Number is 149.4012
The Mixing Number ranges from a minimum of 31.1574 at (KEY POINT #12) t plus 0 s to a maximum of 149.4012 at (KEY POINT #13) t plus 4710.4724 s; it had a mean value of 65.8746 +/- 32.9617 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,

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       Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
       Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
       Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
       (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
       Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
       Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
       Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
       Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
       Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
       Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
       Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
       Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
       Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
       Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
       Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
       Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
       Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
       Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 31.1574):  47.54424134         0.040894
       0.00925           0.3937     0.7506133521     0.7521064616      1.024438211
       1                1     83.92839407      146048.7934    0.06968941165
       0.05879519799    0.06244633988 3.044993839e-006    0.06244633988      39.42664906
       127.628845      100.6049258      39.17344169      39.28004953      40.50803044
       38.04103763      4.178550113      4.217412545      2.079900522      0.6279028921
       0.6780050525     0.6780050525      4.391199227      1.741431674     0.03770177697
       992.4365854      957.9190884      0.6103121585      0.5665133976  0.0006598572759
       0.0002799582589 1.229000858e-005 1.331249756e-005      1530.352222
       1544.530942      472.5647139      490.677592      1.036269744      1.038071277
       1.075071277      0.0716165664    0.07065138186      2738.674818      2731.630843
       165.234021      421.6518015      2676.525757      256.4177805      2317.023017
       164.1759801      164.6199373      169.7542085      159.4497483
KEY POINT #2 (t plus 4710.4724 s with a Mixing Number of 149.4012):  52.79278682
       0.040894          0.00925           0.3937     0.8250667473     0.8387634285
       1.013521767                1                1      44.59055455      158688.6305
       0.05757629867    0.05433400504    0.06933997085 4.075365052e-006    0.06933997085
       106.8742062      136.9111331      123.1365496      106.4698188      105.7248547
       105.2810707      102.8122458      4.225607371      4.251889708       2.1926267
       0.6803649513     0.6841037185     0.6841037185      1.631205396      1.402661442
       0.04187210046     953.3509838      940.5564721      1.230267464      1.184015094
       0.0002626403455  0.0002256798681 1.306417533e-005 1.360468117e-005
       1538.28092       1516.25491      483.1526471      492.826399      2.192160864
       2.243256817      2.280256817      1.28958277      1.27183639      2742.100312
       2740.111995      448.2095102      517.1264666      2710.454327      68.91695641
       2224.973846      446.500846      443.3524884      441.4806741      431.0614571
KEY POINT #3 (t plus 4710.4724 s with a Mixing Number of 149.4012):  52.79278682
       0.040894          0.00925           0.3937     0.8250667473     0.8387634285
       1.013521767                1                1      44.59055455      158688.6305
       0.05757629867    0.05433400504    0.06933997085 4.075365052e-006    0.06933997085
       106.8742062      136.9111331      123.1365496      106.4698188      105.7248547
       105.2810707      102.8122458      4.225607371      4.251889708       2.1926267
       0.6803649513     0.6841037185     0.6841037185      1.631205396      1.402661442
       0.04187210046     953.3509838      940.5564721      1.230267464      1.184015094
       0.0002626403455  0.0002256798681 1.306417533e-005 1.360468117e-005
       1538.28092       1516.25491      483.1526471      492.826399      2.192160864
       2.243256817      2.280256817      1.28958277      1.27183639      2742.100312
       2740.111995      448.2095102      517.1264666      2710.454327      68.91695641
       2224.973846      446.500846      443.3524884      441.4806741      431.0614571
KEY POINT #4 (t plus 4140.8628 s with a Mixing Number of 118.4471):  52.11513321
       0.040894          0.00925           0.3937     0.8144559701     0.8260306021
       1.016158952                1                1      51.00796889       157222.63
       0.05892830093     0.0552861249     0.0684499159 3.205348664e-006     0.0684499159
       99.91473021      135.2083189      118.4195748      98.27768585      98.57437509
       96.9716582      95.26911076      4.216317618      4.243682128      2.164996565
       0.677776608     0.6833189652     0.6833189652      1.754345042      1.461666867
       0.0408767653      958.4544402      944.3741549      1.070370661      1.021753557
       0.0002820124429   0.000235358036 1.290157657e-005 1.355527673e-005
       1545.366108      1523.301601      481.0899033      492.7048239      1.889232339
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      1.936399458      1.973399458      1.011097587     0.9534113086      2741.887487
      2739.285674      418.8116685      497.0687634      2703.629957      78.25709482
      2244.818724      411.9110555      413.1601559       406.40951       399.2423864
KEY POINT #5 (t plus 4631.3719 s with a Mixing Number of 141.1264):  52.58302094
      0.040894         0.00925          0.3937     0.8242110077     0.8376323304
      1.013894763            1                1      45.32355922      158136.6166
      0.05786229243    0.05446704956    0.0690644567 3.787425311e-006    0.0690644567
      105.4113601      136.6749286      122.4801908       105.350684      104.6201209
      104.1289876      101.9570451      4.223560409      4.250714402      2.188643847
      0.6798710961     0.6840097352     0.6840097352      1.655638935      1.410555943
      0.04172935634     954.4428619      941.0934094      1.206931014      1.160233341
      0.0002665099936  0.0002269816097 1.304153986e-005  1.35979263e-005
      1539.892751      1517.269182      482.870725       492.816656       2.147782884
      2.198324342      2.235324342      1.226337153      1.223770151      2742.070133
      2740.015908      442.0262975      514.3330018      2709.514382      72.30670434
      2227.737131      441.7700309      438.6836294      436.612595       427.4496449
KEY POINT #6 (t plus 3943.0615 s with a Mixing Number of 106.6984):  51.89367419
      0.040894         0.00925          0.3937     0.8087494557     0.8194334824
      1.017022921            1                1      53.37752382      156742.6625
      0.05950351797    0.05559916443    0.06815904354 5.128113214e-006    0.06815904354
      96.9188568      134.6550634      116.8584568      95.85216243      95.87126545
      94.48388725      92.53087467      4.212637394      4.241086008      2.15635199
      0.6764805712     0.6830029498     0.6830029498      1.813134486      1.482408596
      0.04056262489     960.5847953      945.6165739      1.021318454      0.9722739989
      0.000291159703  0.0002387335324 1.284780619e-005 1.353900641e-005
      1547.973324      1525.507972      480.3886419      492.6481364      1.796870921
      1.843925686      1.880925686     0.9076257829     0.8729753024      2741.82175
      2738.97259      406.1787011      490.4393639      2701.336659      84.26066277
      2251.382386      401.6857853      401.7649424      395.9259475      387.7098416
KEY POINT #7 (t plus 3943.0615 s with a Mixing Number of 106.6984):  51.89367419
      0.040894         0.00925          0.3937     0.8087494557     0.8194334824
      1.017022921            1                1      53.37752382      156742.6625
      0.05950351797    0.05559916443    0.06815904354 5.128113214e-006    0.06815904354
      96.9188568      134.6550634      116.8584568      95.85216243      95.87126545
      94.48388725      92.53087467      4.212637394      4.241086008      2.15635199
      0.6764805712     0.6830029498     0.6830029498      1.813134486      1.482408596
      0.04056262489     960.5847953      945.6165739      1.021318454      0.9722739989
      0.000291159703  0.0002387335324 1.284780619e-005 1.353900641e-005
      1547.973324      1525.507972      480.3886419      492.6481364      1.796870921
      1.843925686      1.880925686     0.9076257829     0.8729753024      2741.82175
      2738.97259      406.1787011      490.4393639      2701.336659      84.26066277
      2251.382386      401.6857853      401.7649424      395.9259475      387.7098416
KEY POINT #8 (t plus 2533.0399 s with a Mixing Number of 56.4897):  50.86911311
      0.040894         0.00925          0.3937     0.7670491235     0.7727829526
      1.022596251            1                1      71.29258427      154535.4238
      0.06354688101    0.05746005749    0.06681334768 3.472584229e-007    0.06681334768
      75.1998292      131.9270975      107.4673844      75.37922743      75.26905303
      76.56243922      72.88556452      4.191609008      4.226679237      2.109310365
      0.6636385136     0.6805003893     0.6805003893      2.379685076      1.621603114
      0.03882299255     974.7498859      952.8670327       0.76315577      0.7135297173
      0.000376764785   0.000261080032 1.252497593e-005 1.346125995e-005
      1557.883552      1537.405492      475.9813672      492.4799376      1.315982919
      1.361739251      1.398739251     0.3891918089     0.3921183795      2742.819756
      2737.737123      314.8928563      450.6455605       2687.19939      135.7527042
      2292.174195      315.6448356      315.1816468      320.6065329       305.19943
KEY POINT #9 (t plus 4710.4724 s with a Mixing Number of 149.4012):  52.79278682
      0.040894         0.00925          0.3937     0.8250667473     0.8387634285
      1.013521767            1                1      44.59055455      158688.6305
      0.05757629867    0.05433400504    0.06933997085 4.075365052e-006    0.06933997085
      106.8742062      136.9111331      123.1365496      106.4698188      105.7248547
      105.2810707      102.8122458      4.225607371      4.251889708       2.1926267
      0.6803649513     0.6841037185     0.6841037185      1.631205396      1.402661442
      0.04187210046     953.3509838      940.5564721      1.230267464      1.184015094
      0.0002626403455  0.0002256798681 1.306417533e-005 1.360468117e-005
      1538.28092       1516.25491      483.1526471       492.826399      2.192160864
      2.243256817      2.280256817       1.28958277       1.27183639      2742.100312
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    2740.111995     448.2095102     517.1264666     2710.454327     68.91695641
    2224.973846     446.500846      443.3524884     441.4806741     431.0614571
KEY POINT #10 (t plus 3342.0522 s with a Mixing Number of 77.2018):  51.91286615
    0.040894        0.00925         0.3937     0.7900475777     0.7983412379
    1.019641495          1               1      61.74788683      157261.1676
    0.06140255559   0.05649129865   0.06818425096 4.929869221e-006   0.06818425096
    86.86907812     133.2701251     112.3804627     86.8016403      86.75533771
    86.8464076     84.34237182     4.201680752     4.233961286     2.132885535
    0.6713061609    0.6819392307    0.6819392307     2.040765808     1.545546272
    0.03970184905    967.4257134     949.1218659    0.8906134961    0.8407837455
    0.0003260549149  0.0002489320436 1.269371842e-005 1.349935766e-005
    1554.617513     1531.480109     478.3269277     492.5587395     1.552231557
    1.599130461     1.636130461     0.6224009815     0.6207766505     2742.14691
    2738.334109     363.8806394     471.4464167     2694.666738     107.5657773
    2270.700494     363.5972894     363.4014172     363.7867907     353.272279
KEY POINT #11 (t plus 4710.4724 s with a Mixing Number of 149.4012):  52.79278682
    0.040894        0.00925         0.3937     0.8250667473     0.8387634285
    1.013521767          1               1      44.59055455      158688.6305
    0.05757629867   0.05433400504   0.06933997085 4.075365052e-006   0.06933997085
    106.8742062     136.9111331     123.1365496     106.4698188     105.7248547
    105.2810707     102.8122458     4.225607371     4.251889708      2.1926267
    0.6803649513    0.6841037185    0.6841037185     1.631205396     1.402661442
    0.04187210046    953.3509838     940.5564721     1.230267464     1.184015094
    0.0002626403455  0.0002256798681 1.306417533e-005 1.360468117e-005
    1538.28092      1516.25491      483.1526471     492.826399      2.192160864
    2.243256817     2.280256817      1.28958277      1.27183639     2742.100312
    2740.111995     448.2095102     517.1264666     2710.454327     68.91695641
    2224.973846     446.500846      443.3524884     441.4806741     431.0614571
KEY POINT #12 (t plus 0 s with a Mixing Number of 31.1574):  47.54424134        0.040894
    0.00925         0.3937     0.7506133521     0.7521064616     1.024438211
    1               1      83.92839407     146048.7934    0.06968941165
    0.05879519799   0.06244633988 3.044993839e-006   0.06244633988     39.42664906
    127.628845     100.6049258     39.17344169     39.28004953     40.50803044
    38.04103763     4.178550113     4.217412545     2.079900522     0.6279028921
    0.6780050525    0.6780050525     4.391199227     1.741431674    0.03770177697
    992.4365854     957.9190884    0.6103121585    0.5665133976  0.0006598572759
    0.0002799582589 1.229000858e-005 1.331249756e-005     1530.352222
    1544.530942     472.5647139     490.677592      1.036269744     1.038071277
    1.075071277    0.0716165664    0.07065138186     2738.674818     2731.630843
    165.234021     421.6518015     2676.525757     256.4177805     2317.023017
    164.1759801     164.6199373     169.7542085     159.4497483
KEY POINT #13 (t plus 4710.4724 s with a Mixing Number of 149.4012):  52.79278682
    0.040894        0.00925         0.3937     0.8250667473     0.8387634285
    1.013521767          1               1      44.59055455      158688.6305
    0.05757629867   0.05433400504   0.06933997085 4.075365052e-006   0.06933997085
    106.8742062     136.9111331     123.1365496     106.4698188     105.7248547
    105.2810707     102.8122458     4.225607371     4.251889708      2.1926267
    0.6803649513    0.6841037185    0.6841037185     1.631205396     1.402661442
    0.04187210046    953.3509838     940.5564721     1.230267464     1.184015094
    0.0002626403455  0.0002256798681 1.306417533e-005 1.360468117e-005
    1538.28092      1516.25491      483.1526471     492.826399      2.192160864
    2.243256817     2.280256817      1.28958277      1.27183639     2742.100312
    2740.111995     448.2095102     517.1264666     2710.454327     68.91695641
    2224.973846     446.500846      443.3524884     441.4806741     431.0614571
KEY POINT #14 (t plus 3541.4546 s with a Mixing Number of 82.059):  51.94271667
    0.040894        0.00925         0.3937     0.796075022     0.8050500203
    1.018812688          1               1      58.98946833     157209.2581
    0.06101065933   0.05621069089   0.06822345773 4.693175845e-006   0.06822345773
    88.96381937     133.6961586     113.7936472     89.80090978     89.74437531
    89.59501424     87.45537811     4.203782956     4.23615876      2.140081854
    0.6724930684    0.682300243     0.682300243      1.989045894     1.525016272
    0.03996716632    966.0407231     948.0250553    0.9303054679    0.8806027813
    0.0003181942528  0.0002456279455 1.274231976e-005 1.351157993e-005
    1553.515953     1529.653232     478.985529      492.5890744     1.626285214
    1.673286091     1.710286091    0.6746536415    0.6965335951     2742.017752
    2738.537994     372.6900333     477.4366641     2696.786065     104.7466308
    2264.581088     376.2093445     375.9703219     375.3450412     366.3549461
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End

D.6 TEST #6 - T06_RCIC_1ATM_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T06_RCIC_1ATM_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1599.5375 s, and ending (KEY POINT #11) at t
        plus 8065.6533 s, for a time period of 6466.1158 s.
Original Data Record Time:  9753.6069 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
        2493.7446 s, T_bulk = 63.412 C and T_out = 60.8315 C
Stratification Beginning SP12 Temperature = 63.1484 C
Stratification Beginning Pressure = 15.1555 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
        5339.3954 s, T_bulk = 89.5236 C and T_out = 69.9724 C
Stratification Ending SP12 Temperature = 89.4619 C
Stratification Ending Pressure = 15.181 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1918.9338 s.
At t = 1918.9338 s, the pool pressure is 15.1571 psia while the Smoothed Upper, Mid, SP8,
        Lower, and Outlet Temperatures are 58.6399, 58.5941, 60.5965, 58.3806, and
        55.4551 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
        temperatures were 7.8818 +/- 2.0516 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
        temperatures were 7.2439 +/- 1.7663 C.
Minimum Steam Quality:  0.99162 at t plus 94.3014 s
Maximum Steam Quality:  1.0031 at t plus 5586.8996 s
Time-Averaged Steam Quality:  0.99951 +/- 0.0015948
Minimum Turbine Outlet Steam Quality:  1.0143 at t plus 94.3014 s
Maximum Turbine Outlet Steam Quality:  1.0263 at t plus 5586.8996 s
Time-Averaged Turbine Outlet Steam Quality:  1.0222 +/- 0.0018929
Smoothed Changerates may not fully include test beginning and end periods, analysis
        ending at t plus 6376.1137 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.96096 degrees/min at t plus 3451.7614 s
        and 0.30004 degrees/min at t plus 3205.6574 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.75056 degrees/min at t plus
        3658.5653 s and 0.42427 degrees/min at t plus 5030.4897 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.39309 degrees/min at t
        plus 3403.2597 s and -0.23998 degrees/min at t plus 3209.1566 s, respectively
Max and min smoothed lower level changerates:  1.4287 degrees/min at t plus 4462.3792 s
        and 0.060317 degrees/min at t plus 3534.5632 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.65558 degrees/min at t
        plus 3535.8632 s and -0.84751 degrees/min at t plus 4462.5802 s, respectively
Max and min smoothed outlet level changerates:  4.7683 degrees/min at t plus 5506.398 s
        and -0.05232 degrees/min at t plus 4351.1779 s, respectively
Max and min smoothed lower-outlet level changerate differences:  1.4138 degrees/min at t
        plus 4461.9792 s and -4.2263 degrees/min at t plus 5510.7972 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.2455 degrees/min at t plus 2443.2437
        s and 0.066375 degrees/min at t plus 6093.6085 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.72779 degrees/min
        at t plus 2443.2437 s and -0.4286 degrees/min at t plus 6074.4074 s, respectively
The mean steam flow rate was 44.9518 +/- 1.3555 g/s
The mean feedwater flow rate was 43.7802 +/- 1.868 g/s
The mean water injection to steam flow rate was 0.01029 +/- 0.039484 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 8.7257 +/- 0.72648 C over the
        Stratification Period, beginning at 6.0436 C and ending at 9.6791 C
Mean Smoothed SP8-Upper Pool delta T is 7.9596 +/- 0.66496 C over the Stratification
        Period, beginning at 5.4626 C and ending at 9.0724 C
The stratification period begins and ends with Smoothed SP8 readings of 69.6529 and
        99.7966 C, respectively
The stratification period begins and ends with condensing flows of 0.63452 and 2.1519
        kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 4.261 and
        2.6272 kg/s, respectively.
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The stratification period had a mean sparger steam enthalpy of 2729.5634 +/- 0.65645 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.55711 and 12.9775 kg/s, respectively
The plume period had a mean steam enthalpy of 2732.1083 +/- 1.025 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.5269 degrees C at t plus 3550.3621 s with T_upper = 74.565 C and T_mid = 73.0381 C
At t plus 3550.3621 s, Smoothed SP8-SP9 is 9.4824 C and Smoothed SP8-Top is 7.9555 C, where Smoothed SP8 is 82.5205 C and Pool P = 15.1573 psia
Maximum Smoothed Top-Lower delta T is 6.6943 degrees C at t plus 4232.5961 s with T_upper = 81.3674 C and T_low = 74.6731 C
At t plus 4232.5961 s, Smoothed SP8-SP9 is 8.5001 C and Smoothed SP8-Top is 7.7335 C, where Smoothed SP8 is 89.101 C and Pool P = 15.1691 psia
Maximum Smoothed Mid-Lower delta T is 5.9296 degrees C at t plus 4232.1781 s with T_mid = 80.5969 C and T_low = 74.6673 C
At t plus 4232.1781 s, Smoothed SP8-SP9 is 8.4809 C and Smoothed SP8-Top is 7.7178 C, where Smoothed SP8 is 89.0778 C and Pool P = 15.1673 psia
Maximum Smoothed Top-Outlet delta T is 20.766 degrees C at t plus 5289.9936 s with T_upper = 90.436 C and T_out = 69.67 C
At t plus 5289.9936 s, Smoothed SP8-SP9 is 9.8309 C and Smoothed SP8-Top is 9.0926 C, where Smoothed SP8 is 99.5286 C and Pool P = 15.1808 psia
Maximum Smoothed Mid-Outlet delta T is 20.2587 degrees C at t plus 5395.0956 s with T_mid = 90.8427 C and T_out = 70.5839 C
At t plus 5395.0956 s, Smoothed SP8-SP9 is 9.375 C and Smoothed SP8-Top is 8.9039 C, where Smoothed SP8 is 100.2176 C and Pool P = 15.1956 psia
Maximum Smoothed Lower-Outlet delta T is 20.6483 degrees C at t plus 5395.5956 s with T_low = 91.2408 C and T_out = 70.5926 C
At t plus 5395.5956 s, Smoothed SP8-SP9 is 9.363 C and Smoothed SP8-Top is 8.893 C, where Smoothed SP8 is 100.2128 C and Pool P = 15.195 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 10.4338 degrees C at (KEY POINT #14) t plus 3127.2559 s with T_SP8 = 79.4793 C and T_SP9 = 69.0454 C and Pool P = 15.1563 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 9.5321 degrees C at t plus 3136.3554 s with T_SP8 = 79.4261 C and T_upper = 69.8939 C and Pool P = 15.1555 psia
Maximum Top-Mid delta T is 2.3688 degrees C at (KEY POINT #4) t plus 3569.0641 s ignoring SP 4, with temperatures of 75.3338 and 72.965 C, respectively, at Set # 2, where Pool P = 15.1694 psia and T_outlet = 67.1666 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 3966.5699 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99998 C and a raw SP12 Reading of 77.8254 C.
Maximum Top-Lower delta T is 8.9937 degrees C at t plus 4514.1802 s, with temperatures of 84.616 and 75.6223 C, respectively, at Set # 1, where Pool P = 15.1688 psia and T_outlet = 69.1517 C
Maximum Mid-Low delta T is 5.8648 degrees C at (KEY POINT #6) t plus 4193.1748 s ignoring SP 4, with temperatures of 80.2104 and 74.3457 C, respectively, at Set # 2, where Pool P = 15.17 psia and T_outlet = 69.1945 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 4695.5836 s with a Smoothed Mid-Axis Mid-Low Delta T of 1.9542 C and a raw SP12 Reading of 85.2056 C.
Maximum Top-Outlet delta T is 21.1036 degrees C at t plus 5315.694 s, with temperatures of 90.8701 and 69.7665 C, respectively, at Set # 1, where Pool P = 15.1828 psia
Maximum Mid-Outlet delta T is 19.7169 degrees C at t plus 5322.3954 s ignoring SP 4, with temperatures of 89.557 and 69.84 C, respectively, at Set # 2, where Pool P = 15.1831 psia
Maximum Lower-Outlet delta T is 21.028 degrees C at (KEY POINT #8) t plus 5257.9937 s, with temperatures of 90.5616 and 69.5336 C, respectively, at Set # 1, where Pool P = 15.1821 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 5539.1978 s with a Smoothed Mid-Axis Low-Outlet Delta T of 7.0017 C and a raw SP12 Reading of 90.9571 C.
Minimum SP Pressure is 14.7959 psia at t plus 6.2004 s
Maximum SP Pressure is 15.6309 psia at t plus 6465.0158 s
Beginning SP Pressure is 14.8049 psia
Ending SP Pressure is 15.6182 psia
Time-Average SP Pressure is 15.1743 +/- 0.10582 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 74.9717 cm (cold) / 75.1028 cm (hot) at 14.5875 psia
Beginning Smoothed SP Level is 75.3484 cm (cold) / 75.5116 cm (hot) at 14.8063 psia
Ending Smoothed SP Level is 75.3997 cm (cold) / 76.3364 cm (hot) at 15.6264 psia

Minimum Smoothed Cold SP Level is 75.1008 cm at t plus 5040.0893 s and 15.1765 psia
Minimum Smoothed Hot SP Level is 75.5034 cm at t plus 70.301 s and 14.8437 psia
Maximum Smoothed Cold SP Level is 75.4637 cm at t plus 602.6105 s and 15.1555 psia
Maximum Smoothed Hot SP Level is 76.3364 cm at t plus 6466.1158 s and 15.6264 psia
SP 12 Temperature at the beginning is 39.8306 C, and at the end is 99.2528 C
At plume detection, the Mixing Number is 42.0583
The Mixing Number ranges from a minimum of 32.6675 at (KEY POINT #12) t plus 0 s to a maximum of 339.06 at (KEY POINT #13) t plus 6466.1158 s; it had a mean value of 77.987 +/- 59.9332 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11

KEY POINT #1 (t plus 0 s with a Mixing Number of 32.6675): 33.61870469 0.040894
0.00925 0.3937 0.7534840865 0.7551155468 1.016568729
1 1 55.13415808 105535.6918 0.06948997517
0.05850248938 0.04415603236 1.30037419e-005 0.04415603236 40.65352911
120.2664974 102.1188035 41.08179104 40.5275699 40.42258324
38.16358448 4.178536186 4.219367887 2.086054846 0.6294616587
0.6786048255 0.6786048255 4.280823669 1.713513567 0.0379389945
991.970851 956.8227373 0.6416720905 0.6099413941 0.0006448704157
0.000275585966 1.234175832e-005 1.302690385e-005 1532.432611
1543.077992 473.3321193 485.7047149 1.09330231 1.020855477
1.057855477 0.07645624698 0.07821080753 2719.23734 2716.197565
170.3590631 428.0421877 2678.90365 257.6831246 2291.195152
172.1485713 169.8312334 169.3956408 159.9602884

KEY POINT #2 (t plus 1918.9338 s with a Mixing Number of 42.0583): 33.45125815
0.040894 0.00925 0.3937 0.7537078809 0.7570505922
1.020980174 1 1 53.8606921 103272.4104
0.06648122034 0.05831841176 0.04393610197 8.724162092e-006 0.04393610197
58.59412055 126.054289 103.0681018 60.59654989 58.63986414
58.38062962 55.4550783 4.182169612 4.220619497 2.090007905
0.6494597851 0.678966605 0.678966605 3.068143935 1.696451731
0.03809060441 983.93085 956.1299873 0.6619977253 0.6211932874
0.0004764598966 0.0002729063999 1.237423471e-005 1.324609104e-005
1552.979448 1542.13208 473.8094299 489.333797 1.130371167
1.04499655 1.08199655 0.1868339728 0.2050301651 2730.459643
2727.558669 245.3484843 432.0509805 2680.388163 186.7024962
2298.408662 253.7238059 245.5383592 244.4571567 232.2276902

KEY POINT #3 (t plus 2493.7446 s with a Mixing Number of 45.9298): 33.68444255
0.040894 0.00925 0.3937 0.7530948631 0.7569987348
1.02141015 1 1 54.73122245 103909.6369
0.06560982779 0.05836399032 0.04424237487 1.154103052e-005 0.04424237487
63.60934281 126.313333 102.8332465 69.65293169 64.1903773
63.49384354 60.94127534 4.184431795 4.220308015 2.089023095
0.6541578791 0.6788781255 0.6788781255 2.827767606 1.700641516
0.03805288878 981.3195405 956.3017498 0.6569210442 0.6156125871

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      0.0004420687324  0.0002735649437 1.236619828e-005 1.325662984e-005
      1555.740417      1542.368578      473.6916256      489.534141      1.121105112
      1.044972593      1.081972593      0.2352397427     0.3073525482     2731.167499
      2728.171993      266.3284342      431.0590927      2680.021373     164.7306585
      2300.108407      291.6273889      268.7584065      265.8466366     255.1710969
KEY POINT #4 (t plus 3569.0641 s with a Mixing Number of 56.7012):  34.85513898
      0.040894         0.00925          0.3937     0.7521688828     0.7574785317
      1.022208004            1                1      57.09371824      107291.888
      0.06389554859    0.05839787366    0.04578001024 1.043834163e-005    0.04578001024
      73.26725229      127.0386625      102.6585705      82.15160653     74.69531829
      72.01815678      67.07823504      4.190275291      4.22007713      2.088293553
      0.6621755194     0.6788118816     0.6788118816     2.445683516     1.703770991
      0.03802492611     975.889492      956.4293394     0.6531658099     0.6106291096
      0.0003864833787  0.0002740566004 1.236022187e-005 1.328493775e-005
      1557.870333      1542.543421      473.6038871      490.0258855     1.114254166
      1.045374669      1.082374669     0.3588144316     0.5169964432     2732.963342
      2729.703649      306.7679731      430.3214161      2679.748366      123.553443
      2302.641926      344.0261592      312.7513202      301.5359269     280.8521765
KEY POINT #5 (t plus 3966.5699 s with a Mixing Number of 64.8484):  34.96515093
      0.040894         0.00925          0.3937     0.7519153274     0.7577651514
      1.022146017            1                1      57.23322137     107647.9383
      0.06305193824    0.05839493091    0.04592450394 9.267380662e-006    0.04592450394
      77.92571556      126.9837462      102.6737438      86.57575871     78.77495782
      73.44954442      68.50865109      4.19378925      4.22009716      2.088356827
      0.6655743347     0.6788176507     0.6788176507      2.29205247      1.703498696
      0.03802735211     973.0908454      956.4182616     0.6534913156     0.6110473239
      0.0003637596471  0.0002740138293 1.236074098e-005 1.328278929e-005
      1557.511258      1542.528269      473.6115126      489.9884393     1.114847902
      1.045904264      1.082904264     0.4357009338     0.6153617654     2732.862684
      2729.587042      326.2962707      430.3854931      2679.772088     104.0892224
      2302.477191      362.6050211      329.8567486      307.5333403     286.8409587
KEY POINT #6 (t plus 4193.1748 s with a Mixing Number of 70.0039):  34.99259878
      0.040894         0.00925          0.3937     0.7517180741     0.7578512293
      1.022360935            1                1      57.3155004      107657.5204
      0.06263106329    0.05839467626    0.04596055494 1.215585658e-005    0.04596055494
      80.22797372      127.2242593      102.6750568      88.67529704     80.86306193
      74.38103294      69.17260048      4.195692773      4.220098893     2.088362303
      0.6671445102     0.6788181497     0.6788181497     2.222279991     1.703475138
      0.03802756206     971.6662224      956.417303     0.6535194885     0.6106873975
      0.0003533580689  0.0002740101288 1.236078591e-005 1.329203319e-005
      1557.021773      1542.526957      473.6121725      490.1430529     1.114899291
      1.045870676      1.082870676     0.478541111     0.6672463991     2733.357516
      2730.07245      335.9536255      430.3910378      2679.77414      94.43741239
      2302.966478      371.4284606      338.6170838      311.4369582     289.6211384
KEY POINT #7 (t plus 4695.5836 s with a Mixing Number of 85.5049):  35.0999542
      0.040894         0.00925          0.3937     0.7513841272     0.7582466336
      1.022493344            1                1      57.49639955     107939.7222
      0.06171630615    0.05839321068    0.04610155947 9.817189291e-006    0.04610155947
      85.18389499      127.3787229      102.6826134      93.78764876     85.98766825
      83.05586048      69.38512022      4.20016547      4.22010887      2.088393822
      0.6702831646     0.6788210217     0.6788210217      2.08432122      1.703339566
      0.03802877049     968.5087162      956.4117857     0.6536816508     0.6106022099
      0.0003326262818   0.000273988833 1.236104444e-005 1.329795462e-005
      1555.298702      1542.519408      473.6159698      490.241374      1.115195091
      1.046142706      1.083142706     0.5828593551     0.8090277951     2733.687485
      2730.381649      356.7580465      430.4229494      2679.785954     73.66490296
      2303.264536      392.932797      360.1330076      347.8234947     290.5111107
KEY POINT #8 (t plus 5257.9937 s with a Mixing Number of 107.9094):  35.2597335
      0.040894         0.00925          0.3937     0.7510906657     0.7585561098
      1.022469635            1                1      57.69857671     108431.0911
      0.06090789267    0.05838729727    0.04631141943 1.203898719e-005    0.04631141943
      89.51128175      127.3806203      102.7131017      98.94114857     90.24512486
      89.57608434      69.60450552      4.204491708      4.220149137     2.088521038
      0.6727588085     0.6788326019     0.6788326019     1.976055595     1.702792796
      0.03803364752     965.6525158      956.3895225     0.6543362554     0.6112611702
      0.0003161877582  0.0002739029419 1.236208754e-005  1.32979529e-005
      1553.077594      1542.488934      473.6312888      490.2384031     1.116389203
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    1.046972782      1.083972782      0.688897302      0.9764525467      2733.703283
    2730.374157      374.9430744      430.551703      2679.833613      55.60862864
    2303.15158      414.6403209      378.0274807      375.216933      291.4299087
KEY POINT #9 (t plus 5339.3954 s with a Mixing Number of 112.1973):  35.25567187
    0.040894         0.00925          0.3937     0.7511954324       0.75873113
    1.02250456              1               1      57.67630645      108402.9345
    0.06079392943    0.0583848113    0.04630608473 1.437555777e-005    0.04630608473
    90.11750747      127.4314054      102.7259183      99.79659508      90.72415477
    90.09711114      69.97792266      4.20512923      4.220166071      2.08857454
    0.6730861886     0.6788374666     0.6788374666      1.961713226      1.70256305
    0.0380356984      965.24515      956.3801624      0.6546115947     0.6114576163
    0.0003139979786  0.0002738668498 1.236252604e-005  1.32998747e-005
    1552.714991      1542.476115      473.6377276      490.2693031      1.116891495
    1.047370107      1.084370107     0.7049615784      1.006840251      2733.798535
    2730.471978      377.4921695      430.6058283      2679.853647      53.11365884
    2303.192706      418.2467698      380.0420831      377.4077928      292.9937872
KEY POINT #10 (t plus 5539.1978 s with a Mixing Number of 129.8136):  35.2706178
    0.040894         0.00925          0.3937     0.7513709795     0.7591961707
    1.022353578              1               1      57.57518572      108487.8471
    0.06041295463    0.05837495693    0.04632571526 1.187598661e-005    0.04632571526
    92.13743023      127.3104675      102.776719      100.9247491      92.50645738
    92.55809907      83.96140689      4.207309496      4.220233225      2.088786734
    0.6741428818     0.6788567289     0.6788567289      1.915293874      1.701653012
    0.03804383142     963.8751112      956.3430545     0.6557038816     0.6127580707
    0.0003068901237  0.0002737238764 1.236426416e-005 1.329509879e-005
    1551.417776      1542.425258      473.6632435      490.1845114      1.118884257
    1.049351473      1.086351473     0.7607584011      1.048108636      2733.523662
    2730.20876      385.988547      430.8203662      2679.933043      44.83181918
    2302.703296      423.0044448      387.539928      387.7599112      351.629311
KEY POINT #11 (t plus 6466.1158 s with a Mixing Number of 339.06):  35.97569466
    0.040894         0.00925          0.3937     0.7539972924     0.7633644226
    1.022374924              1               1      57.3638417      110452.1493
    0.05894224473    0.05823659944    0.04725178892 1.136963162e-005    0.04725178892
    99.84236027      127.9957525      103.4893393      103.0199205      99.91495031
    99.92173244      96.34699752      4.216424056      4.221181203      2.091785599
    0.6776988425     0.679123618      0.679123618      1.755841693      1.688987857
    0.03815859551     958.4731683      955.8212934     0.6711833089     0.6273002295
    0.0002822135219  0.0002717323632 1.238865181e-005 1.331970511e-005
    1545.256895      1541.703826      474.0202583      490.5264999      1.147149309
    1.077405201      1.114405201      1.008487765      1.128465065      2734.617122
    2731.326512      418.441991      433.8302292      2681.045248      15.38823823
    2300.786893      2680.500638      418.7467874      418.7780137      403.7164348
KEY POINT #12 (t plus 0 s with a Mixing Number of 32.6675):  33.61870469         0.040894
    0.00925          0.3937     0.7534840865     0.7551155468      1.016568729
    1                1      55.13415808      105535.6918    0.06948997517
    0.05850248938    0.04415603236  1.30037419e-005    0.04415603236      40.65352911
    120.2664974      102.1188035      41.08179104      40.5275699      40.42258324
    38.16358448      4.178536186      4.219367887      2.086054846     0.6294616587
    0.6786048255     0.6786048255      4.280823669      1.713513567      0.0379389945
    991.970851      956.8227373     0.6416720905     0.6099413941  0.0006448704157
    0.000275585966 1.234175832e-005 1.302690385e-005      1532.432611
    1543.077992      473.3321193      485.7047149      1.09330231      1.020855477
    1.057855477    0.07645624698    0.07821080753      2719.23734      2716.197565
    170.3590631      428.0421877      2678.90365      257.6831246      2291.195152
    172.1485713      169.8312334      169.3956408      159.9602884
KEY POINT #13 (t plus 6466.1158 s with a Mixing Number of 339.06):  35.97569466
    0.040894         0.00925          0.3937     0.7539972924     0.7633644226
    1.022374924              1               1      57.3638417      110452.1493
    0.05894224473    0.05823659944    0.04725178892 1.136963162e-005    0.04725178892
    99.84236027      127.9957525      103.4893393      103.0199205      99.91495031
    99.92173244      96.34699752      4.216424056      4.221181203      2.091785599
    0.6776988425     0.679123618      0.679123618      1.755841693      1.688987857
    0.03815859551     958.4731683      955.8212934     0.6711833089     0.6273002295
    0.0002822135219  0.0002717323632 1.238865181e-005 1.331970511e-005
    1545.256895      1541.703826      474.0202583      490.5264999      1.147149309
    1.077405201      1.114405201      1.008487765      1.128465065      2734.617122
```

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        2731.326512       418.441991      433.8302292      2681.045248      15.38823823
        2300.786893      2680.500638      418.7467874      418.7780137      403.7164348
KEY POINT #14 (t plus 3127.2559 s with a Mixing Number of 51.324):  34.21651105
        0.040894          0.00925           0.3937     0.7525615571     0.7572260426
        1.021783813              1                1      55.96267997      105468.0082
        0.06465073079    0.05839631101    0.04494121303 1.022471405e-005    0.04494121303
        69.04542817      126.5739472      102.6666278       79.4792623      69.96616991
        69.900613      64.41381573      4.187481144      4.220087766       2.08832715
        0.6588343493     0.6788149454     0.6788149454      2.601114413      1.703626386
        0.03802621429      978.3262467       956.423457     0.6533386437      0.611555697
        0.0004092444748  0.0002740338866 1.236049753e-005  1.32670563e-005
        1557.433417      1542.535375      473.6079365      489.7254432      1.114569419
        1.044979033      1.081979033     0.2993478644     0.4642375266      2731.893413
        2728.761592      289.0833655      430.3554423      2679.760963      141.2720768
        2301.537971      332.8124276       292.937828      292.6661358      269.7000898
End
```

D.7 TEST #7 -

T07_RCIC_040GPM_1ATM_107KW_RESULTS_RCICLAND.TXT

```
Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T07_RCIC_040GPM_1ATM_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1060.8267 s, and ending (KEY POINT #11) at t
        plus 6992.932 s, for a time period of 5932.1053 s.
Original Data Record Time:  9933.5122 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
        2306.6409 s, T_bulk = 62.4304 C and T_out = 59.8726 C
Stratification Beginning SP12 Temperature = 62.3943 C
Stratification Beginning Pressure = 15.2119 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
        5115.3906 s, T_bulk = 87.477 C and T_out = 75.872 C
Stratification Ending SP12 Temperature = 87.3474 C
Stratification Ending Pressure = 15.2371 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1577.3292 s.
At t = 1577.3292 s, the pool pressure is 15.2115 psia while the Smoothed Upper, Mid, SP8,
        Lower, and Outlet Temperatures are 55.7306, 55.8196, 57.8205, 55.5877, and
        53.5748 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
        temperatures were 7.5076 +/- 1.9013 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
        temperatures were 7.0083 +/- 1.6631 C.
Minimum Steam Quality:  0.51464 at t plus 430.4086 s
Maximum Steam Quality:  0.69599 at t plus 5886.9037 s
Time-Averaged Steam Quality:  0.5947 +/- 0.028316
Minimum Turbine Outlet Steam Quality:  0.56058 at t plus 430.4086 s
Maximum Turbine Outlet Steam Quality:  0.73594 at t plus 5886.9037 s
Time-Averaged Turbine Outlet Steam Quality:  0.63837 +/- 0.027843
Smoothed Changerates may not fully include test beginning and end periods, analysis
        ending at t plus 5842.1031 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.76703 degrees/min at t plus 2.9012 s and
        0.35867 degrees/min at t plus 5572.4977 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.74181 degrees/min at t plus 0 s and
        0.4422 degrees/min at t plus 5008.5895 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.1515 degrees/min at t
        plus 4918.4873 s and -0.32795 degrees/min at t plus 5520.8978 s, respectively
Max and min smoothed lower level changerates:  1.0368 degrees/min at t plus 5185.4916 s
        and 0.21497 degrees/min at t plus 3813.4911 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.41708 degrees/min at t
        plus 3813.4911 s and -0.54314 degrees/min at t plus 5185.4916 s, respectively
Max and min smoothed outlet level changerates:  3.003 degrees/min at t plus 5245.093 s
        and 0.044062 degrees/min at t plus 4669.0831 s, respectively
```

Max and min smoothed lower-outlet level changerate differences: 0.79912 degrees/min at t plus 4664.1818 s and -2.0592 degrees/min at t plus 5238.8166 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.0569 degrees/min at t plus 2182.5398 s and 0.19047 degrees/min at t plus 5801.6018 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.56343 degrees/min at t plus 2182.5398 s and -0.44703 degrees/min at t plus 5501.0976 s, respectively
The mean steam flow rate was 45.4318 +/- 2.288 g/s
The mean feedwater flow rate was 43.9783 +/- 6.5187 g/s
The mean water injection to steam flow rate was 24.4514 +/- 1.938 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 8.398 +/- 0.5925 C over the Stratification Period, beginning at 6.4057 C and ending at 9.6157 C
Mean Smoothed SP8-Upper Pool delta T is 7.7858 +/- 0.49303 C over the Stratification Period, beginning at 6.3481 C and ending at 8.6376 C
The stratification period begins and ends with Smoothed SP8 readings of 68.5801 and 97.0486 C, respectively
The stratification period begins and ends with condensing flows of 0.58206 and 1.7117 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 3.9852 and 2.6253 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1853.8155 +/- 31.3013 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.49165 and 12.8538 kg/s, respectively
The plume period had a mean steam enthalpy of 1855.171 +/- 28.7074 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.6167 degrees C at t plus 5399.2958 s with T_upper = 91.4565 C and T_mid = 89.8397 C
At t plus 5399.2958 s, Smoothed SP8-SP9 is 9.6572 C and Smoothed SP8-Top is 8.0405 C, where Smoothed SP8 is 99.4969 C and Pool P = 15.2537 psia
Maximum Smoothed Top-Lower delta T is 3.516 degrees C at t plus 4330.1777 s with T_upper = 81.6498 C and T_low = 78.1338 C
At t plus 4330.1777 s, Smoothed SP8-SP9 is 8.4271 C and Smoothed SP8-Top is 7.6149 C, where Smoothed SP8 is 89.2647 C and Pool P = 15.2228 psia
Maximum Smoothed Mid-Lower delta T is 2.8565 degrees C at t plus 4493.78 s with T_mid = 82.3186 C and T_low = 79.4621 C
At t plus 4493.78 s, Smoothed SP8-SP9 is 8.3456 C and Smoothed SP8-Top is 7.8892 C, where Smoothed SP8 is 90.6643 C and Pool P = 15.2244 psia
Maximum Smoothed Top-Outlet delta T is 12.7765 degrees C at t plus 5041.0883 s with T_upper = 87.993 C and T_out = 75.2165 C
At t plus 5041.0883 s, Smoothed SP8-SP9 is 9.5834 C and Smoothed SP8-Top is 8.5166 C, where Smoothed SP8 is 96.5096 C and Pool P = 15.2369 psia
Maximum Smoothed Mid-Outlet delta T is 11.794 degrees C at t plus 5004.2892 s with T_mid = 86.5799 C and T_out = 74.7859 C
At t plus 5004.2892 s, Smoothed SP8-SP9 is 9.6996 C and Smoothed SP8-Top is 8.8064 C, where Smoothed SP8 is 96.2795 C and Pool P = 15.2373 psia
Maximum Smoothed Lower-Outlet delta T is 11.5539 degrees C at t plus 5003.4892 s with T_low = 86.3334 C and T_out = 74.7795 C
At t plus 5003.4892 s, Smoothed SP8-SP9 is 9.7073 C and Smoothed SP8-Top is 8.8108 C, where Smoothed SP8 is 96.2799 C and Pool P = 15.2359 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 9.827 degrees C at (KEY POINT #14) t plus 5224.0168 s with T_SP8 = 98.1009 C and T_SP9 = 88.2739 C and Pool P = 15.2371 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 9.0174 degrees C at t plus 4980.2878 s with T_SP8 = 96.188 C and T_upper = 87.1706 C and Pool P = 15.2362 psia
Maximum Top-Mid delta T is 1.9252 degrees C at (KEY POINT #4) t plus 2874.8504 s ignoring SP 4, with temperatures of 68.4544 and 66.5292 C, respectively, at Set # 2, where Pool P = 15.2104 psia and T_outlet = 63.9168 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 2899.0508 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99986 C and a raw SP12 Reading of 66.8159 C.
Maximum Top-Lower delta T is 5.4951 degrees C at t plus 4646.0817 s, with temperatures of 83.8844 and 78.3893 C, respectively, at Set # 1, where Pool P = 15.2234 psia and T_outlet = 73.991 C
Maximum Mid-Low delta T is 3.3858 degrees C at (KEY POINT #6) t plus 4256.1744 s ignoring SP 4, with temperatures of 80.0133 and 76.6275 C, respectively, at Set # 3, where Pool P = 15.2232 psia and T_outlet = 72.7493 C

Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 4734.0838 s with a Smoothed Mid-Axis Mid-Low Delta T of 1.1282 C and a raw SP12 Reading of 84.3611 C.
Maximum Top-Outlet delta T is 13.3329 degrees C at t plus 4994.3887 s, with temperatures of 87.8401 and 74.5072 C, respectively, at Set # 1, where Pool P = 15.2372 psia
Maximum Mid-Outlet delta T is 12.0255 degrees C at t plus 4994.3887 s ignoring SP 4, with temperatures of 86.5327 and 74.5072 C, respectively, at Set # 2, where Pool P = 15.2372 psia
Maximum Lower-Outlet delta T is 13.2484 degrees C at (KEY POINT #8) t plus 5026.4885 s, with temperatures of 88.1312 and 74.8828 C, respectively, at Set # 1, where Pool P = 15.2383 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 5271.0925 s with a Smoothed Mid-Axis Low-Outlet Delta T of 4.4094 C and a raw SP12 Reading of 88.5184 C.
Minimum SP Pressure is 14.6906 psia at t plus 6.2004 s
Maximum SP Pressure is 15.3891 psia at t plus 5929.5041 s
Beginning SP Pressure is 14.697 psia
Ending SP Pressure is 15.386 psia
Time-Average SP Pressure is 15.1885 +/- 0.11567 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 75.9557 cm (cold) / 76.0986 cm (hot) at 14.588 psia
Beginning Smoothed SP Level is 76.2437 cm (cold) / 76.4121 cm (hot) at 14.6922 psia
Ending Smoothed SP Level is 76.4278 cm (cold) / 77.3165 cm (hot) at 15.3713 psia
Minimum Smoothed Cold SP Level is 76.2437 cm at t plus 0 s and 14.6922 psia
Minimum Smoothed Hot SP Level is 76.4121 cm at t plus 0 s and 14.6922 psia
Maximum Smoothed Cold SP Level is 76.7899 cm at t plus 818.5158 s and 15.202 psia
Maximum Smoothed Hot SP Level is 77.3177 cm at t plus 5920.2056 s and 15.3701 psia
SP 12 Temperature at the beginning is 39.8405 C, and at the end is 94.0427 C
At plume detection, the Mixing Number is 43.2166
The Mixing Number ranges from a minimum of 34.4199 at (KEY POINT #12) t plus 0 s to a maximum of 178.8432 at (KEY POINT #13) t plus 5932.1053 s; it had a mean value of 66.7905 +/- 32.89 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 34.4199): 62.76991779 0.040894
0.00925 0.3937 0.7624370901 0.7641214556 0.648764989
0.648764989 0.9996254285 61.55938181 205822.7268 0.06951847535
0.05832044601 0.0555986307 0.02684566771 0.08244429841 40.47851248
103.0576225 103.0576225 40.58445142 40.28685713 40.1624464
37.19098989 4.178538489 4.220605573 2.089963867 0.6292403337
0.6789626714 0.6789626714 4.296398612 1.696638245 0.03808891862
992.0403828 956.1376567 0.6617705245 1.019664525 0.0006469887267
0.0002729357233 1.23738761e-005 1.247147513e-005 1532.139931
1542.142667 473.8041774 467.4131047 1.129956371 1.012991595
1.049991595 0.07574905557 0.07617644636 1894.456827 1890.667269
169.6270536 432.0067208 2680.371804 262.3796672 1462.450106
170.0697236 168.8247087 168.3079537 155.8954722

```
KEY POINT #2 (t plus 1577.3292 s with a Mixing Number of 43.2166):  51.10309333
       0.040894          0.00925          0.3937      0.766728267     0.7699845671
       0.6268761988      0.6268761988     0.9995831832     47.85805592      167259.007
       0.06695767876     0.05825010069    0.04343259296    0.02368807286    0.06712066583
       55.81959573       103.4198521      103.4198521      57.82050192      55.73063612
       55.58766588       53.57483893      4.181146414      4.221088276      2.091491346
       0.6466987074      0.679097866      0.679097866         3.216176      1.690214612
       0.03814734919      985.3113718      955.8722703     0.6696609527      1.067805458
       0.0004974465507  0.0002719254043 1.238627331e-005 1.249445358e-005
       1550.929933       1541.77483       473.9855214      466.9259323      1.144367513
       1.048799342       1.085799342     0.1639082329      0.180182513      1844.668807
       1842.378413       233.7467359      433.5367076      2680.936926      199.7899717
       1411.132099       242.1135202      233.3733403      232.7785423      224.3672795
KEY POINT #3 (t plus 2306.6409 s with a Mixing Number of 48.3286):  52.74878944
       0.040894          0.00925          0.3937      0.7657557584     0.7697192457
       0.620167995       0.620167995      0.9995717839     48.94692571      172626.0615
       0.06586046953     0.05825930359     0.0441288739    0.02515330919    0.06928218309
       62.17443278       103.3724809      103.3724809       68.5801356      62.23208255
       62.2839657       59.78796539      4.183729505      4.221024986      2.091290973
       0.6528519828      0.6790802765     0.6790802765      2.893244126      1.691051936
       0.03813968921      982.0826811      955.9070101     0.6686247357      1.077673187
       0.000451477602  0.0002720571473 1.238465189e-005 1.249584783e-005
       1555.072045       1541.823154      473.961831      466.7066371      1.142474287
       1.048754655       1.085754655     0.2204112751     0.2933369334      1829.576386
       1827.180584       260.3249775      433.3366104      2680.863063      173.0116328
       1396.239776       287.1353383       260.56475      260.7847388      250.3472428
KEY POINT #4 (t plus 2874.8504 s with a Mixing Number of 53.5496):  54.16368689
       0.040894          0.00925          0.3937      0.7654008946     0.7700640185
       0.6167691088      0.6167691088     0.9995658142      50.01174278      177242.2243
       0.06496983811     0.0582625183    0.04490332478    0.02623723621    0.07114056099
       67.24619402       103.3559322      103.3559322      75.81384014      67.74017525
       67.41812704        63.793274       4.186402534      4.221002888      2.091221019
       0.657333878      0.6790741254     0.6790741254      2.672622532      1.691344641
       0.03813701459      979.3366184      955.9191437      0.668263051      1.083019385
       0.0004196455834  0.0002721031975 1.238408547e-005 1.249685181e-005
       1557.018101       1541.84002       473.9535532      466.5968483      1.141813517
       1.048756398       1.085756398     0.2766674432      0.39928527      1821.999968
       1819.498793       281.5503986      433.266709       2680.837257      151.7163104
       1388.733259       317.4414962      283.6170751      282.27167       267.1036424
KEY POINT #5 (t plus 2899.0508 s with a Mixing Number of 53.7305):  54.31838199
       0.040894          0.00925          0.3937      0.7653804714     0.7700664586
       0.615162394       0.615162394      0.9995629045      50.02945279      177739.2359
       0.0649432215     0.05826315751    0.04491120394    0.02643253922    0.07134374317
       67.39662208       103.3526416      103.3526416        76.085473      67.92278376
       67.606076      63.94730632      4.186490049      4.220998495      2.091207112
       0.6574611195      0.6790729019     0.6790729019      2.666517426      1.691402855
       0.03813648285      979.2529463      955.9215563     0.6681911516      1.085728085
       0.0004187592736   0.000272112356 1.238397284e-005 1.249749894e-005
       1557.058268       1541.843372      473.9519071      466.5462897      1.141682165
       1.048761852       1.085761852     0.2785061563     0.4038203416      1818.382029
       1815.879083       282.1801579      433.2528097      2680.832126      151.0726518
       1385.129219       318.5802477      284.3816115      283.0585287      267.7481985
KEY POINT #6 (t plus 4256.1744 s with a Mixing Number of 76.163):  54.59438101
       0.040894          0.00925          0.3937      0.7641417585     0.7706478762
       0.6339950069      0.6339950069     0.9995965088      51.80618872      178762.9746
       0.06263583904     0.05826142447    0.04596260457    0.02574364577    0.07170625034
       80.20192902       103.3615631      103.3615631      88.34557052      80.75592984
       77.59232976       72.76413373      4.195669788      4.221010407      2.091244819
       0.6671273502      0.6790762188     0.6790762188      2.223063829      1.691245033
       0.03813792459       971.683982      955.9150153     0.6683861006      1.053819676
       0.0003534755489  0.0002720875268  1.23842782e-005 1.248906616e-005
       1557.029141       1541.834282      473.9563699      467.1127497      1.142038316
       1.04966526        1.08666526     0.4780374088     0.6588645356      1860.913368
       1858.229487       335.844652       433.2904937      2680.846038      97.44584173
       1427.622874       370.0427642       338.167838      324.8999085      304.6653185
KEY POINT #7 (t plus 4734.0838 s with a Mixing Number of 89.7654):  53.7975338
       0.040894          0.00925          0.3937      0.7638674995     0.7710459505
```

0.6494145412 0.6494145412 0.9996226137 52.28203177 176247.2085
0.06185243901 0.05826048824 0.04620002663 0.02445961554 0.07065964217
84.45042306 103.3663826 103.3663826 92.5764095 84.92067764
82.7250061 74.3376087 4.19947018 4.221016842 2.091265192
0.6698394606 0.6790780102 0.6790780102 2.103766304 1.691159787
0.03813870352 968.9852408 955.9114815 0.6684914345 1.028987053
0.0003355627319 0.0002720741154 1.238444316e-005 1.248244648e-005
1555.610807 1541.82937 473.9587807 467.5523541 1.142230753
1.050471252 1.087471252 0.5663176215 0.7733582661 1895.631175
1892.897764 353.6779378 433.3108513 2680.853554 79.63291356
1462.320324 387.8356612 355.651528 346.4349003 311.2589737
KEY POINT #8 (t plus 5026.4885 s with a Mixing Number of 99.9306): 53.37147386
0.040894 0.00925 0.3937 0.7638845355 0.7714364408
0.6599528996 0.6599528996 0.9996396549 52.68850969 174907.925
0.06141837991 0.05825820487 0.04649273021 0.0236073093 0.07010003951
86.78425901 103.3781367 103.3781367 96.38139181 87.77146406
86.11734418 75.0695407 4.201718606 4.22103254 2.091314887
0.6712274496 0.6790823781 0.6790823781 2.043054019 1.690951921
0.03814060348 967.4645859 955.9028629 0.6687483861 1.012962298
0.0003263792908 0.0002720414118 1.238484547e-005 1.247841144e-005
1554.554114 1541.817387 473.9646599 467.8448941 1.142700192
1.050576788 1.087576788 0.6203585733 0.8900268658 1919.388233
1916.612154 363.4814245 433.3605008 2680.871883 69.87907629
1486.027733 403.8544871 367.6285443 360.6808623 314.3267263
KEY POINT #9 (t plus 5115.3906 s with a Mixing Number of 103.3045): 53.17275931
0.040894 0.00925 0.3937 0.7638683343 0.7715189598
0.6637080796 0.6637080796 0.9996458281 52.81687985 174286.1283
0.06129727881 0.05826115097 0.04654049812 0.02329854245 0.06983904057
87.43289801 103.362971 103.362971 97.0486115 88.41103293
87.26862844 75.82156107 4.202363822 4.221012287 2.091250771
0.6716005182 0.6790767421 0.6790767421 2.026745392 1.691220129
0.03813815213 967.037168 955.913983 0.6684168706 1.006737987
0.0003239041914 0.0002720836088 1.238432639e-005 1.247630457e-005
1554.22638 1541.832847 473.9570742 467.9393254 1.14209453
1.050561372 1.087561372 0.6361208216 0.9119174939 1927.804348
1925.014725 366.2070313 433.2964408 2680.848234 67.08940954
1494.507907 406.6651976 370.316672 365.5181278 317.4790803
KEY POINT #10 (t plus 5271.0925 s with a Mixing Number of 111.1609): 52.52276806
0.040894 0.00925 0.3937 0.7638635196 0.7717240823
0.6745615611 0.6745615611 0.9996628164 53.03099463 172218.5199
0.0610443191 0.05826199252 0.04660970484 0.02237561352 0.06898531837
88.7843407 103.3586388 103.3586388 98.22514349 90.06847388
89.73277512 83.93812277 4.203736501 4.221006502 2.091232459
0.672360206 0.6790751317 0.6790751317 1.993524517 1.69129676
0.038137452 966.1401222 955.9171593 0.6683221963 0.9904164238
0.0003188512302 0.0002720956647 1.238417811e-005 1.247174856e-005
1553.496774 1541.837262 473.9549071 468.2218655 1.141921569
1.050880973 1.087880973 0.6700378619 0.9516060051 1952.210261
1949.397975 371.8872345 433.2781419 2680.841478 61.3909074
1518.932119 411.6227609 377.2849346 375.8760637 351.5316616
KEY POINT #11 (t plus 5932.1053 s with a Mixing Number of 178.8432): 46.23888974
0.040894 0.00925 0.3937 0.7642777677 0.7731653399
0.7887226921 0.7887226921 0.9998127396 54.57513419 152087.9996
0.05984736138 0.05826154971 0.04716247208 0.01356937141 0.06073184349
95.11764944 103.3609184 103.3609184 101.8728813 95.2814624
95.32345981 92.24149602 4.210683342 4.221009546 2.091242094
0.6756071181 0.6790759791 0.6790759791 1.850464876 1.691256437
0.03813782039 961.8194069 955.915488 0.6683720111 0.847251966
0.0002969083971 0.0002720893209 1.238425613e-005 1.24328886e-005
1549.25959 1541.834939 473.9560474 470.7547676 1.142012576
1.05981119 1.09681119 0.8497597903 1.08386506 2208.96563
2205.987185 398.5330327 433.2877705 2680.845033 34.75473779
1775.67786 427.004853 399.2215177 399.4010307 386.4320368
KEY POINT #12 (t plus 0 s with a Mixing Number of 34.4199): 62.76991779 0.040894
0.00925 0.3937 0.7624370901 0.7641214556 0.648764989
0.648764989 0.9996254285 61.55938181 205822.7268 0.06951847535
0.05832044601 0.0555986307 0.02684566771 0.08244429841 40.47851248

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       103.0576225      103.0576225      40.58445142      40.28685713      40.1624464
       37.19098989      4.178538489      4.220605573      2.089963867      0.6292403337
       0.6789626714     0.6789626714     4.296398612      1.696638245     0.03808891862
       992.0403828      956.1376567     0.6617705245      1.019664525  0.0006469887267
       0.0002729357233  1.23738761e-005 1.247147513e-005      1532.139931
       1542.142667      473.8041774      467.4131047      1.129956371      1.012991595
       1.049991595    0.07574905557    0.07617644636      1894.456827      1890.667269
       169.6270536      432.0067208      2680.371804      262.3796672      1462.450106
       170.0697236      168.8247087      168.3079537      155.8954722
KEY POINT #13 (t plus 5932.1053 s with a Mixing Number of 178.8432):  46.23888974
       0.040894          0.00925          0.3937     0.7642777677     0.7731653399
       0.7887226921     0.7887226921     0.9998127396      54.57513419      152087.9996
       0.05984736138    0.05826154971    0.04716247208    0.01356937141    0.06073184349
       95.11764944      103.3609184      103.3609184      101.8728813       95.2814624
       95.32345981      92.24149602      4.210683342      4.221009546      2.091242094
       0.6756071181     0.6790759791     0.6790759791      1.850464876      1.691256437
       0.03813782039      961.8194069       955.915488     0.6683720111      0.847251966
       0.0002969083971  0.0002720893209 1.238425613e-005  1.24328886e-005
       1549.25959      1541.834939      473.9560474      470.7547676      1.142012576
       1.05981119       1.09681119      0.8497597903      1.08386506       2208.96563
       2205.987185      398.5330327      433.2877705      2680.845033      34.75473779
       1775.67786       427.004853       399.2215177      399.4010307      386.4320368
KEY POINT #14 (t plus 5224.0168 s with a Mixing Number of 107.9805):  52.25779211
       0.040894          0.00925          0.3937     0.7638343662     0.7716369862
       0.6779964433     0.6779964433     0.9996681932      53.05206165      171374.2032
       0.0611399602    0.05826425709    0.04662938222    0.02200790707    0.06863728929
       88.2739224       103.346981       103.346981       98.1009468      89.44822195
       88.66259308      78.98420529      4.203213579      4.220990938       2.09118319
       0.6720760672     0.6790707968     0.6790707968      2.005952665      1.691503007
       0.03813556817      966.4799353      955.9257064     0.6680674812     0.9850284885
       0.0003207433438  0.0002721281121 1.238377909e-005 1.246996404e-005
       1553.779699      1541.849139      473.9490753      468.3052863      1.141456235
       1.050582826      1.087582826     0.6570548657     0.9473499918      1959.904429
       1957.089908      369.7416805      433.2288994      2680.823298      63.48721885
       1526.67553      411.0993324      374.6769044      371.376822      330.7412094
End
```

D.8 TEST #8 - T08_RCIC_040GPM_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T08_RCIC_040GPM_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2044.3429 s, and ending (KEY POINT #11) at t
       plus 10480.7805 s, for a time period of 8436.4376 s.
Original Data Record Time:  12198.2097 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2290.736 s, T_bulk = 61.5556 C and T_out = 59.4322 C
Stratification Beginning SP12 Temperature = 61.2481 C
Stratification Beginning Pressure = 16.4767 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       7496.9238 s, T_bulk = 109.8205 C and T_out = 74.1689 C
Stratification Ending SP12 Temperature = 109.6427 C
Stratification Ending Pressure = 36.1733 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1659.7259 s.
At t = 1659.7259 s, the pool pressure is 15.7153 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 55.9093, 56.0772, 58.0778, 55.7861, and
       53.6478 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 10.1925 +/- 2.9825 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.4804 +/- 2.8168 C.
Minimum Steam Quality:  0.51672 at t plus 685.5112 s
Maximum Steam Quality:  0.66112 at t plus 8105.1336 s
Time-Averaged Steam Quality:  0.59234 +/- 0.020428
Minimum Turbine Outlet Steam Quality:  0.56247 at t plus 685.5112 s
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Maximum Turbine Outlet Steam Quality: 0.67746 at t plus 8105.1336 s
Time-Averaged Turbine Outlet Steam Quality: 0.62502 +/- 0.015747
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 8346.4374 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.85108 degrees/min at t plus 3701.0607 s and 0.3597 degrees/min at t plus 6995.7151 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.69463 degrees/min at t plus 3615.5578 s and 0.39895 degrees/min at t plus 7258.2191 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.26167 degrees/min at t plus 3374.954 s and -0.16867 degrees/min at t plus 3555.5584 s, respectively
Max and min smoothed lower level changerates: 2.3212 degrees/min at t plus 5971.3975 s and 0.0072092 degrees/min at t plus 3350.0536 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.61763 degrees/min at t plus 3605.0002 s and -1.7776 degrees/min at t plus 5971.4996 s, respectively
Max and min smoothed outlet level changerates: 7.6632 degrees/min at t plus 7786.1273 s and -0.02798 degrees/min at t plus 4186.5685 s, respectively
Max and min smoothed lower-outlet level changerate differences: 2.2359 degrees/min at t plus 5971.3975 s and -7.144 degrees/min at t plus 7785.6283 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.0759 degrees/min at t plus 2181.1358 s and 0.22496 degrees/min at t plus 7665.9485 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.5205 degrees/min at t plus 2181.1358 s and -0.28715 degrees/min at t plus 3776.562 s, respectively
The mean steam flow rate was 45.4844 +/- 1.0202 g/s
The mean feedwater flow rate was 44.9409 +/- 1.271 g/s
The mean water injection to steam flow rate was 24.8476 +/- 1.115 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 10.9507 +/- 2.1231 C over the Stratification Period, beginning at 6.143 C and ending at 13.4693 C
Mean Smoothed SP8-Upper Pool delta T is 10.1609 +/- 2.1201 C over the Stratification Period, beginning at 6.0543 C and ending at 12.3153 C
The stratification period begins and ends with Smoothed SP8 readings of 67.9793 and 123.1198 C, respectively
The stratification period begins and ends with condensing flows of 0.549 and 1.247 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 4.2001 and 1.7081 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1872.7689 +/- 12.1382 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.49108 and 13.0555 kg/s, respectively
The plume period had a mean steam enthalpy of 1869.6989 +/- 16.6767 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.5818 degrees C at t plus 8335.7358 s with T_upper = 117.7687 C and T_mid = 116.1869 C
At t plus 8335.7358 s, Smoothed SP8-SP9 is 12.2572 C and Smoothed SP8-Top is 10.6754 C, where Smoothed SP8 is 128.4441 C and Pool P = 41.4713 psia
Maximum Smoothed Top-Lower delta T is 11.438 degrees C at t plus 5761.6936 s with T_upper = 97.0643 C and T_low = 85.6264 C
At t plus 5761.6936 s, Smoothed SP8-SP9 is 12.8879 C and Smoothed SP8-Top is 12.2202 C, where Smoothed SP8 is 109.2845 C and Pool P = 27.3769 psia
Maximum Smoothed Mid-Lower delta T is 10.7702 degrees C at t plus 5761.6936 s with T_mid = 96.3966 C and T_low = 85.6264 C
At t plus 5761.6936 s, Smoothed SP8-SP9 is 12.8879 C and Smoothed SP8-Top is 12.2202 C, where Smoothed SP8 is 109.2845 C and Pool P = 27.3769 psia
Maximum Smoothed Top-Outlet delta T is 36.6847 degrees C at t plus 7425.8217 s with T_upper = 110.2833 C and T_out = 73.5986 C
At t plus 7425.8217 s, Smoothed SP8-SP9 is 13.5258 C and Smoothed SP8-Top is 12.4333 C, where Smoothed SP8 is 122.7166 C and Pool P = 35.7827 psia
Maximum Smoothed Mid-Outlet delta T is 35.5999 degrees C at t plus 7418.8493 s with T_mid = 109.1478 C and T_out = 73.5479 C
At t plus 7418.8493 s, Smoothed SP8-SP9 is 13.6406 C and Smoothed SP8-Top is 12.5746 C, where Smoothed SP8 is 122.7884 C and Pool P = 35.7411 psia
Maximum Smoothed Lower-Outlet delta T is 35.5758 degrees C at t plus 7432.4221 s with T_low = 109.2327 C and T_out = 73.6568 C
At t plus 7432.4221 s, Smoothed SP8-SP9 is 13.5696 C and Smoothed SP8-Top is 12.4893 C, where Smoothed SP8 is 122.8228 C and Pool P = 35.8225 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 14.2505 degrees C at (KEY POINT #14) t plus 6969.9137 s with T_SP8 = 120.2456 C and T_SP9 = 105.995 C and Pool P = 33.4157 psia

Maximum Smoothed Condensing Region SP8-Upper delta T is 13.363 degrees C at t plus 6445.1106 s with T_SP8 = 116.3356 C and T_upper = 102.9726 C and Pool P = 30.7583 psia
Maximum Top-Mid delta T is 2.2528 degrees C at (KEY POINT #4) t plus 3584.158 s ignoring SP 4, with temperatures of 75.2131 and 72.9603 C, respectively, at Set # 2, where Pool P = 19.0685 psia and T_outlet = 67.756 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 4528.174 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99985 C and a raw SP12 Reading of 83.6957 C.
Maximum Top-Lower delta T is 14.3987 degrees C at t plus 5941.0208 s, with temperatures of 98.8861 and 84.4874 C, respectively, at Set # 1, where Pool P = 28.2713 psia and T_outlet = 70.9469 C
Maximum Mid-Low delta T is 11.7386 degrees C at (KEY POINT #6) t plus 5770.8931 s ignoring SP 4, with temperatures of 96.41 and 84.6714 C, respectively, at Set # 2, where Pool P = 27.4266 psia and T_outlet = 70.7088 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6037.4233 s with a Smoothed Mid-Axis Mid-Low Delta T of 3.9117 C and a raw SP12 Reading of 98.7858 C.
Maximum Top-Outlet delta T is 37.2082 degrees C at t plus 7431.7221 s, with temperatures of 110.7704 and 73.5622 C, respectively, at Set # 1, where Pool P = 35.8096 psia
Maximum Mid-Outlet delta T is 35.6618 degrees C at t plus 7396.9201 s ignoring SP 4, with temperatures of 108.9664 and 73.3046 C, respectively, at Set # 2, where Pool P = 35.6445 psia
Maximum Lower-Outlet delta T is 36.8155 degrees C at (KEY POINT #8) t plus 7430.621 s, with temperatures of 110.3773 and 73.5618 C, respectively, at Set # 1, where Pool P = 35.8104 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 7818.7272 s with a Smoothed Mid-Axis Low-Outlet Delta T of 12.2654 C and a raw SP12 Reading of 111.8494 C.
Minimum SP Pressure is 14.6753 psia at t plus 61.8995 s
Maximum SP Pressure is 42.2321 psia at t plus 8436.0375 s
Beginning SP Pressure is 14.6832 psia
Ending SP Pressure is 42.2311 psia
Time-Average SP Pressure is 23.6178 +/- 8.2121 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 75.5226 cm (cold) / 75.6601 cm (hot) at 14.6978 psia
Beginning Smoothed SP Level is 75.7776 cm (cold) / 75.9411 cm (hot) at 14.6894 psia
Ending Smoothed SP Level is 83.6256 cm (cold) / 85.4091 cm (hot) at 42.2433 psia
Minimum Smoothed Cold SP Level is 75.7691 cm at t plus 145.5033 s and 14.6974 psia
Minimum Smoothed Hot SP Level is 75.9392 cm at t plus 33.1999 s and 14.6897 psia
Maximum Smoothed Cold SP Level is 83.6945 cm at t plus 7358.0208 s and 35.419 psia
Maximum Smoothed Hot SP Level is 85.4091 cm at t plus 8436.4376 s and 42.2433 psia
SP 12 Temperature at the beginning is 40.0358 C, and at the end is 116.7484 C
At plume detection, the Mixing Number is 43.5377
The Mixing Number ranges from a minimum of 34.185 at (KEY POINT #12) t plus 0 s to a maximum of 223.004 at (KEY POINT #13) t plus 8433.2384 s; it had a mean value of 94.7469 +/- 55.3088 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,

Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11

KEY POINT #1 (t plus 0 s with a Mixing Number of 34.185): 53.72431041 0.040894
0.00925 0.3937 0.7577762961 0.7594107385 0.6152278213
0.6152278213 0.9995760134 50.96844979 176262.2459 0.06952849958
0.05843773759 0.04564824051 0.02491522739 0.07056346789 40.41693034
102.452972 102.452972 40.55870406 40.27360842 40.00712038
37.61120412 4.178538843 4.219806227 2.087438042 0.6291624666
0.6787334333 0.6787334333 4.301829735 1.70746906 0.03799210993
992.0628711 956.5793401 0.6487682168 1.054069932 0.0006477263726
0.0002746373352 1.235318831e-005 1.246439326e-005 1532.03691
1542.748058 473.5004852 466.2084479 1.106234776 1.012797239
1.049797239 0.07550156658 0.07607238244 1816.297344 1813.699562
169.3697131 429.4532049 2679.426806 260.0834918 1386.84414
169.96212 168.7693311 167.6589008 157.6513844

KEY POINT #2 (t plus 1659.7259 s with a Mixing Number of 43.5377): 52.28111092
0.040894 0.00925 0.3937 0.7664612406 0.7697324921
0.6211750017 0.6211750017 0.9995606342 47.18911133 170650.8854
0.06691360516 0.05808454857 0.04408799687 0.0245799202 0.06866791707
56.07723374 104.271131 104.271131 58.07779441 55.90925758
55.78607262 53.64782984 4.181226652 4.222234033 2.095123787
0.6469618358 0.679409304 0.679409304 3.201927145 1.675306591
0.03828596276 985.1867307 955.2462701 0.6885061668 1.10790624
0.0004954346741 0.0002695774029 1.241541883e-005 1.252840702e-005
1551.142337 1540.895226 474.4099509 467.0754777 1.178833702
1.083257124 1.120257124 0.165930582 0.1823718932 1833.977881
1831.751069 234.8268931 437.1330752 2682.262049 202.3061822
1396.844806 243.192404 234.1231086 233.6110263 224.6753562

KEY POINT #3 (t plus 2290.736 s with a Mixing Number of 48.6299): 52.55772476
0.040894 0.00925 0.3937 0.7752490371 0.7793552202
0.6266878639 0.6266878639 0.9995543761 46.13245975 171020.2019
0.06591937549 0.05786340586 0.04449091525 0.02454031651 0.06903123177
61.83631569 105.4056553 105.4056553 67.97932698 61.92498151
61.63627103 59.27000849 4.183551217 4.223785875 2.100059212
0.6525443204 0.6798107027 0.6798107027 2.909016881 1.65584059
0.03847355566 982.2641222 954.4069497 0.7142903852 1.139278613
0.0004537442821 0.0002665045502 1.245428451e-005 1.256749537e-005
1554.915511 1539.69016 474.9717621 467.6681173 1.226095615
1.135761498 1.172761498 0.2170352809 0.285726708 1849.148881
1847.020678 258.917686 441.9276765 2684.02152 183.0099905
1407.221205 284.6268984 259.2872053 258.0823037 248.1881914

KEY POINT #4 (t plus 3584.158 s with a Mixing Number of 62.797): 52.68799233
0.040894 0.00925 0.3937 0.7894662381 0.7957639283
0.6400902514 0.6400902514 0.999524489 41.90766409 169668.7323
0.06384662748 0.05712861208 0.04533634359 0.02386598636 0.06920232995
73.53903298 109.1543943 109.1543943 82.61570887 74.30705287
72.2578697 67.66618872 4.190408938 4.229117703 2.117157954
0.6623962235 0.6810268018 0.6810268018 2.436195686 1.594636098
0.03911730497 975.7418303 951.5930071 0.805129927 1.257240017
0.000385100081 0.0002567887673 1.258287462e-005 1.269899721e-005
1557.921933 1535.446452 476.7964372 469.4585556 1.393509102
1.314641765 1.351641765 0.3629615203 0.526652352 1888.219354
1886.463102 307.9286456 457.7837289 2689.780498 149.8550833
1430.435625 345.9955389 311.1458005 302.5620871 283.3357794

KEY POINT #5 (t plus 4528.174 s with a Mixing Number of 80.946): 53.6500332
0.040894 0.00925 0.3937 0.7917778743 0.7997669357
0.630992654 0.630992654 0.9994378883 37.13089726 170708.0342
0.06197993025 0.05633737692 0.04575401368 0.02471189582 0.0704659095
83.76224041 113.1561774 113.1561774 93.16928573 84.68226876
77.51456894 69.36786971 4.198725819 4.235161741 2.136812139
0.6694415377 0.6821402982 0.6821402982 2.122234569 1.534205998
0.03984677406 969.4486187 948.5208896 0.9122272578 1.444889221
0.0003383674083 0.0002471083282 1.272039308e-005 1.285214529e-005
1555.973863 1530.483983 478.6893431 470.5592211 1.592529782
1.517919296 1.554919296 0.5511563485 0.7906506141 1877.609074
1876.23037 350.8249702 474.7341319 2695.831682 123.9091617
1402.874942 390.3663939 354.6869766 324.6113402 290.4775158

KEY POINT #6 (t plus 5770.8931 s with a Mixing Number of 118.6919): 54.72733836
0.040894 0.00925 0.3937 0.821934091 0.833500857
0.6223704691 0.6223704691 0.9992879696 30.76480826 170866.641
0.0595855964 0.0550535703 0.04650052478 0.02538035659 0.07188088137
96.48960771 119.5759872 119.5759872 109.4204607 97.08317546
85.80243676 70.76936609 4.212112216 4.245643388 2.171558638
0.6762890265 0.6835349339 0.6835349339 1.821925746 1.446701991
0.04111429597 960.8962966 943.4470521 1.107920078 1.77889418
0.0002925250624 0.0002329143688 1.294142239e-005 1.309804981e-005
1548.33611 1521.626524 481.6034511 472.2978806 1.96012287
1.891211702 1.928211702 0.8935473575 1.406072249 1874.219714
1873.273241 404.3741308 501.9823402 2705.317763 97.60820939
1372.237374 458.9479807 406.8732271 359.4237917 296.3774566
KEY POINT #7 (t plus 6037.4233 s with a Mixing Number of 128.3454): 54.54818148
0.040894 0.00925 0.3937 0.8272183083 0.839618162
0.6208302011 0.6208302011 0.9992514288 29.32208913 169594.3486
0.05912013134 0.05476530632 0.04634022377 0.02530534643 0.0716455702
98.91801372 121.0055404 121.0055404 112.4051565 99.54028795
94.61053138 71.10890471 4.215053716 4.248113313 2.17985958
0.677362164 0.6837806943 0.6837806943 1.773542525 1.428657865
0.04141370538 959.1782718 942.2930258 1.155801955 1.860310199
0.0002850095595 0.0002299582413 1.299069559e-005 1.315311125e-005
1546.280246 1519.50843 482.23128 472.6630067 2.050746277
1.983352398 2.020352398 0.9756414115 1.553501364 1874.330888
1873.471103 414.6133615 508.0598338 2707.391096 93.44647227
1366.271054 471.5847514 417.2352433 396.4697426 297.8071228
KEY POINT #8 (t plus 7430.621 s with a Mixing Number of 177.1392): 54.02916768
0.040894 0.00925 0.3937 0.8369291415 0.8524069313
0.6230186294 0.6230186294 0.9990914903 23.93491903 164753.3665
0.05711178159 0.05337908213 0.04642663935 0.0245372392 0.07096387855
109.2398885 127.8220237 127.8220237 122.7755747 110.320628
109.2087661 73.6428534 4.228983875 4.260601013 2.222386231
0.6811176741 0.6846331946 0.6846331946 1.593239661 1.349070651
0.04293234762 951.5792457 936.6700536 1.407641583 2.257336555
0.0002566062498 0.000216781282 1.322583352e-005 1.341076562e-005
1535.577245 1508.704496 485.1164839 474.6445853 2.531142697
2.469033752 2.506033752 1.397535866 2.167662947 1895.831968
1895.259088 458.2264389 537.0921031 2717.07023 78.86566423
1358.739865 515.6135902 462.7964923 458.0961365 308.4622795
KEY POINT #9 (t plus 7496.9238 s with a Mixing Number of 179.4484): 54.12980052
0.040894 0.00925 0.3937 0.8369085534 0.8525346678
0.6197716266 0.6197716266 0.9990703524 23.64279262 164880.2502
0.0570309056 0.05331450834 0.04632629647 0.02476975691 0.07109605339
109.650488 128.1372799 128.1372799 123.1197805 110.804489
109.6635286 74.27756467 4.229586459 4.261207751 2.224473142
0.6812406383 0.6846599641 0.6846599641 1.586825236 1.345631849
0.04300633452 951.2672672 936.4052007 1.420277714 2.289484216
0.0002555828677 0.0002162063686 1.32367143e-005 1.342540455e-005
1535.088732 1508.177198 485.2455256 474.5837894 2.555397986
2.49352322 2.53052322 1.417008656 2.19101784 1889.523195
1888.964213 459.9647629 538.4370334 2717.509327 78.47227056
1351.086162 517.0786703 464.8454628 460.0212303 311.1239816
KEY POINT #10 (t plus 7818.7272 s with a Mixing Number of 192.6342): 52.32604733
0.040894 0.00925 0.3937 0.836706884 0.8530505304
0.6504355915 0.6504355915 0.9991471506 22.93661151 158952.7681
0.05655951107 0.05298960091 0.04644880316 0.02227813503 0.06872693819
112.0362717 129.7205377 129.7205377 124.8840163 113.1896579
112.3856205 99.47162513 4.233169009 4.264295021 2.235116955
0.6819143481 0.6847776336 0.6847776336 1.550582439 1.328665042
0.04338306765 949.4388671 935.0686793 1.485126728 2.281332938
0.0002497808169 0.0002133623726 1.329136461e-005 1.346199506e-005
1532.153603 1505.492808 485.8876409 476.3081907 2.680083639
2.619498381 2.656498381 1.534621052 2.313966246 1960.098142
1959.572054 470.069007 545.1945269 2719.702727 75.12551995
1414.903615 524.5913384 474.9512825 471.5492497 416.9996506
KEY POINT #11 (t plus 8436.4376 s with a Mixing Number of 222.9409): 54.00500197
0.040894 0.00925 0.3937 0.83625599 0.85409058

```
       0.6657485431     0.6657485431     0.9991195732      21.99650688      162601.1362
       0.05556218624    0.05227234482    0.04793883523    0.0229933032    0.07093213843
       117.0431362       133.198449       133.198449      128.7958563      118.5570557
       118.1676518      114.8017052      4.241117599      4.27131634      2.259459609
       0.6831107929     0.6849384351     0.6849384351       1.4798746      1.293103368
       0.04424135742       945.521179      932.0953496      1.635961297      2.455162643
       0.0002383613016  0.0002073590732 1.341143962e-005  1.35821963e-005
       1525.49409        1499.3862      487.2630998      477.8560994        2.9713541
       2.912575501      2.949575501      1.807600497      2.606677198      2001.482666
       2000.998819      491.3044963      560.0570577      2724.450471      68.75256133
       1441.425608      541.2705742      497.7259029      496.0760129      481.8069935
KEY POINT #12 (t plus 0 s with a Mixing Number of 34.185):  53.72431041         0.040894
       0.00925          0.3937     0.7577762961     0.7594107385     0.6152278213
       0.6152278213     0.9995760134      50.96844979      176262.2459    0.06952849958
       0.05843773759    0.04564824051    0.02491522739    0.07056346789      40.41693034
       102.452972       102.452972      40.55870406      40.27360842      40.00712038
       37.61120412      4.178538843      4.219806227      2.087438042      0.6291624666
       0.6787334333     0.6787334333      4.301829735       1.70746906    0.03799210993
       992.0628711      956.5793401     0.6487682168      1.054069932  0.0006477263726
       0.0002746373352 1.235318831e-005 1.246439326e-005       1532.03691
       1542.748058      473.5004852      466.2084479      1.106234776      1.012797239
       1.049797239    0.07550156658    0.07607238244      1816.297344      1813.699562
       169.3697131      429.4532049      2679.426806      260.0834918       1386.84414
       169.96212      168.7693311      167.6589008      157.6513844
KEY POINT #13 (t plus 8433.2384 s with a Mixing Number of 223.004):  54.53360289
       0.040894          0.00925           0.3937     0.8362537688     0.8540776755
       0.6588858279     0.6588858279     0.9990925676      21.99292637      164135.6216
       0.05556530433    0.05227558577     0.0479378614    0.02368856075    0.07162642214
       117.0275663      133.1827864      133.1827864      128.7969579      118.5379646
       118.1624395      114.7926244      4.241092144      4.271283968      2.259347005
       0.6831074821     0.6849380103     0.6849380103      1.480084054      1.293258441
       0.04423739607      945.5335147      932.1088551      1.635255465      2.479597393
       0.0002383953136  0.0002073853834 1.341089881e-005 1.358691754e-005
       1525.515664      1499.414341      487.2570141      477.5652006      2.969987218
       2.910874258      2.947874258      1.806693896      2.606763663      1986.592099
       1986.10841      491.2383425      559.9900666      2724.429311      68.75172411
       1426.602032      541.2751538      497.6447669      496.0537771      481.7683927
KEY POINT #14 (t plus 6969.9137 s with a Mixing Number of 160.6076):  54.82757732
       0.040894          0.00925           0.3937     0.8361723611     0.8507478675
       0.6088828619     0.6088828619     0.9990959047      25.27295277      168101.9254
       0.057748293    0.05382773325    0.04607279185    0.02593974703    0.07201253888
       105.9950486      125.6261661      125.6261661      120.2455708      106.9515011
       105.4718306      72.66685253      4.224350717      4.256447563      2.208147451
       0.6800762099     0.6844158434     0.6844158434      1.645848745       1.37359626
       0.04242635029      954.0194914      938.5030926      1.322116246      2.169417156
       0.0002649644055  0.0002208675259 1.315005766e-005 1.333785405e-005
       1539.275482      1512.310231      484.2068131      473.4494984      2.367336754
       2.303463459      2.340463459       1.25125868      2.002153376      1859.545156
       1858.906434      444.4995253      527.7297917      2713.990442      83.23026636
       1331.815364      504.8522431      448.5393068       442.290792      304.3595185
End
```

D.9 TEST #9 - T09_RCIC_14PSIG_107KW_RESULTS_RCICLAND.TXT

```
Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T09_RCIC_14PSIG_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1785.2361 s, and ending (KEY POINT #11) at t
       plus 11121.3801 s, for a time period of 9336.144 s.
Original Data Record Time:  12508.3004 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       1231.6184 s, T_bulk = 51.446 C and T_out = 46.6852 C
Stratification Beginning SP12 Temperature = 51.3612 C
Stratification Beginning Pressure = 30.9121 psia
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Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
        9306.5423 s, T_bulk = 127.6598 C and T_out = 65.9489 C
Stratification Ending SP12 Temperature = 127.5488 C
Stratification Ending Pressure = 72.0254 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 863.2124 s.
At t = 863.2124 s, the pool pressure is 30.4636 psia while the Smoothed Upper, Mid, SP8,
        Lower, and Outlet Temperatures are 48.6881, 48.7419, 50.7443, 49.1189, and
        43.8525 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
        temperatures were 15.0062 +/- 3.9978 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
        temperatures were 13.6782 +/- 3.7886 C.
Minimum Steam Quality:  0.98945 at t plus 8926.3376 s
Maximum Steam Quality:  1.0028 at t plus 1557.1231 s
Time-Averaged Steam Quality:  0.99725 +/- 0.0023927
Minimum Turbine Outlet Steam Quality:  0.99147 at t plus 8926.3376 s
Maximum Turbine Outlet Steam Quality:  1.0122 at t plus 1557.1231 s
Time-Averaged Turbine Outlet Steam Quality:  1.0034 +/- 0.0048722
Smoothed Changerates may not fully include test beginning and end periods, analysis
        ending at t plus 9246.2429 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.8275 degrees/min at t plus 2863.1438 s
        and 0.357 degrees/min at t plus 9239.5435 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.88415 degrees/min at t plus
        3745.6562 s and 0.37111 degrees/min at t plus 2919.885 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.38408 degrees/min at t
        plus 2863.9438 s and -0.27744 degrees/min at t plus 3744.8562 s, respectively
Max and min smoothed lower level changerates:  3.102 degrees/min at t plus 7515.3159 s
        and -0.19145 degrees/min at t plus 2218.7339 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.69331 degrees/min at t
        plus 2218.7339 s and -2.5958 degrees/min at t plus 7515.3159 s, respectively
Max and min smoothed outlet level changerates:  0.70738 degrees/min at t plus 667.6102 s
        and 0.012087 degrees/min at t plus 3460.4519 s, respectively
Max and min smoothed lower-outlet level changerate differences:  3.0035 degrees/min at t
        plus 7515.3159 s and -0.54718 degrees/min at t plus 2114.0309 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.4205 degrees/min at t plus 1724.7257
        s and 0.12903 degrees/min at t plus 8107.6237 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.90237 degrees/min
        at t plus 1724.7257 s and -0.41519 degrees/min at t plus 3557.1535 s,
        respectively
The mean steam flow rate was 43.4815 +/- 1.1074 g/s
The mean feedwater flow rate was 43.4205 +/- 1.6892 g/s
The mean water injection to steam flow rate was 0.0027484 +/- 0.038867 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 15.5421 +/- 3.1807 C over the
        Stratification Period, beginning at 4.0088 C and ending at 14.8862 C
Mean Smoothed SP8-Upper Pool delta T is 14.1602 +/- 3.1092 C over the Stratification
        Period, beginning at 3.4709 C and ending at 14.2405 C
The stratification period begins and ends with Smoothed SP8 readings of 55.7904 and
        142.5166 C, respectively
The stratification period begins and ends with condensing flows of 0.31847 and 0.8453
        kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 6.3985 and
        1.4057 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2733.0317 +/- 1.8199 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.30716 and 12.9002
        kg/s, respectively
The plume period had a mean steam enthalpy of 2733.0351 +/- 1.8789 kJ/kg.
Maximum Smoothed Top-Mid delta T is 3.7619 degrees C at t plus 3411.8522 s with T_upper =
        74.5053 C and T_mid = 70.7434 C
At t plus 3411.8522 s, Smoothed SP8-SP9 is 17.2901 C and Smoothed SP8-Top is 13.5282 C,
        where Smoothed SP8 is 88.0335 C and Pool P = 35.7393 psia
Maximum Smoothed Top-Lower delta T is 27.7551 degrees C at t plus 7050.8083 s with
        T_upper = 111.3447 C and T_low = 83.5895 C
At t plus 7050.8083 s, Smoothed SP8-SP9 is 17.7157 C and Smoothed SP8-Top is 17.2516 C,
        where Smoothed SP8 is 128.5963 C and Pool P = 54.7955 psia
Maximum Smoothed Mid-Lower delta T is 27.2911 degrees C at t plus 7050.9083 s with T_mid
        = 110.8813 C and T_low = 83.5902 C
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At t plus 7050.9083 s, Smoothed SP8-SP9 is 17.7079 C and Smoothed SP8-Top is 17.244 C, where Smoothed SP8 is 128.5892 C and Pool P = 54.7959 psia
Maximum Smoothed Top-Outlet delta T is 62.3497 degrees C at t plus 9298.3438 s with T_upper = 128.3087 C and T_out = 65.9591 C
At t plus 9298.3438 s, Smoothed SP8-SP9 is 14.8796 C and Smoothed SP8-Top is 14.135 C, where Smoothed SP8 is 142.4437 C and Pool P = 71.9578 psia
Maximum Smoothed Mid-Outlet delta T is 61.8155 degrees C at t plus 9336.144 s with T_mid = 127.8872 C and T_out = 66.0718 C
At t plus 9336.144 s, Smoothed SP8-SP9 is 14.656 C and Smoothed SP8-Top is 14.1326 C, where Smoothed SP8 is 142.5433 C and Pool P = 72.2619 psia
Maximum Smoothed Lower-Outlet delta T is 60.9292 degrees C at t plus 9332.5438 s with T_low = 126.9894 C and T_out = 66.0602 C
At t plus 9332.5438 s, Smoothed SP8-SP9 is 14.7466 C and Smoothed SP8-Top is 14.2285 C, where Smoothed SP8 is 142.6 C and Pool P = 72.2426 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 18.5497 degrees C at (KEY POINT #14) t plus 3487.1534 s with T_SP8 = 89.9851 C and T_SP9 = 71.4354 C and Pool P = 35.9873 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 17.9235 degrees C at t plus 6529.1004 s with T_SP8 = 124.7097 C and T_upper = 106.7862 C and Pool P = 51.1953 psia
Maximum Top-Mid delta T is 5.0676 degrees C at (KEY POINT #4) t plus 2954.044 s ignoring SP 4, with temperatures of 70.9112 and 65.8436 C, respectively, at Set # 2, where Pool P = 34.4004 psia and T_outlet = 56.6531 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5793.2884 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.6889 C and a raw SP12 Reading of 97.9773 C.
Maximum Top-Lower delta T is 29.9102 degrees C at t plus 7110.2087 s, with temperatures of 111.8397 and 81.9296 C, respectively, at Set # 2, where Pool P = 55.2218 psia and T_outlet = 62.6679 C
Maximum Mid-Low delta T is 29.399 degrees C at (KEY POINT #6) t plus 7110.3097 s ignoring SP 4, with temperatures of 111.322 and 81.923 C, respectively, at Set # 2, where Pool P = 55.225 psia and T_outlet = 62.6726 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 7719.7385 s with a Smoothed Mid-Axis Mid-Low Delta T of 9.7901 C and a raw SP12 Reading of 116.277 C.
Maximum Top-Outlet delta T is 62.8564 degrees C at t plus 9322.2432 s, with temperatures of 128.7874 and 65.931 C, respectively, at Set # 1, where Pool P = 72.1576 psia
Maximum Mid-Outlet delta T is 61.8181 degrees C at t plus 9335.944 s ignoring SP 4, with temperatures of 127.9223 and 66.1041 C, respectively, at Set # 2, where Pool P = 72.2539 psia
Maximum Lower-Outlet delta T is 61.9354 degrees C at (KEY POINT #8) t plus 9198.5651 s, with temperatures of 127.6744 and 65.7391 C, respectively, at Set # 1, where Pool P = 71.1036 psia
Low-Outlet Reconvergence NOT Detected, setting t to (KEY POINT #10) t plus 9336.144 s with a Smoothed Mid-Axis Low-Outlet Delta T of 61.5178 C and a raw SP12 Reading of 127.9371 C.
Minimum SP Pressure is 29.6403 psia at t plus 2.2341 s
Maximum SP Pressure is 72.2619 psia at t plus 9336.144 s
Beginning SP Pressure is 29.643 psia
Ending SP Pressure is 72.2619 psia
Time-Average SP Pressure is 44.313 +/- 12.7652 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 84.3452 cm (cold) / 84.5256 cm (hot) at 28.7816 psia
Beginning Smoothed SP Level is 84.8555 cm (cold) / 85.0933 cm (hot) at 29.6403 psia
Ending Smoothed SP Level is 83.0104 cm (cold) / 85.0647 cm (hot) at 72.2683 psia
Minimum Smoothed Cold SP Level is 83.0104 cm at t plus 9336.144 s and 72.2683 psia
Minimum Smoothed Hot SP Level is 85.0647 cm at t plus 9336.144 s and 72.2683 psia
Maximum Smoothed Cold SP Level is 85.3284 cm at t plus 2849.542 s and 34.118 psia
Maximum Smoothed Hot SP Level is 86.3905 cm at t plus 5309.1817 s and 43.6737 psia
SP 12 Temperature at the beginning is 40.432 C, and at the end is 127.9371 C
At plume detection, the Mixing Number is 44.8139
The Mixing Number ranges from a minimum of 40.6672 at (KEY POINT #12) t plus 0 s to a maximum of 227.6333 at (KEY POINT #13) t plus 9336.144 s; it had a mean value of 101.5207 +/- 55.3862 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat

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        Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,
        Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
        Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
        Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
        (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
        Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
        Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 40.6672):  33.76693435         0.040894
        0.00925          0.3937     0.8485546192     0.8509330776     1.006321913
        1                1      29.08978363      104078.2906    0.06956789776
        0.05461064697    0.04435072261 2.873584963e-006    0.04435072261      40.17477116
        128.1872887      121.7707737      40.95337758      40.39381282      40.10855865
        35.78166995      4.178287122       4.24945629      2.184389716     0.6289091084
        0.683902644      0.683902644       4.32283105      1.419200572    0.04157663592
        992.1991288      941.6716776      1.182111113      1.160858486  0.0006506656297
        0.0002284045199 1.301707796e-005 1.326756047e-005      1531.796404
        1518.353279      482.5641462      487.1692282      2.100644111      2.043628264
        2.080628264     0.07453512326    0.07768109615      2723.231497      2722.385281
        168.4491613      511.3146326      2708.494898      342.8654713      2211.916864
        171.7024015      169.3628751      168.1741013       150.098729
KEY POINT #2 (t plus 863.2124 s with a Mixing Number of 44.8139):  32.6807584
        0.040894         0.00925          0.3937     0.849949505     0.853339833
        1.00818448              1                1      27.6033057      99949.3041
        0.0681547526    0.0544380914    0.0429240995 1.64553121e-006    0.0429240995
        48.7418885      130.923766      122.623128      50.7443126      48.6880715
        49.1189473      43.8525311      4.17904386      4.25096942      2.18950736
        0.639169894     0.684030619     0.684030619     3.65170825      1.40882831
        0.0417603234     988.656179      940.976636      1.21198238      1.18398903
        0.000558515788  0.000226696926  1.3046469e-005  1.3371248e-005      1544.07468
        1517.04922      482.932261      488.858548      2.15738425      2.10005754
        2.13705754     0.116004907     0.128147623      2728.4444       2727.68245
        204.252012      514.941273      2709.71935      310.689261      2213.50312
        212.620629      204.025637      205.829326      183.826502
KEY POINT #3 (t plus 1231.6184 s with a Mixing Number of 46.6016):  32.716868
        0.040894         0.00925          0.3937     0.850691483     0.854592475
        1.00848238              1                1      27.290695       99854.8597
        0.0676438943    0.0543455994    0.0429715272 2.25075822e-006    0.0429715272
        51.7815561      131.670552      123.079385      55.7903787      52.3194826
        52.67409      46.7207198      4.17970493      4.25178691      2.19227802
        0.642524488     0.684095728     0.684095728     3.45331433      1.40334508
        0.0418596129     987.279239      940.603309      1.22822066      1.19889148
        0.000530860207  0.000225792683 1.30622038e-005 1.33986829e-005      1547.42652
        1516.34367      483.12816       489.261057      2.18826638      2.13094974
        2.16794974     0.134854788     0.163680226      2729.72339      2728.97861
        216.958526      516.883142      2710.37259      299.924617      2212.84025
        233.716477      219.205479      220.690697      195.813983
KEY POINT #4 (t plus 2954.044 s with a Mixing Number of 57.9211):  33.37585138
        0.040894         0.00925          0.3937     0.8532480159     0.8602631332
        1.007630461              1                1      25.23634313      101276.1001
        0.06511002431    0.05367185635    0.04383705998 4.269703282e-006    0.04383705998
        66.45283314      134.0109917      126.3901786      81.35163822      69.31646446
        64.25081069      56.7564521      4.185657708      4.257878355      2.213042816
        0.6567264215     0.6844976072     0.6844976072      2.704917272      1.364947777
        0.04260056052      979.8315702      937.8676479      1.351384425      1.322660023
        0.0004243994049  0.0002194293518 1.317642005e-005 1.347674392e-005
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     1557.022434     1511.069028     484.5254664     490.0238924     2.423321546
     2.371756258     2.408756258     0.2671392587    0.5007010359     2732.36862
     2731.731747     278.3384693     530.9861625      2715.06621     252.6476932
     2201.382457     340.7738457     290.3256494     269.1243844     237.7814188
KEY POINT #5 (t plus 5793.2884 s with a Mixing Number of 107.8478):  34.11235112
     0.040894        0.00925          0.3937     0.8497175675    0.8630182943
     1.002367204           1               1      19.30114921     102516.8077
     0.05920094968   0.05163672361   0.04480440558 -2.770918988e-007
     0.04480440558    98.49738588     138.5053254     136.2612536     115.4003738
     99.55306462     79.10375697     60.86295201     4.214252361     4.277780275
     2.281999753     0.6772500231    0.6849697532    0.6849697532    1.781643145
     1.263622223    0.04503300884    959.5342859     929.4343473     1.778771606
     1.767363165  0.0002863183686  0.0002023346097 1.351720083e-005 1.360743198e-005
     1546.900173     1493.773399      488.43414      490.1455943     3.248610425
     3.200048958     3.237048958     0.9609907668    1.713975674     2734.023852
     2733.651318     412.9323082     573.1674781      2728.54909     160.2351699
     2160.856374     484.3601303     417.3806177     331.4105876     255.0240284
KEY POINT #6 (t plus 7110.3097 s with a Mixing Number of 147.3186):  33.3599877
     0.040894        0.00925          0.3937     0.838709315     0.854676993
     0.998997339     0.998997339     0.999997731      15.9558964      99393.1252
     0.0566826981    0.0503765366     0.043816224 4.84494435e-007     0.043816224
     111.414024      142.282429      142.282429      129.079417      111.831217
     85.1110821      62.6422973      4.23192498      4.29129066      2.32934001
     0.681815622     0.68473371      0.68473371      1.5597958       1.21026093
     0.0466903822     949.976688      924.086836      2.08869387      2.09078548
     0.000251302457  0.000193113569 1.37251232e-005 1.37255301e-005     1533.19981
     1482.11198      490.625201      490.603461      3.85459128      3.80724395
     3.84424395      1.50320024      2.62901209      2734.48343      2734.22884
     467.521238      599.004243      2736.37189      131.483005      2135.47919
     542.540031      469.285669      356.670271      262.517738
KEY POINT #7 (t plus 7719.7385 s with a Mixing Number of 167.2513):  33.0524828
     0.040894        0.00925          0.3937     0.835208479      0.85248605
     0.997012214     0.997012214     0.999992707      14.6936239      97799.0762
     0.0556916471    0.0498006115    0.0434123358 8.39660351e-007    0.0434123358
     116.396253      145.012503      145.012503      133.187222      117.031524
     109.39799      63.5500628      4.23974749      4.29778355      2.35212747
     0.683045332     0.684498048     0.684498048      1.48855648      1.18791931
     0.0474872888     946.093939      921.611333      2.24278278      2.24948741
     0.000239814177  0.000189197161 1.38193856e-005 1.38206646e-005      1526.6686
     1476.55597      491.569745      491.502462      4.15778018      4.11098529
     4.14798529      1.77024594      2.97037429      2733.66715      2733.45125
     488.646656      610.747901      2739.81244      122.101245      2122.91925
     560.087642      491.33916       459.016078      266.340688
KEY POINT #8 (t plus 9198.5651 s with a Mixing Number of 222.4009):  31.339967
     0.040894        0.00925          0.3937     0.830598794     0.850836238
     0.995288335     0.995288335     0.999986342      11.8089978      91260.2105
     0.0535709685    0.0484336709    0.0411630552 5.13564559e-006    0.0411630552
     126.884045      151.440702      151.440702      141.690248      127.602321
     125.768352      65.7619254      4.25817273      4.3140334       2.4090229
     0.684699365     0.683630181     0.683630181      1.35932459      1.13944741
     0.0494795821     937.572284      915.656556      2.64176705      2.65423684
     0.000218574666   0.00018056435 1.40412678e-005 1.40435421e-005      1510.8241
     1462.82701      493.672313      493.556926      4.94772622      4.90229787
     4.93929787      2.46008028      3.79123779      2737.84075      2737.7013
     533.261502      638.475552      2747.63897      105.214051      2099.3652
     596.533164      536.319363      528.51314       275.661192
KEY POINT #9 (t plus 9306.5423 s with a Mixing Number of 226.0249):  31.8489377
     0.040894        0.00925          0.3937     0.830208997     0.850672155
     0.995410686     0.995410686      0.99998653      11.8579833      92632.8756
     0.0534183137    0.0483305874    0.0418315558   3.960987e-006    0.0418315558
     127.630394      151.922626      151.922626      142.516573      128.276043
     126.724289      65.9780009      4.25959031      4.31530828      2.41347066
     0.684769566     0.683547546     0.683547546      1.35107332      1.13603328
     0.0496356447     936.947969      915.202966       2.6738275      2.68611893
     0.000217197858  0.000179948386 1.40578975e-005  1.4060132e-005     1509.59222
     1461.76163      493.823047      493.709989      5.01147465      4.96596092
     5.00296092      2.51649072      3.87987471       2738.6777      2738.53709
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      536.444451      640.558792      2748.20976      104.114341      2098.11891
      600.082623      539.193878      532.586861      276.570678
KEY POINT #10 (t plus 9336.144 s with a Mixing Number of 227.6333):  31.930864
      0.040894        0.00925         0.3937     0.830104244      0.85064691
      0.995511991     0.995511991     0.999986786      11.8526515      92842.8601
      0.0533657316    0.0483037315    0.0419391608  4.6456069e-006    0.0419391608
      127.887219      152.048116      152.048116      142.543257      128.410618
      126.944755      66.071764       4.26008296      4.31564159      2.41463298
      0.68479195     0.683525629     0.683525629      1.34826082      1.13514907
      0.0496764382     936.732307      915.08469      2.68222676      2.69428329
      0.000216727741  0.000179788675 1.40622276e-005 1.40644176e-005      1509.16392
      1461.4834      493.862139      493.751414      5.02818173      4.98272056
      5.01972056      2.5361433       3.88276448      2739.04111      2738.90063
      537.539618      641.10136       2748.35801      103.561742      2097.93975
      600.198208      539.768437      533.526757      276.964446
KEY POINT #11 (t plus 9336.144 s with a Mixing Number of 227.6333):  31.930864
      0.040894        0.00925         0.3937     0.830104244      0.85064691
      0.995511991     0.995511991     0.999986786      11.8526515      92842.8601
      0.0533657316    0.0483037315    0.0419391608  4.6456069e-006    0.0419391608
      127.887219      152.048116      152.048116      142.543257      128.410618
      126.944755      66.071764       4.26008296      4.31564159      2.41463298
      0.68479195     0.683525629     0.683525629      1.34826082      1.13514907
      0.0496764382     936.732307      915.08469      2.68222676      2.69428329
      0.000216727741  0.000179788675 1.40622276e-005 1.40644176e-005      1509.16392
      1461.4834      493.862139      493.751414      5.02818173      4.98272056
      5.01972056      2.5361433       3.88276448      2739.04111      2738.90063
      537.539618      641.10136       2748.35801      103.561742      2097.93975
      600.198208      539.768437      533.526757      276.964446
KEY POINT #12 (t plus 0 s with a Mixing Number of 40.6672):  33.76693435         0.040894
      0.00925         0.3937     0.8485546192     0.8509330776      1.006321913
      1               1      29.08978363      104078.2906    0.06956789776
      0.05461064697    0.04435072261 2.873584963e-006    0.04435072261      40.17477116
      128.1872887      121.7707737      40.95337758      40.39381282      40.10855865
      35.78166995      4.178287122      4.24945629      2.184389716     0.6289091084
      0.683902644      0.683902644      4.32283105      1.419200572    0.04157663592
      992.1991288      941.6716776      1.182111113      1.160858486  0.0006506656297
      0.0002284045199 1.301707796e-005 1.326756047e-005      1531.796404
      1518.353279      482.5641462      487.1692282      2.100644111      2.043628264
      2.080628264    0.07453512326    0.07768109615      2723.231497      2722.385281
      168.4491613      511.3146326      2708.494898      342.8654713      2211.916864
      171.7024015      169.3628751      168.1741013      150.098729
KEY POINT #13 (t plus 9336.144 s with a Mixing Number of 227.6333):  31.930864
      0.040894        0.00925         0.3937     0.830104244      0.85064691
      0.995511991     0.995511991     0.999986786      11.8526515      92842.8601
      0.0533657316    0.0483037315    0.0419391608  4.6456069e-006    0.0419391608
      127.887219      152.048116      152.048116      142.543257      128.410618
      126.944755      66.071764       4.26008296      4.31564159      2.41463298
      0.68479195     0.683525629     0.683525629      1.34826082      1.13514907
      0.0496764382     936.732307      915.08469      2.68222676      2.69428329
      0.000216727741  0.000179788675 1.40622276e-005 1.40644176e-005      1509.16392
      1461.4834      493.862139      493.751414      5.02818173      4.98272056
      5.01972056      2.5361433       3.88276448      2739.04111      2738.90063
      537.539618      641.10136       2748.35801      103.561742      2097.93975
      600.198208      539.768437      533.526757      276.964446
KEY POINT #14 (t plus 3487.1534 s with a Mixing Number of 62.9271):  33.59573585
      0.040894        0.00925         0.3937     0.853087058     0.8611924652
      1.006902591              1              1      24.32605045      101791.6099
      0.06422432382    0.05337635945    0.04412586425 4.462237049e-006    0.04412586425
      71.43539144      134.6822165      127.8353201      89.98507493      75.11532501
      67.55597884      57.87352082      4.188702783      4.26062655      2.222474032
      0.6608319386     0.6846343461     0.6846343461      2.510844745      1.348925204
      0.04293546128      977.0210177      936.6588916      1.408172695      1.381199685
      0.0003961241669  0.0002167569756 1.322629242e-005 1.349682968e-005
      1558.029679      1508.682305      485.1219343      490.0944751      2.532161907
      2.481098945      2.518098945     0.3318913955     0.7014258766      2732.727755
      2732.135999      299.2100883      537.1488235      2717.088765      237.9387352
      2195.578932      377.0462199      314.6275604      282.9666881      242.4615249
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End

D.10 TEST #10 - T10_RCIC_10PSIG_157KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T10_RCIC_10PSIG_157kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1972.1408 s, and ending (KEY POINT #11) at t
       plus 8424.3438 s, for a time period of 6452.203 s.
Original Data Record Time:  10330.6779 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       1916.9306 s, T_bulk = 66.152 C and T_out = 63.0554 C
Stratification Beginning SP12 Temperature = 65.9766 C
Stratification Beginning Pressure = 29.2395 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       6423.3044 s, T_bulk = 132.5826 C and T_out = 78.5434 C
Stratification Ending SP12 Temperature = 133.7023 C
Stratification Ending Pressure = 74.314 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1165.6177 s.
At t = 1165.6177 s, the pool pressure is 27.5849 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 55.863, 55.8709, 57.8771, 55.3824, and 52.4329
       C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 10.9224 +/- 2.9501 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.9327 +/- 2.6307 C.
Minimum Steam Quality:  0.98553 at t plus 0.50003 s
Maximum Steam Quality:  1.0025 at t plus 3712.3603 s
Time-Averaged Steam Quality:  0.99903 +/- 0.0016174
Minimum Turbine Outlet Steam Quality:  0.99869 at t plus 6360.4018 s
Maximum Turbine Outlet Steam Quality:  1.0206 at t plus 1419.2222 s
Time-Averaged Turbine Outlet Steam Quality:  1.0127 +/- 0.005388
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 6362.2019 s; using 300 s smoothing
Max and min smoothed upper level changerates:  1.3845 degrees/min at t plus 3065.2483 s
       and 0.66302 degrees/min at t plus 6279.0011 s, respectively
Max and min smoothed mid (SP9) level changerates:  1.2455 degrees/min at t plus 3279.2766
       s and 0.64553 degrees/min at t plus 42.3004 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.57573 degrees/min at t
       plus 3021.6488 s and -0.24031 degrees/min at t plus 3293.5524 s, respectively
Max and min smoothed lower level changerates:  3.9956 degrees/min at t plus 6080.9978 s
       and 0.10504 degrees/min at t plus 3136.4504 s, respectively
Max and min smoothed mid-lower level changerate differences:  1.0207 degrees/min at t
       plus 3255.2522 s and -3.2352 degrees/min at t plus 6080.9978 s, respectively
Max and min smoothed outlet level changerates:  1.2034 degrees/min at t plus 922.8158 s
       and -0.055276 degrees/min at t plus 4047.0655 s, respectively
Max and min smoothed lower-outlet level changerate differences:  3.9659 degrees/min at t
       plus 6080.9978 s and -0.34609 degrees/min at t plus 3136.3504 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.8571 degrees/min at t plus 1997.0322
       s and 0.30683 degrees/min at t plus 3022.8479 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  1.0434 degrees/min
       at t plus 1996.9562 s and -0.51214 degrees/min at t plus 3110.5499 s,
       respectively
The mean steam flow rate was 65.4446 +/- 3.2311 g/s
The mean feedwater flow rate was 64.2034 +/- 8.469 g/s
The mean water injection to steam flow rate was 0.0020395 +/- 0.038746 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 12.0158 +/- 1.1432 C over the
       Stratification Period, beginning at 8.0814 C and ending at 9.9239 C
Mean Smoothed SP8-Upper Pool delta T is 10.8785 +/- 1.197 C over the Stratification
       Period, beginning at 7.4879 C and ending at 9.3168 C
The stratification period begins and ends with Smoothed SP8 readings of 74.1375 and
       143.6922 C, respectively
The stratification period begins and ends with condensing flows of 0.6247 and 1.7129 kg/s,
       respectively.
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The stratification period begins and ends with condensing+cooling flows of 4.652 and 3.3957 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2749.7712 +/- 1.412 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.54326 and 19.2421 kg/s, respectively
The plume period had a mean steam enthalpy of 2750.1193 +/- 1.3926 kJ/kg.
Maximum Smoothed Top-Mid delta T is 2.861 degrees C at t plus 3209.1506 s with T_upper = 86.2736 C and T_mid = 83.4126 C
At t plus 3209.1506 s, Smoothed SP8-SP9 is 11.7256 C and Smoothed SP8-Top is 8.8646 C, where Smoothed SP8 is 95.1382 C and Pool P = 34.6579 psia
Maximum Smoothed Top-Lower delta T is 27.5226 degrees C at t plus 5602.6905 s with T_upper = 124.1762 C and T_low = 96.6537 C
At t plus 5602.6905 s, Smoothed SP8-SP9 is 11.1787 C and Smoothed SP8-Top is 10.0628 C, where Smoothed SP8 is 134.239 C and Pool P = 60.8373 psia
Maximum Smoothed Mid-Lower delta T is 26.5378 degrees C at t plus 5625.3898 s with T_mid = 123.3843 C and T_low = 96.8465 C
At t plus 5625.3898 s, Smoothed SP8-SP9 is 10.939 C and Smoothed SP8-Top is 10.0063 C, where Smoothed SP8 is 134.3233 C and Pool P = 61.2028 psia
Maximum Smoothed Top-Outlet delta T is 56.2813 degrees C at t plus 6452.203 s with T_upper = 134.8783 C and T_out = 78.597 C
At t plus 6452.203 s, Smoothed SP8-SP9 is 10.0443 C and Smoothed SP8-Top is 9.2832 C, where Smoothed SP8 is 144.1615 C and Pool P = 74.7639 psia
Maximum Smoothed Mid-Outlet delta T is 55.5202 degrees C at t plus 6452.203 s with T_mid = 134.1172 C and T_out = 78.597 C
At t plus 6452.203 s, Smoothed SP8-SP9 is 10.0443 C and Smoothed SP8-Top is 9.2832 C, where Smoothed SP8 is 144.1615 C and Pool P = 74.7639 psia
Maximum Smoothed Lower-Outlet delta T is 52.1101 degrees C at t plus 6452.203 s with T_low = 130.707 C and T_out = 78.597 C
At t plus 6452.203 s, Smoothed SP8-SP9 is 10.0443 C and Smoothed SP8-Top is 9.2832 C, where Smoothed SP8 is 144.1615 C and Pool P = 74.7639 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 15.0367 degrees C at (KEY POINT #14) t plus 2719.0435 s with T_SP8 = 91.8245 C and T_SP9 = 76.7878 C and Pool P = 32.01 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 14.0666 degrees C at t plus 2719.0435 s with T_SP8 = 91.8245 C and T_upper = 77.7579 C and Pool P = 32.01 psia
Maximum Top-Mid delta T is 3.9524 degrees C at (KEY POINT #4) t plus 3144.4509 s ignoring SP 4, with temperatures of 85.8823 and 81.9299 C, respectively, at Set # 2, where Pool P = 34.2614 psia and T_outlet = 75.1862 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 3931.4639 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.3172 C and a raw SP12 Reading of 96.3293 C.
Maximum Top-Lower delta T is 32.341 degrees C at t plus 5791.0942 s, with temperatures of 126.8237 and 94.4827 C, respectively, at Set # 1, where Pool P = 63.8087 psia and T_outlet = 78.2266 C
Maximum Mid-Low delta T is 28.9671 degrees C at (KEY POINT #6) t plus 5714.7929 s ignoring SP 4, with temperatures of 124.5781 and 95.611 C, respectively, at Set # 2, where Pool P = 62.5867 psia and T_outlet = 78.0357 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6203.1998 s with a Smoothed Mid-Axis Mid-Low Delta T of 9.6535 C and a raw SP12 Reading of 131.1013 C.
Maximum Top-Outlet delta T is 56.636 degrees C at t plus 6434.803 s, with temperatures of 135.1033 and 78.4673 C, respectively, at Set # 1, where Pool P = 74.4924 psia
Maximum Mid-Outlet delta T is 55.4838 degrees C at t plus 6437.1032 s ignoring SP 4, with temperatures of 133.896 and 78.4122 C, respectively, at Set # 2, where Pool P = 74.525 psia
Maximum Lower-Outlet delta T is 54.9649 degrees C at (KEY POINT #8) t plus 6450.903 s, with temperatures of 133.5889 and 78.624 C, respectively, at Set # 3, where Pool P = 74.7499 psia
Low-Outlet Reconvergence NOT Detected, setting t to (KEY POINT #10) t plus 6452.203 s with a Smoothed Mid-Axis Low-Outlet Delta T of 52.1669 C and a raw SP12 Reading of 134.0296 C.
Minimum SP Pressure is 25.9227 psia at t plus 0 s
Maximum SP Pressure is 74.7675 psia at t plus 6451.904 s
Beginning SP Pressure is 25.9227 psia
Ending SP Pressure is 74.7639 psia
Time-Average SP Pressure is 40.3044 +/- 14.1225 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 80.1156 cm (cold) / 80.2746 cm (hot) at 24.665 psia

Beginning Smoothed SP Level is 81.0583 cm (cold) / 81.2619 cm (hot) at 25.9319 psia
Ending Smoothed SP Level is 81.0978 cm (cold) / 83.2189 cm (hot) at 74.7735 psia
Minimum Smoothed Cold SP Level is 81.0583 cm at t plus 0 s and 25.9319 psia
Minimum Smoothed Hot SP Level is 81.2619 cm at t plus 0 s and 25.9319 psia
Maximum Smoothed Cold SP Level is 83.1427 cm at t plus 3236.4521 s and 34.8253 psia
Maximum Smoothed Hot SP Level is 84.3811 cm at t plus 4253.4953 s and 43.0168 psia
SP 12 Temperature at the beginning is 39.7463 C, and at the end is 134.0296 C
At plume detection, the Mixing Number is 46.2584
The Mixing Number ranges from a minimum of 38.6305 at (KEY POINT #12) t plus 2.5011 s to a maximum of 252.9774 at (KEY POINT #13) t plus 6452.203 s; it had a mean value of 99.0716 +/- 60.5542 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11

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KEY POINT #1 (t plus 0 s with a Mixing Number of 41.1958):  257.3335301        0.040894
        0.00925          0.3937     0.8105830862     0.8126194415     0.9838296021
        0.9838296021      0.999981729      241.0381455      816781.0739     0.0695738875
        0.05541243958     0.3379912399 4.038358636e-006     0.3379912399       40.1379383
        117.7902705      117.7902705      40.70699012      40.11092407      40.05886316
        36.43836618      4.178350449      4.242628517      2.161482433      0.628849109
        0.6831949643     0.6831949643       4.32628639      1.469952462    0.04074923736
        992.2023808      944.8762526      1.050373147      1.067617759   0.000651113729
        0.0002367080021 1.287989823e-005 1.288398779e-005      1531.692757
        1524.198641      480.8083173      480.5581457      1.851544355      1.787944945
        1.824944945    0.07438906537     0.0766734004      2725.097645      2666.998257
        168.2726106      494.3958618      2702.707536      326.1232512      2230.701783
        170.6503075      168.1582294      167.943802      152.819856
KEY POINT #2 (t plus 1165.6177 s with a Mixing Number of 46.2584):  49.1132336
        0.040894         0.00925          0.3937     0.8205645728     0.824634847
        1.017625724            1                1      46.11465092      146958.3118
        0.06694890457    0.05497971799     0.0645071115 2.709577341e-006     0.0645071115
        55.87090261      138.1830239      119.9426414      57.87708811      55.86297469
        55.38237326      52.43291771      4.180971248       4.24627207      2.173667669
        0.6467949388     0.6836002001     0.6836002001      3.213067018      1.442026556
        0.04119047656     985.3226842      943.1519023      1.120045228      1.065069248
        0.0004970604584  0.0002321494304 1.295405844e-005 1.366670963e-005
        1551.115574      1521.088247      481.7652195      494.3649894      1.983047923
        1.901624553      1.938624553     0.1643092829     0.1806620894      2746.794799
        2744.668238      234.0336685      503.5407506      2705.850927      269.5070821
        2243.254048      242.4221823      233.9990787      231.992713      219.6668265
KEY POINT #3 (t plus 1916.9306 s with a Mixing Number of 53.4326):  49.20223294
        0.040894         0.00925          0.3937     0.8253830445     0.8311087707
        1.017533227            1                1      43.92808279       146663.826
        0.06517999864    0.05463916443    0.06462400649 1.504310264e-006    0.06462400649
        66.05614466      139.6641609      121.6297645      74.13754097      66.64960553
        65.81865718      63.07675956       4.18551385      4.249207722      2.183550381
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     0.6563662249     0.6838806746     0.6838806746      2.721559526      1.420932861
     0.04154647237      980.035506      941.7863618      1.177227158      1.120089363
     0.0004267910264  0.0002286893433 1.301221616e-005 1.371896649e-005
     1556.835112      1518.567251      482.5029778      494.9959654      2.091375776
     2.016286841      2.053286841      0.2624803447     0.3722368402     2748.752112
     2746.822436      276.6487359      510.7147904      2708.29182      234.0660545
     2238.037322      310.4935079       279.13137      275.6562331      264.1861035
KEY POINT #4 (t plus 3144.4509 s with a Mixing Number of 70.9155):  50.87332857
     0.040894         0.00925          0.3937     0.8313617057     0.8407891344
     1.01539176              1                1      39.21006123      150840.509
     0.06223235455     0.053655728     0.06681888441 -4.914349453e-007
     0.06681888441     82.39601961      141.9854557      126.4691629      94.07735194
     85.08668145      80.13992228      75.09412564      4.197296317      4.25802714
     2.213552472      0.6686282908     0.6845056858     0.6845056858      2.159805289
     1.364060771    0.04261868221      970.3591151      937.8018131      1.354439727
     1.297446441  0.0003440564616   0.000219281682 1.317914559e-005 1.379214319e-005
     1556.626537      1510.939897      484.5582786      495.4662667      2.429170194
     2.363198391      2.400198391      0.5220629254     0.8177588869     2750.327959
     2748.790531       345.156262      531.3228751      2715.177169      186.1666131
     2219.005084      394.2529497      356.4517461      335.6904219      314.5356505
KEY POINT #5 (t plus 3931.4639 s with a Mixing Number of 94.5454):  52.79563695
     0.040894         0.00925          0.3937     0.8306661632     0.8427682819
     1.012922759             1                1      35.14669514      155809.0478
     0.05959657143    0.05264387607    0.06934371432 1.094732897e-006    0.06934371432
     96.43217726      144.1397939      131.3998553      108.9569306      97.8740747
     84.57606543      77.27605605      4.211847223      4.267643702      2.246705244
     0.6763105373     0.6848719841     0.6848719841      1.823029717      1.311207577
     0.04379217078     960.9764841      933.6394181      1.556493023      1.502174535
     0.0002927300403  0.0002104227526 1.334933942e-005 1.385686395e-005
     1548.556602      1502.579991      486.5578233      495.6872556      2.817684379
     2.75408574       2.79108574     0.8916775873      1.384245073     2751.280435
     2750.045145      404.1977432      552.3677171      2722.007414      148.1699739
     2198.912718      457.0506856      410.2707583      354.3408568      323.7139194
KEY POINT #6 (t plus 5714.7929 s with a Mixing Number of 195.0669):  50.64139732
     0.040894         0.00925          0.3937     0.8143423413     0.8327188869
     1.004119071             1                1      21.78800405      147558.2536
     0.05402257286    0.04941850634    0.06651425745 2.978211043e-006    0.06651425745
     124.6695233       150.548969      146.8165806      135.7664646      125.6489051
     98.83053988      78.09219538      4.254158455      4.302205246      2.367637153
     0.6844298253       0.68429867       0.68429867      1.384521688      1.17374697
     0.04802983535      939.390677      919.9580091      2.349513506      2.324382936
     0.0002227486227  0.0001866934385 1.388166781e-005 1.403465582e-005
     1514.304701      1472.794005      492.1770741      495.1169771      4.368440455
     4.315326961      4.352326961      2.298725171      3.202457234      2751.270067
     2750.79535      523.7958379      618.5186749      2742.048379      94.72283707
     2132.751392      571.1240105      527.9619841      414.4217996      327.2610664
KEY POINT #7 (t plus 6203.1998 s with a Mixing Number of 233.173):  50.56742029
     0.040894         0.00925          0.3937     0.8123511693     0.8326517055
     1.002155027             1                1      19.36275597      146537.7098
     0.0527093552    0.04848393899    0.06641709332 4.412215866e-006    0.06641709332
     131.0822197      153.1033332      151.2055536      141.5771159      131.8442462
     122.9422286      78.30448987      4.266452192      4.313414281      2.406861873
     0.6849880612      0.683669616      0.683669616      1.314393552      1.141123993
     0.04940377733     934.0087767      915.8775158      2.626235757      2.611755251
     0.0002110287073  0.0001808664207 1.403315323e-005 1.411175382e-005
     1503.621234      1463.345031      493.5984149       495.143807      4.916857548
     4.865317528      4.902317528      2.791227949      3.779230508      2752.281449
     2751.906532      551.1526357      637.4592949      2747.359641      86.3066592
     2114.822154      596.0455124      554.4032111       516.489923      328.1952522
KEY POINT #8 (t plus 6450.903 s with a Mixing Number of 252.8339):  51.14267371
     0.040894         0.00925          0.3937     0.8109885354     0.8321955778
     1.001374747             1                1      18.52145709      147730.5167
     0.0520856965    0.04802346033    0.06717265214 2.925668418e-006    0.06717265214
     134.0996809      154.5479284      153.3561834      144.1102798      134.8586189
     130.6840064       78.5953019      4.272620604      4.319148973      2.426850764
     0.6850927627     0.6832873392     0.6832873392      1.284183636      1.126049382
     0.05010550744     931.4161109      913.8477628      2.771043231      2.76138648
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      0.0002059122483  0.0001781404835  1.41073606e-005 1.415705126e-005
      1498.255113      1458.56305       494.2657226      495.2520296      5.204999524
      5.153982016      5.190982016      3.050867162      4.055535615      2753.128484
      2752.785439      564.0549508      646.7595487      2749.894162       82.7045979
      2106.368935      606.9369943      567.297062       549.474537       329.4377951
KEY POINT #9 (t plus 6423.3044 s with a Mixing Number of 250.3901):  51.16210873
      0.040894         0.00925           0.3937     0.8112077353     0.8323074586
      1.001539273              1                1      18.64275535      147806.5434
      0.05215435689    0.04807266997     0.0671981788 4.572812691e-006     0.0671981788
      133.7683343      154.464291       153.1267197      143.6922164      134.3754158
      130.0756522      78.53382515      4.271930547      4.318529308      2.42469403
      0.6850862333     0.6833304363     0.6833304363      1.287419313      1.127630339
      0.05002972968     931.7027597      914.065282        2.7552949       2.744529408
      0.0002064624502  0.0001784274406 1.409944372e-005 1.415514649e-005
      1498.855055      1459.077992      494.1954396      495.2998064      5.17362747
      5.122445185      5.159445185      3.021435686      4.008849231      2753.211876
      2752.864324      562.6372597      645.7666301       2749.62591      83.12937042
      2107.445246      605.1395057      565.2299081      546.8778219      329.1774789
KEY POINT #10 (t plus 6452.203 s with a Mixing Number of 252.9774):  51.13763826
      0.040894         0.00925           0.3937     0.8109780487      0.832189445
      1.001377363              1                1      18.51524771      147711.4225
      0.05208206345    0.04802132927     0.0671660384 3.141450903e-006     0.0671660384
      134.1172077      154.5600938      153.3661185      144.1615285      134.8782838
      130.7070469      78.59696661      4.272657249      4.319175845      2.426944274
      0.6850930617     0.6832854607     0.6832854607      1.284013007      1.125981078
      0.05010879331     931.4009179      913.8383397      2.771726713      2.762049465
      0.000205883213  0.0001781280798 1.410770338e-005 1.415748724e-005
      1498.223257      1458.540729      494.2687607      495.256942      5.206361271
      5.155452495      5.192452495      3.052430398      4.061288672      2753.145316
      2752.802502      564.1299337      646.8025425      2749.905765      82.67260879
      2106.342774      607.1572176      567.3812115      549.5729167      329.4448934
KEY POINT #11 (t plus 6452.203 s with a Mixing Number of 252.9774):  51.13763826
      0.040894         0.00925           0.3937     0.8109780487      0.832189445
      1.001377363              1                1      18.51524771      147711.4225
      0.05208206345    0.04802132927     0.0671660384 3.141450903e-006     0.0671660384
      134.1172077      154.5600938      153.3661185      144.1615285      134.8782838
      130.7070469      78.59696661      4.272657249      4.319175845      2.426944274
      0.6850930617     0.6832854607     0.6832854607      1.284013007      1.125981078
      0.05010879331     931.4009179      913.8383397      2.771726713      2.762049465
      0.000205883213  0.0001781280798 1.410770338e-005 1.415748724e-005
      1498.223257      1458.540729      494.2687607      495.256942      5.206361271
      5.155452495      5.192452495      3.052430398      4.061288672      2753.145316
      2752.802502      564.1299337      646.8025425      2749.905765      82.67260879
      2106.342774      607.1572176      567.3812115      549.5729167      329.4448934
KEY POINT #12 (t plus 2.5011 s with a Mixing Number of 38.6305):  39.40112862
      0.040894         0.00925           0.3937     0.8105904393     0.8126271725
      1.009952704              1                1      38.61207197      121336.5071
      0.0695674414    0.05541210227    0.05175087876  3.57555551e-006    0.05175087876
      40.17757731      128.0891226      117.7919521      40.73250617      40.13704332
      40.10490675      36.44859844      4.178350003      4.24263132       2.16149177
      0.6288994247     0.6831953017     0.6831953017      4.322730487      1.469930186
      0.04074957652     992.1872013      944.8749132      1.050426178      1.020505995
      0.0006506306831  0.0002367043755 1.287995615e-005 1.327934842e-005
      1531.759797      1524.196257      480.8090717      488.053821       1.851644238
      1.78806451       1.82506451    0.07454626102    0.07677723164     2726.179522
      2724.68863      168.4382468      494.4030033      2702.710004      325.9647565
      2231.776518      170.756933      168.2673755      168.1361986      152.8626227
KEY POINT #13 (t plus 6452.203 s with a Mixing Number of 252.9774):  51.13763826
      0.040894         0.00925           0.3937     0.8109780487      0.832189445
      1.001377363              1                1      18.51524771      147711.4225
      0.05208206345    0.04802132927     0.0671660384 3.141450903e-006     0.0671660384
      134.1172077      154.5600938      153.3661185      144.1615285      134.8782838
      130.7070469      78.59696661      4.272657249      4.319175845      2.426944274
      0.6850930617     0.6832854607     0.6832854607      1.284013007      1.125981078
      0.05010879331     931.4009179      913.8383397      2.771726713      2.762049465
      0.000205883213  0.0001781280798 1.410770338e-005 1.415748724e-005
      1498.223257      1458.540729      494.2687607      495.256942      5.206361271
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        5.155452495      5.192452495      3.052430398      4.061288672      2753.145316
        2752.802502      564.1299337      646.8025425      2749.905765      82.67260879
        2106.342774      607.1572176      567.3812115      549.5729167      329.4448934
KEY POINT #14 (t plus 2719.0435 s with a Mixing Number of 63.8539):  50.35810645
        0.040894          0.00925          0.3937     0.8300810069      0.837959011
        1.016525651              1              1      41.39879462      149576.2235
        0.06325900197     0.0540880934     0.0661421729 -7.132868137e-008
        0.0661421729      76.78777623      141.1606023      124.3474068      91.82445469
        77.757858      77.16956636      71.59102345      4.192634712      4.254086628
        2.200093324     0.6648331172     0.6842642768     0.6842642768      2.327823526
        1.388353817     0.0421391175      973.8366231      939.5610909      1.274273454
        1.216413488  0.0003691268802  0.0002233148978 1.310594076e-005 1.376785933e-005
        1557.891245      1514.355551      483.6683652      495.4015744      2.275990406
        2.207587238      2.244587238     0.4157471496     0.7518799169      2750.083318
        2748.369458      321.6177763      522.2820334      2712.179969      200.6642571
        2227.801285       384.760959       325.683984      323.2199838      299.8448517
End
```

D.11 TEST #11 - T11_RCIC_040GPM_15PSIG_107KW_RESULTS_RCICLAND.TXT

```
Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T11_RCIC_040GPM_15PSIG_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1720.5394 s, and ending (KEY POINT #11) at t
        plus 13127.1358 s, for a time period of 11406.5964 s.
Original Data Record Time:  14133.5534 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
        474.7432 s, T_bulk = 44.7957 C and T_out = 41.8025 C
Stratification Beginning SP12 Temperature = 44.8096 C
Stratification Beginning Pressure = 30.6351 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
        10855.9869 s, T_bulk = 142.6046 C and T_out = 79.3774 C
Stratification Ending SP12 Temperature = 142.3466 C
Stratification Ending Pressure = 93.9264 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 63.4006 s.
At t = 63.4006 s, the pool pressure is 30.255 psia while the Smoothed Upper, Mid, SP8,
        Lower, and Outlet Temperatures are 41.9098, 41.9583, 43.9636, 42.6139, and
        37.9249 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
        temperatures were 14.4716 +/- 3.928 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
        temperatures were 13.1285 +/- 3.7928 C.
Minimum Steam Quality:  0.48095 at t plus 173.7019 s
Maximum Steam Quality:  0.64477 at t plus 10597.7832 s
Time-Averaged Steam Quality:  0.573 +/- 0.018701
Minimum Turbine Outlet Steam Quality:  0.50262 at t plus 173.7019 s
Maximum Turbine Outlet Steam Quality:  0.6546 at t plus 5559.395 s
Time-Averaged Turbine Outlet Steam Quality:  0.58546 +/- 0.017517
Smoothed Changerates may not fully include test beginning and end periods, analysis
        ending at t plus 11316.5953 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.78977 degrees/min at t plus 2178.7366 s
        and 0.35376 degrees/min at t plus 10039.4732 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.85454 degrees/min at t plus
        4461.7762 s and 0.37284 degrees/min at t plus 121.4019 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.31384 degrees/min at t
        plus 2313.3383 s and -0.24154 degrees/min at t plus 4372.2751 s, respectively
Max and min smoothed lower level changerates:  3.2834 degrees/min at t plus 7374.3268 s
        and -0.465 degrees/min at t plus 1461.9236 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.98842 degrees/min at t
        plus 1461.9236 s and -2.7773 degrees/min at t plus 7374.3268 s, respectively
Max and min smoothed outlet level changerates:  1.5524 degrees/min at t plus 11223.794 s
        and 0.01224 degrees/min at t plus 2811.0468 s, respectively
```

Max and min smoothed lower-outlet level changerate differences: 3.1244 degrees/min at t plus 7374.3268 s and -1.1057 degrees/min at t plus 11312.095 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.6029 degrees/min at t plus 2539.8443 s and 0.064231 degrees/min at t plus 2336.1386 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 1.0535 degrees/min at t plus 2539.8443 s and -0.48684 degrees/min at t plus 4821.6818 s, respectively
The mean steam flow rate was 43.6958 +/- 1.0217 g/s
The mean feedwater flow rate was 43.0951 +/- 1.8745 g/s
The mean water injection to steam flow rate was 24.8662 +/- 1.5428 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 14.9345 +/- 3.2237 C over the Stratification Period, beginning at 4.2025 C and ending at 12.4052 C
Mean Smoothed SP8-Upper Pool delta T is 13.5533 +/- 3.193 C over the Stratification Period, beginning at 4.0696 C and ending at 11.5742 C
The stratification period begins and ends with Smoothed SP8 readings of 50.0135 and 154.9343 C, respectively
The stratification period begins and ends with condensing flows of 0.26462 and 1.0086 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 6.028 and 1.6314 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1842.6926 +/- 31.658 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.25075 and 12.7902 kg/s, respectively
The plume period had a mean steam enthalpy of 1839.1216 +/- 36.3323 kJ/kg.
Maximum Smoothed Top-Mid delta T is 4.2898 degrees C at t plus 3193.6537 s with T_upper = 74.4347 C and T_mid = 70.1449 C
At t plus 3193.6537 s, Smoothed SP8-SP9 is 16.9027 C and Smoothed SP8-Top is 12.6129 C, where Smoothed SP8 is 87.0476 C and Pool P = 36.1484 psia
Maximum Smoothed Top-Lower delta T is 27.8172 degrees C at t plus 6776.0996 s with T_upper = 111.4737 C and T_low = 83.6565 C
At t plus 6776.0996 s, Smoothed SP8-SP9 is 17.4617 C and Smoothed SP8-Top is 16.8828 C, where Smoothed SP8 is 128.3566 C and Pool P = 55.1412 psia
Maximum Smoothed Mid-Lower delta T is 27.2384 degrees C at t plus 6776.0996 s with T_mid = 110.8949 C and T_low = 83.6565 C
At t plus 6776.0996 s, Smoothed SP8-SP9 is 17.4617 C and Smoothed SP8-Top is 16.8828 C, where Smoothed SP8 is 128.3566 C and Pool P = 55.1412 psia
Maximum Smoothed Top-Outlet delta T is 64.9496 degrees C at t plus 10477.7813 s with T_upper = 140.3277 C and T_out = 75.378 C
At t plus 10477.7813 s, Smoothed SP8-SP9 is 12.4129 C and Smoothed SP8-Top is 11.7965 C, where Smoothed SP8 is 152.1242 C and Pool P = 89.2598 psia
Maximum Smoothed Mid-Outlet delta T is 64.3334 degrees C at t plus 10478.5813 s with T_mid = 139.7161 C and T_out = 75.3826 C
At t plus 10478.5813 s, Smoothed SP8-SP9 is 12.4223 C and Smoothed SP8-Top is 11.8063 C, where Smoothed SP8 is 152.1383 C and Pool P = 89.271 psia
Maximum Smoothed Lower-Outlet delta T is 63.9533 degrees C at t plus 10466.6817 s with T_low = 139.3108 C and T_out = 75.3575 C
At t plus 10466.6817 s, Smoothed SP8-SP9 is 12.6062 C and Smoothed SP8-Top is 11.9386 C, where Smoothed SP8 is 152.2335 C and Pool P = 89.1229 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 19.116 degrees C at (KEY POINT #14) t plus 3728.6633 s with T_SP8 = 95.6193 C and T_SP9 = 76.5034 C and Pool P = 37.9149 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 18.1473 degrees C at t plus 5969.2014 s with T_SP8 = 121.7678 C and T_upper = 103.6205 C and Pool P = 49.3167 psia
Maximum Top-Mid delta T is 5.5814 degrees C at (KEY POINT #4) t plus 3224.7534 s ignoring SP 4, with temperatures of 75.834 and 70.2526 C, respectively, at Set # 2, where Pool P = 36.2443 psia and T_outlet = 53.0573 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5152.1887 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.8604 C and a raw SP12 Reading of 93.3204 C.
Maximum Top-Lower delta T is 30.3173 degrees C at t plus 6783.017 s, with temperatures of 111.5853 and 81.268 C, respectively, at Set # 1, where Pool P = 55.1801 psia and T_outlet = 62.5785 C
Maximum Mid-Low delta T is 28.9055 degrees C at (KEY POINT #6) t plus 7006.5198 s ignoring SP 4, with temperatures of 112.8796 and 83.9741 C, respectively, at Set # 2, where Pool P = 56.878 psia and T_outlet = 63.3334 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 7583.1307 s with a Smoothed Mid-Axis Mid-Low Delta T of 9.6295 C and a raw SP12 Reading of 117.6405 C.

Maximum Top-Outlet delta T is 65.3332 degrees C at t plus 10472.581 s, with temperatures of 140.7526 and 75.4194 C, respectively, at Set # 1, where Pool P = 89.1915 psia
Maximum Mid-Outlet delta T is 64.3771 degrees C at t plus 10500.7806 s ignoring SP 4, with temperatures of 139.7928 and 75.4157 C, respectively, at Set # 2, where Pool P = 89.5158 psia
Maximum Lower-Outlet delta T is 65.1433 degrees C at (KEY POINT #8) t plus 10246.2761 s, with temperatures of 139.0592 and 73.9158 C, respectively, at Set # 1, where Pool P = 86.599 psia
Low-Outlet Reconvergence NOT Detected, setting t to (KEY POINT #10) t plus 11406.5964 s with a Smoothed Mid-Axis Low-Outlet Delta T of 54.392 C and a raw SP12 Reading of 146.2414 C.
Minimum SP Pressure is 30.2004 psia at t plus 0.72404 s
Maximum SP Pressure is 100.6833 psia at t plus 11406.5964 s
Beginning SP Pressure is 30.2119 psia
Ending SP Pressure is 100.6833 psia
Time-Average SP Pressure is 53.757 +/- 20.796 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 82.4117 cm (cold) / 82.5908 cm (hot) at 29.1824 psia
Beginning Smoothed SP Level is 82.9202 cm (cold) / 83.1472 cm (hot) at 30.2062 psia
Ending Smoothed SP Level is 80.5492 cm (cold) / 83.0359 cm (hot) at 100.6793 psia
Minimum Smoothed Cold SP Level is 80.5491 cm at t plus 11406.0984 s and 100.6731 psia
Minimum Smoothed Hot SP Level is 83.0307 cm at t plus 11373.0965 s and 100.2564 psia
Maximum Smoothed Cold SP Level is 83.3973 cm at t plus 2763.147 s and 34.9134 psia
Maximum Smoothed Hot SP Level is 84.4218 cm at t plus 5168.8306 s and 44.3343 psia
SP 12 Temperature at the beginning is 40.068 C, and at the end is 146.2414 C
At plume detection, the Mixing Number is 41.7762
The Mixing Number ranges from a minimum of 41.5283 at (KEY POINT #12) t plus 0 s to a maximum of 385.9168 at (KEY POINT #13) t plus 11406.5964 s; it had a mean value of 146.4924 +/- 98.3745 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 41.5283): 51.93560575 0.040894
0.00925 0.3937 0.8292021165 0.8314723941 0.5678812083
0.5678812083 0.9990263334 24.49114808 160309.6877 0.06936023809
0.05447575745 0.04253736055 0.02567675743 0.06821411798 41.44894025
122.4372006 122.4372006 43.20682017 41.18381806 42.35866673
37.28460024 4.178284794 4.250637801 2.188384554 0.6305141057
0.6840034086 0.6840034086 4.210964235 1.411076474 0.04172005549
991.706868 941.1285134 1.205415076 2.120586817 0.0006354455189
0.0002270673634 1.304005738e-005 1.324844863e-005 1533.905345
1517.335238 482.8522016 470.7387834 2.144901972 2.082642456
2.119642456 0.07974254461 0.08744027887 1761.420997 1760.821181
173.7764499 514.1500638 2709.452706 340.3736138 1247.270934
181.1214253 172.6671929 177.5791424 156.3821675

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KEY POINT #2 (t plus 63.4006 s with a Mixing Number of 41.7762):  52.61513672
       0.040894          0.00925          0.3937     0.8292696849     0.8315887113
       0.5559115839     0.5559115839     0.9989765036      24.25836821      162258.9805
       0.06927697149    0.05446677636    0.04234170292    0.02676493581    0.06910663873
       41.95833511      122.4815396      122.4815396      43.96357087      41.90983264
       42.61393157      37.92485553      4.178297667      4.250716806      2.188651986
       0.6311474355     0.6840099333     0.6840099333      4.167536662      1.410539619
       0.04172964823      991.5060769      941.0923079      1.206978599      2.168947897
       0.0006295219457  0.0002269789203 1.304158637e-005 1.326055047e-005
       1534.718463      1517.267109      482.871306      470.1628244      2.14787332
       2.085970308      2.122970308     0.08191054673    0.09094621882      1735.251852
       1734.663384      175.9051431      514.3387413      2709.516316      338.4335981
       1220.913111      184.2837109      175.7009867      178.6460119      159.0576867
KEY POINT #3 (t plus 474.7432 s with a Mixing Number of 43.7712):  51.33043566
       0.040894          0.00925          0.3937      0.830087817     0.8328879139
       0.5758816793     0.5758816793     0.9990458803       24.2529995      158331.561
       0.06864265726    0.05439235052    0.04219816355    0.02522110197    0.06741926552
       45.81099419      122.8488183      122.8488183      50.01345847      45.94381784
       46.99629622      41.78658835      4.178589633      4.251373143      2.190875153
       0.6357972284     0.6840631211     0.6840631211      3.861164322      1.406110038
       0.04180935325      989.9275043      940.7920789      1.219992952      2.11645721
       0.0005874990823  0.0002262487881 1.305425215e-005 1.325766526e-005
       1540.36334       1516.70087      483.0292642      471.2241486      2.172615558
       2.111791551      2.148791551      0.1000176194     0.1235952177      1780.055528
       1779.46732      192.0054128      515.9017811      2710.042669      323.8963683
       1264.153747      209.5671263      192.5589469      196.9599582      175.1953679
KEY POINT #4 (t plus 3224.7534 s with a Mixing Number of 63.3311):  52.07016481
       0.040894          0.00925          0.3937     0.8336091063     0.8411033843
       0.586075699      0.586075699      0.9989302471      21.51585712      158275.194
       0.06435663462    0.05331658078    0.04315959317    0.02523125958    0.06839085276
       70.69552728      128.1271651      128.1271651      88.00389459      74.81594398
       66.4096137      53.08174763      4.188210457      4.261188243      2.224406018
       0.6602463609     0.6846591225     0.6846591225      2.538124355      1.345741867
       0.04300395541      977.4486877      936.4137049      1.419870877      2.420083222
       0.0004001201435  0.0002162247695 1.323636519e-005 1.345351262e-005
       1557.952988      1508.194154      485.2413915      473.0124331      2.554616845
       2.498971444      2.535971444      0.3215121482     0.6502718104     1815.975171
       1815.512239      296.1126575      538.3938788      2717.495251      242.2812213
       1277.581292      368.7194436      313.374239      278.1695573      222.4300301
KEY POINT #5 (t plus 5152.1887 s with a Mixing Number of 99.533):  52.70975744
       0.040894          0.00925          0.3937     0.8326729697     0.8442138637
       0.5895572808     0.5895572808     0.9987272322      18.26131982      157264.6774
       0.06005935976    0.05196519464    0.04414188843    0.02508902861    0.06923091704
       94.00314999      134.6807034      134.6807034      111.2705446      95.19391211
       77.55693127      57.66649982      4.208948793      4.274411169      2.270238551
       0.6751822515     0.6849664285     0.6849664285      1.874035833      1.278628578
       0.04462023499      962.6837394      930.8125245      1.70387594      2.886415547
       0.0003006251194  0.0002048978481  1.34626218e-005  1.37062744e-005
       1550.497167      1496.697095      487.8345582      474.6299318      3.103035722
       3.050342207      3.087342207     0.8155151569      1.496030663      1840.20274
       1839.869264      393.9931732      566.3992819      2726.443816      172.4061087
       1273.803458      466.8592252      399.0045484      324.9117587      241.6439652
KEY POINT #6 (t plus 7006.5198 s with a Mixing Number of 155.698):  53.15762646
       0.040894          0.00925          0.3937     0.8206589521     0.8360486108
       0.5801127467     0.5801127467     0.9983184452      14.37905228      154598.1809
       0.05637965217    0.05015047135    0.04431866146    0.02550050308    0.06981916454
       112.9432554      143.3556339      143.3556339      130.0252859      113.3300644
       86.35842006      63.19041769      4.234258261      4.293814953      2.338199593
       0.6822254692     0.6846505861     0.6846505861      1.537178842      1.201346856
       0.04700021231      948.7978033      923.1174981      2.148219385      3.696879699
       0.0002476709005  0.0001915552576 1.376217967e-005 1.406114848e-005
       1531.271547      1479.947654      491.0001605      475.6336504      3.971577048
       3.92174186       3.95874186      1.581384021      2.704640547     1841.851983
       1841.645226      474.0028645      603.618507      2737.73248      129.6156425
       1238.233476      546.5806218      475.6396037      361.9181448      264.8203122
KEY POINT #7 (t plus 7583.1307 s with a Mixing Number of 175.9764):  52.70112555
       0.040894          0.00925          0.3937     0.8181472306     0.8348711691
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      0.5850008498     0.5850008498     0.9982259704      13.39137841      152145.4219
      0.05541557117    0.04957152589    0.04433906145    0.02488051814    0.0692195796
      117.7746581      146.0947941      146.0947941      134.3366933      118.1825392
      108.6498921      65.08122911      4.242006963      4.300423474      2.361388916
      0.68333638      0.684382594      0.684382594      1.470046117      1.179362041
      0.04781123481     945.0024882      920.6211524      2.306334208      3.935451895
      0.0002368067759  0.0001876872958 1.385675044e-005 1.416513097e-005
      1524.752808      1474.307707      491.9357011      476.3344456      4.283153498
      4.234302588      4.271302588      1.850617233      3.072061513      1859.152845
      1858.973516      494.5010357      615.4086878      2741.157443      120.9076521
      1243.744157      565.0065684      496.2302015      455.8619367      272.7574635
KEY POINT #8 (t plus 10246.2761 s with a Mixing Number of 302.0953):  55.28498864
      0.040894         0.00925          0.3937      0.809506126     0.8317681112
      0.5709957639     0.5709957639     0.9973792704      9.961627705      153674.0249
      0.05127119922    0.04681982019    0.04617651441    0.02643680517    0.07261331958
      138.0146118      158.9422389      158.9422389      151.0355301      138.6521086
      137.3992973      73.99768946      4.280887045      4.334828344      2.481116227
      0.6851061293      0.682068899      0.682068899      1.247388765      1.089492721
      0.05201825679     928.0168591      908.4819177      3.177235941        5.5497947
      0.0001996300485  0.0001714275726 1.430002946e-005 1.471181826e-005
      1491.082157      1445.682276      495.9089759      476.6845576      6.016877622
      5.970558302      6.007558302      3.416508093      4.894634273      1861.765071
      1861.665837      580.8517064      670.9782099      2756.260978      90.12650354
      1190.786861      636.7928755      583.580078      578.2192406      310.2324316
KEY POINT #9 (t plus 10855.9869 s with a Mixing Number of 342.8635):  52.23001898
      0.040894         0.00925          0.3937     0.8072732135     0.8309211749
      0.5972873996     0.5972873996     0.9974535251       9.12320242      144316.8037
      0.05032461126    0.04613184635    0.04515227767    0.02344853338    0.06860081105
      142.5291179      162.1130047      162.1130047       154.93431      143.3601392
      142.3655315      79.44118949      4.291116817      4.344256783       2.51342093
      0.6848850461      0.681233463      0.681233463       1.20811269      1.070306512
      0.05316346884      923.991349      905.3754189      3.428179521      5.724965486
      0.000192821205  0.0001678373651  1.44093389e-005 1.480003951e-005
      1482.259285      1438.078809      496.7836284      478.8213197      6.520752269
      6.475347192      6.512347192      3.881233046      5.424903593      1924.200493
      1924.11726      600.2331255      684.7670515      2759.731648      84.53392598
      1239.433441      653.6576813      603.7988324      599.5323504      333.0905744
KEY POINT #10 (t plus 11406.5964 s with a Mixing Number of 385.9168):  50.1687406
      0.040894         0.00925          0.3937     0.8054920922     0.8303586289
      0.5999331189     0.5999331189     0.9973039573      8.247569074      137601.7783
      0.04950970951    0.04553063065    0.04328649632    0.02260695657    0.06589345288
      146.3864884      164.8713265      164.8713265      157.5307597      146.9636104
      146.2390726      91.74867797      4.30035866      4.352786477      2.542409057
      0.6845226314     0.6804225959     0.6804225959      1.177001578      1.054477431
      0.05419589534     920.4830717      902.636879      3.659169545      6.082851826
      0.0001873527957  0.0001648347041 1.450439759e-005 1.490969451e-005
      1474.359774      1431.294321      497.5100956      479.1831393      6.985879604
      6.941593621      6.978593621      4.317457839      5.802804908      1936.24337
      1936.175347      616.8326195      696.7881222      2762.663777      79.95550274
      1239.455247      664.919533      619.3137714      616.199846      384.8115022
KEY POINT #11 (t plus 11406.5964 s with a Mixing Number of 385.9168):  50.1687406
      0.040894         0.00925          0.3937     0.8054920922     0.8303586289
      0.5999331189     0.5999331189     0.9973039573      8.247569074      137601.7783
      0.04950970951    0.04553063065    0.04328649632    0.02260695657    0.06589345288
      146.3864884      164.8713265      164.8713265      157.5307597      146.9636104
      146.2390726      91.74867797      4.30035866      4.352786477      2.542409057
      0.6845226314     0.6804225959     0.6804225959      1.177001578      1.054477431
      0.05419589534     920.4830717      902.636879      3.659169545      6.082851826
      0.0001873527957  0.0001648347041 1.450439759e-005 1.490969451e-005
      1474.359774      1431.294321      497.5100956      479.1831393      6.985879604
      6.941593621      6.978593621      4.317457839      5.802804908      1936.24337
      1936.175347      616.8326195      696.7881222      2762.663777      79.95550274
      1239.455247      664.919533      619.3137714      616.199846      384.8115022
KEY POINT #12 (t plus 0 s with a Mixing Number of 41.5283):  51.93560575         0.040894
      0.00925          0.3937     0.8292021165     0.8314723941     0.5678812083
      0.5678812083     0.9990263334      24.49114808      160309.6877    0.06936023809
      0.05447575745    0.04253736055    0.02567675743    0.06821411798      41.44894025
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       122.4372006      122.4372006      43.20682017      41.18381806      42.35866673
       37.28460024      4.178284794      4.250637801      2.188384554      0.6305141057
       0.6840034086     0.6840034086      4.210964235      1.411076474    0.04172005549
       991.706868      941.1285134      1.205415076      2.120586817  0.0006354455189
       0.0002270673634 1.304005738e-005 1.324844863e-005      1533.905345
       1517.335238      482.8522016      470.7387834      2.144901972      2.082642456
       2.119642456    0.07974254461    0.08744027887      1761.420997      1760.821181
       173.7764499      514.1500638      2709.452706      340.3736138      1247.270934
       181.1214253      172.6671929      177.5791424      156.3821675
KEY POINT #13 (t plus 11406.5964 s with a Mixing Number of 385.9168):  50.1687406
       0.040894          0.00925           0.3937     0.8054920922     0.8303586289
       0.5999331189     0.5999331189     0.9973039573      8.247569074      137601.7783
       0.04950970951    0.04553063065    0.04328649632    0.02260695657    0.06589345288
       146.3864884      164.8713265      164.8713265      157.5307597      146.9636104
       146.2390726      91.74867797      4.30035866      4.352786477      2.542409057
       0.6845226314     0.6804225959     0.6804225959      1.177001578      1.054477431
       0.05419589534      920.4830717      902.636879      3.659169545      6.082851826
       0.0001873527957  0.0001648347041 1.450439759e-005 1.490969451e-005
       1474.359774      1431.294321      497.5100956      479.1831393      6.985879604
       6.941593621      6.978593621      4.317457839      5.802804908      1936.24337
       1936.175347      616.8326195      696.7881222      2762.663777      79.95550274
       1239.455247      664.919533      619.3137714      616.199846      384.8115022
KEY POINT #14 (t plus 3728.6633 s with a Mixing Number of 70.0468):  51.71263843
       0.040894          0.00925           0.3937     0.8331180342      0.84159306
       0.5938811055     0.5938811055     0.9989195901      20.78552986      156614.3522
       0.06331065192     0.0530192329    0.04337256963    0.02454869495    0.06792126458
       76.50338008      129.576347      129.576347      95.61934406      80.1998285
       70.46600166      53.73312429      4.192325115      4.264011067      2.234136314
       0.664651186     0.6847680729     0.6847680729      2.336890743      1.330189573
       0.04334839948      974.0263263      935.1908406      1.479123968      2.487915332
       0.0003704906374  0.0002136184302 1.328638713e-005 1.350282785e-005
       1557.999209      1505.739773      485.8295737      473.734237      2.668527836
       2.613634496      2.650634496     0.4108821901     0.8655603746      1836.657733
       1836.225695      320.4580645      544.5788928      2719.503789      224.1208283
       1292.07884      400.7639162      335.9588855      295.1622079      225.1626045
End
```

D.12 TEST #12 - T12_RCIC_5PSIG_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T12_RCIC_5PSIG_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1804.8372 s, and ending (KEY POINT #11) at t
       plus 12746.8131 s, for a time period of 10941.9759 s.
Original Data Record Time:  14288.3382 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2625.7422 s, T_bulk = 63.4675 C and T_out = 60.0729 C
Stratification Beginning SP12 Temperature = 63.2378 C
Stratification Beginning Pressure = 23.6034 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       10146.3644 s, T_bulk = 130.4416 C and T_out = 76.0545 C
Stratification Ending SP12 Temperature = 130.314 C
Stratification Ending Pressure = 64.5798 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1987.1317 s.
At t = 1987.1317 s, the pool pressure is 22.6159 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 58.161, 58.0852, 60.0925, 58.0885, and 54.4546
       C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 12.0007 +/- 2.561 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 11.0272 +/- 2.3492 C.
Minimum Steam Quality:  0.98998 at t plus 10912.0752 s
Maximum Steam Quality:  1.0061 at t plus 3455.8547 s
Time-Averaged Steam Quality:  1.0001 +/- 0.0027551
Minimum Turbine Outlet Steam Quality:  0.99215 at t plus 10912.0752 s
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Maximum Turbine Outlet Steam Quality: 1.0206 at t plus 2252.4358 s
Time-Averaged Turbine Outlet Steam Quality: 1.0093 +/- 0.0070392
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 10851.9747 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.72556 degrees/min at t plus 3837.4615 s and 0.34665 degrees/min at t plus 8694.4393 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.82435 degrees/min at t plus 5060.2814 s and 0.37529 degrees/min at t plus 10152.2637 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.288 degrees/min at t plus 3491.5557 s and -0.22808 degrees/min at t plus 5059.5804 s, respectively
Max and min smoothed lower level changerates: 3.9973 degrees/min at t plus 7440.4466 s and -0.11894 degrees/min at t plus 3422.3538 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.68162 degrees/min at t plus 5509.9901 s and -3.5466 degrees/min at t plus 7440.4466 s, respectively
Max and min smoothed outlet level changerates: 5.706 degrees/min at t plus 10779.9746 s and -0.020841 degrees/min at t plus 4164.7662 s, respectively
Max and min smoothed lower-outlet level changerate differences: 3.9164 degrees/min at t plus 7440.4466 s and -5.2007 degrees/min at t plus 10777.3755 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.37 degrees/min at t plus 2604.743 s and 0.16669 degrees/min at t plus 9222.1495 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.83882 degrees/min at t plus 2534.64 s and -0.31375 degrees/min at t plus 4438.4719 s, respectively
The mean steam flow rate was 44.6559 +/- 0.83056 g/s
The mean feedwater flow rate was 43.7258 +/- 1.8014 g/s
The mean water injection to steam flow rate was 0.0030939 +/- 0.036284 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 12.6626 +/- 1.1657 C over the Stratification Period, beginning at 7.3739 C and ending at 11.5956 C
Mean Smoothed SP8-Upper Pool delta T is 11.6236 +/- 1.1461 C over the Stratification Period, beginning at 7.0097 C and ending at 10.6215 C
The stratification period begins and ends with Smoothed SP8 readings of 71.0506 and 141.8864 C, respectively
The stratification period begins and ends with condensing flows of 0.46557 and 1.2492 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 3.4858 and 1.9138 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2737.3289 +/- 1.2347 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.42606 and 12.9278 kg/s, respectively
The plume period had a mean steam enthalpy of 2737.5098 +/- 1.129 kJ/kg.
Maximum Smoothed Top-Mid delta T is 2.3721 degrees C at t plus 4318.67 s with T_upper = 81.1101 C and T_mid = 78.7379 C
At t plus 4318.67 s, Smoothed SP8-SP9 is 13.3206 C and Smoothed SP8-Top is 10.9484 C, where Smoothed SP8 is 92.0585 C and Pool P = 28.112 psia
Maximum Smoothed Top-Lower delta T is 26.12 degrees C at t plus 7175.8164 s with T_upper = 109.9648 C and T_low = 83.8448 C
At t plus 7175.8164 s, Smoothed SP8-SP9 is 14.061 C and Smoothed SP8-Top is 13.3846 C, where Smoothed SP8 is 123.3494 C and Pool P = 43.0219 psia
Maximum Smoothed Mid-Lower delta T is 25.491 degrees C at t plus 7108.8356 s with T_mid = 108.8059 C and T_low = 83.3148 C
At t plus 7108.8356 s, Smoothed SP8-SP9 is 13.5815 C and Smoothed SP8-Top is 13.046 C, where Smoothed SP8 is 122.3873 C and Pool P = 42.5877 psia
Maximum Smoothed Top-Outlet delta T is 55.7836 degrees C at t plus 9916.7602 s with T_upper = 129.9466 C and T_out = 74.163 C
At t plus 9916.7602 s, Smoothed SP8-SP9 is 12.1269 C and Smoothed SP8-Top is 10.9029 C, where Smoothed SP8 is 140.8495 C and Pool P = 62.5965 psia
Maximum Smoothed Mid-Outlet delta T is 54.6949 degrees C at t plus 10002.8262 s with T_mid = 129.4256 C and T_out = 74.7307 C
At t plus 10002.8262 s, Smoothed SP8-SP9 is 11.84 C and Smoothed SP8-Top is 10.9513 C, where Smoothed SP8 is 141.2657 C and Pool P = 63.3059 psia
Maximum Smoothed Lower-Outlet delta T is 54.659 degrees C at t plus 9979.3608 s with T_low = 129.1915 C and T_out = 74.5325 C
At t plus 9979.3608 s, Smoothed SP8-SP9 is 11.8816 C and Smoothed SP8-Top is 10.9366 C, where Smoothed SP8 is 141.0424 C and Pool P = 63.0955 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 14.6068 degrees C at (KEY POINT #14) t plus 7383.8183 s with T_SP8 = 125.5408 C and T_SP9 = 110.934 C and Pool P = 44.3567 psia

Maximum Smoothed Condensing Region SP8-Upper delta T is 14.0174 degrees C at t plus 6976.313 s with T_SP8 = 122.1298 C and T_upper = 108.1125 C and Pool P = 41.7433 psia
Maximum Top-Mid delta T is 4.0962 degrees C at (KEY POINT #4) t plus 3860.4618 s ignoring SP 4, with temperatures of 77.2292 and 73.133 C, respectively, at Set # 2, where Pool P = 26.6314 psia and T_outlet = 66.5982 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5546.8143 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.365 C and a raw SP12 Reading of 92.5302 C.
Maximum Top-Lower delta T is 28.2301 degrees C at t plus 7267.5177 s, with temperatures of 110.4139 and 82.1838 C, respectively, at Set # 1, where Pool P = 43.6193 psia and T_outlet = 70.9363 C
Maximum Mid-Low delta T is 26.9159 degrees C at (KEY POINT #6) t plus 7132.716 s ignoring SP 4, with temperatures of 108.9358 and 82.0198 C, respectively, at Set # 2, where Pool P = 42.7502 psia and T_outlet = 70.8574 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 7568.5219 s with a Smoothed Mid-Axis Mid-Low Delta T of 8.9696 C and a raw SP12 Reading of 112.2591 C.
Maximum Top-Outlet delta T is 56.0469 degrees C at t plus 9937.9614 s, with temperatures of 130.2269 and 74.18 C, respectively, at Set # 1, where Pool P = 62.7758 psia
Maximum Mid-Outlet delta T is 54.8058 degrees C at t plus 9971.2614 s ignoring SP 4, with temperatures of 129.2698 and 74.464 C, respectively, at Set # 2, where Pool P = 63.0442 psia
Maximum Lower-Outlet delta T is 55.8925 degrees C at (KEY POINT #8) t plus 9958.5596 s, with temperatures of 130.2648 and 74.3723 C, respectively, at Set # 1, where Pool P = 62.9523 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 10826.4753 s with a Smoothed Mid-Axis Low-Outlet Delta T of 18.6259 C and a raw SP12 Reading of 134.8564 C.
Minimum SP Pressure is 20.7345 psia at t plus 3.3002 s
Maximum SP Pressure is 72.0881 psia at t plus 10941.8769 s
Beginning SP Pressure is 20.7411 psia
Ending SP Pressure is 72.0878 psia
Time-Average SP Pressure is 37.6823 +/- 15.285 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.8408 cm (cold) / 76.9744 cm (hot) at 19.8052 psia
Beginning Smoothed SP Level is 77.2727 cm (cold) / 77.4443 cm (hot) at 20.7443 psia
Ending Smoothed SP Level is 80.5617 cm (cold) / 82.7283 cm (hot) at 72.0942 psia
Minimum Smoothed Cold SP Level is 77.081 cm at t plus 2589.7431 s and 23.5424 psia
Minimum Smoothed Hot SP Level is 77.432 cm at t plus 1352.9224 s and 21.8473 psia
Maximum Smoothed Cold SP Level is 80.5617 cm at t plus 10941.9759 s and 72.0942 psia
Maximum Smoothed Hot SP Level is 82.7283 cm at t plus 10941.9759 s and 72.0942 psia
SP 12 Temperature at the beginning is 40.0548 C, and at the end is 135.7365 C
At plume detection, the Mixing Number is 45.1143
The Mixing Number ranges from a minimum of 35.5449 at (KEY POINT #12) t plus 0 s to a maximum of 324.5116 at (KEY POINT #13) t plus 10941.9759 s; it had a mean value of 121.5718 +/- 82.5853 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,

Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 35.5449): 36.74278043 0.040894
0.00925 0.3937 0.7727272112 0.7744428647 1.013830827
1 1 44.37054148 113638.555 0.06960802964
0.05669326994 0.04825930734 5.369110399e-006 0.04825930734 39.9279
126.0464525 111.3605831 40.254814 39.90993725 39.77263922
36.10383451 4.178441517 4.232404205 2.127809291 0.6285635417
0.6816640914 0.6816640914 4.345415173 1.560724542 0.03951391151
992.2673163 949.9080109 0.8628299974 0.8281816502 0.0006536814121
0.0002513677393 1.265866011e-005 1.322226654e-005 1531.278148
1532.764912 477.8471204 487.9843209 1.500526546 1.430270643
1.467270643 0.07356088776 0.074853381 2725.885401 2723.916656
167.363289 467.1253442 2693.129181 299.7620551 2258.760057
168.7292794 167.2867256 166.7161371 151.389944
KEY POINT #2 (t plus 1987.1317 s with a Mixing Number of 45.1143): 33.29175894
0.040894 0.00925 0.3937 0.7715302102 0.7751237984
1.016584172 1 1 37.48203207 101441.1898
0.06656891855 0.05619593154 0.04372660989 3.167943558e-006 0.04372660989
58.08518687 131.3749932 113.867857 60.09252345 58.16104109
58.08848508 54.4545953 4.181854431 4.236275444 2.140465022
0.6489886753 0.6823185531 0.6823185531 3.094284458 1.523953972
0.03998125798 984.2091035 947.9672189 0.9324287261 0.8882701672
0.0004802069524 0.0002454566712 1.274487264e-005 1.34209111e-005
1552.719641 1529.555812 479.0199123 491.0507761 1.630252629
1.559633422 1.596633422 0.1824351316 0.2003137005 2735.104591
2733.699689 243.2635295 477.7513178 2696.896994 234.4877882
2257.353274 251.6587243 243.5793071 243.2788414 228.0886855
KEY POINT #3 (t plus 2625.7422 s with a Mixing Number of 49.3637): 33.61592801
0.040894 0.00925 0.3937 0.7708277044 0.7751013837
1.016298871 1 1 36.51856141 102231.1524
0.06559803438 0.05597040308 0.04415238537 1.444633323e-006 0.04415238537
63.67671048 132.136723 115.0003254 71.05056892 64.04086639
63.92397438 60.01292945 4.184337002 4.238072154 2.146378258
0.6542487518 0.6825899803 0.6825899803 2.824616495 1.507934193
0.04019829595 981.3083273 947.081646 0.965320339 0.9205463359
0.0004416474617 0.0002428700441 1.278383898e-005 1.344687728e-005
1555.870825 1528.050889 479.5421062 491.3414066 1.69178831
1.627515465 1.664515465 0.2359562517 0.3264581152 2736.037677
2734.704072 266.658778 482.5541904 2698.585267 215.8954124
2253.483487 297.5286262 268.1811498 267.6949246 251.3368011
KEY POINT #4 (t plus 3860.4618 s with a Mixing Number of 60.3683): 34.06822742
0.040894 0.00925 0.3937 0.7796344099 0.7859375877
1.014495487 1 1 33.10467625 103279.5676
0.06374329296 0.0552690297 0.0447464519 4.273279688e-006 0.0447464519
74.11243538 133.536148 118.5046793 87.11077406 76.09323829
71.92660993 66.51598939 4.190706084 4.243825352 2.165474868
0.6628561015 0.6833353839 0.6833353839 2.416362139 1.460554098
0.04089410502 975.4246439 944.3061223 1.073098502 1.029204475
0.0003822029881 0.0002351765713 1.290450855e-005 1.348946481e-005
1558.01297 1523.179502 481.1278694 491.5744006 1.894376909
1.836611955 1.873611955 0.371843793 0.6282517547 2736.832152
2735.736232 310.3737676 497.4302896 2703.754489 187.0565221
2239.401862 364.9147252 318.6748099 301.2167717 278.5638509
KEY POINT #5 (t plus 5546.8143 s with a Mixing Number of 92.0947): 34.43303698
0.040894 0.00925 0.3937 0.7906587965 0.8002630366
1.010668877 1 1 27.16584348 103852.991
0.06032226132 0.05391272745 0.04522560608 4.422981698e-006 0.04522560608
92.61678931 135.9567038 125.2090808 104.5746443 93.59585103
80.81217003 69.59510311 4.207562137 4.255672873 2.205501345
0.6744534338 0.6843684348 0.6843684348 1.904461967 1.378370474
0.04233206922 963.6029847 938.8489405 1.306355243 1.267636122
0.0003052767544 0.0002216601867 1.313566733e-005 1.355863323e-005
1551.333592 1512.981773 484.0318918 491.6803025 2.337220857
2.282916234 2.319916234 0.774525943 1.191327526 2737.476894
2736.738911 388.1002074 525.9525779 2713.401289 137.8523705
2211.524316 438.4991295 392.2189047 338.5045382 291.4917108

```
KEY POINT #6 (t plus 7132.716 s with a Mixing Number of 143.9185):  34.46850236
       0.040894         0.00925          0.3937     0.7936001899     0.8066328841
       1.005989782             1                1      21.23532754      103235.9045
       0.05715875109    0.05220730897     0.0452721876 2.997454564e-006     0.0452721876
       109.0012555      139.3065764      133.512651      122.9519762      109.5888518
       83.6218816       70.87250423      4.228517124      4.271967187      2.261724238
       0.681073495      0.6849463852     0.6849463852      1.596958703      1.290001963
       0.04432101024      951.7833198      931.8242013      1.650172542      1.623275386
       0.0002572169424  0.0002068326237 1.342228873e-005 1.365372777e-005
       1535.964741      1498.820462      487.3849742      491.6797796       2.99888237
       2.947339621      2.984339621      1.386320156      2.179606568      2738.284207
       2737.833268      457.2522208      561.4010518      2724.874534      104.1488309
       2176.883156      516.3967744      459.7358935      350.3496907      296.895603
KEY POINT #7 (t plus 7568.5219 s with a Mixing Number of 158.2462):  34.3890483
       0.040894         0.00925          0.3937     0.7938815699      0.807855654
       1.004616318             1                1      19.91050393      102853.8601
       0.0565048281     0.05176533495    0.04516782974 3.336132587e-006    0.04516782974
       112.3122155      140.0556361      135.6429571      126.0869207      112.9788216
       103.5110444      71.34661629      4.23346829       4.27645375       2.27736597
       0.6820171859     0.6849717051     0.6849717051      1.546469392      1.269440818
       0.04487045054      949.2498497      929.9747411      1.749164601      1.727308783
       0.0002491382079  0.0002033299301 1.349584978e-005 1.367285331e-005
       1531.914511      1494.924005      488.2007929      491.5174487      3.191019716
       3.139932432      3.176932432      1.548726575      2.400972138      2738.082828
       2737.6864      471.2747516      570.5191536      2727.728037      99.24440201
       2167.563674      529.7467747      474.095921      434.0739845      298.8970521
KEY POINT #8 (t plus 9958.5596 s with a Mixing Number of 261.9274):  33.8784854
       0.040894         0.00925          0.3937     0.800058681     0.818971741
       0.998511898      0.998511898      0.999996177      14.3369466       99756.094
       0.0531357949     0.0493827721     0.0444972378 3.20031273e-006    0.0444972378
       129.008753       146.985007       146.985007       141.201043       130.014237
       128.781019       74.3651954       4.26245004       4.30262348       2.36910341
       0.684836973      0.68427829       0.68427829       1.33616756       1.17244715
       0.0480811409      935.750247       919.802946       2.35968188       2.36318952
       0.000214678633  0.000186463012  1.3887482e-005 1.38881418e-005       1507.1028
       1472.43914       492.233088       492.198757       4.38853673       4.33986951
       4.37686951       2.62343172       3.73953596       2739.30187       2739.09632
       542.274986       619.244574       2742.25557       76.9695882       2120.05729
       594.398726       546.560632       541.305561       311.640434
KEY POINT #9 (t plus 10146.3644 s with a Mixing Number of 272.7161):  33.7373221
       0.040894         0.00925          0.3937      0.80105839     0.820408721
       0.99812994       0.99812994     0.999995074      13.9384004      99111.0164
       0.0528723374     0.0491861279     0.0443118289 5.00569437e-006    0.0443118289
       130.290749       147.910974       147.910974       141.886355       131.264903
       130.258845       76.0622183       4.26496933       4.30493956       2.37722021
       0.684922898      0.684160874      0.684160874      1.32261417       1.16537081
       0.0483652152      934.664461       918.948275       2.41621708       2.42073209
       0.000212402167   0.00018520611 1.39194458e-005 1.39202896e-005      1504.91087
       1470.47712       492.538947       492.495272       4.50035097       4.45187066
       4.48887066       2.7261803        3.81212433       2739.61938       2739.4251
       547.748586       623.236722       2743.38992       75.488136       2116.38266
       597.345492       551.903108       547.613738       318.761594
KEY POINT #10 (t plus 10826.4753 s with a Mixing Number of 316.6516):  33.7994594
       0.040894         0.00925          0.3937     0.805137114     0.826409671
       0.996083561      0.996083561      0.999988672      12.7629043      98437.3687
       0.0518835953     0.048444757     0.0443934421 7.07100109e-006    0.0443934421
       135.073787       151.388851       151.388851       146.045237       136.198714
       135.540262       116.178688       4.27476849       4.31389672       2.40854587
       0.685082622      0.683638927      0.683638927      1.27479818       1.1398165
       0.0494628474      930.551659       915.705299       2.638336        2.64867951
       0.000204301608  0.000180630873 1.40394785e-005 1.40413657e-005      1496.38835
       1462.94134       493.656038       493.56026       4.9409062       4.89285723
       4.92985723       3.13873719       4.27734725       2739.47927       2739.31638
       568.200615       638.251449       2747.57742       70.0508339       2101.22782
       615.236284       573.009621       570.196096       487.784473
KEY POINT #11 (t plus 10941.9759 s with a Mixing Number of 324.5116):  33.8222319
       0.040894         0.00925          0.3937     0.805616916     0.827282965
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       0.995951535     0.995951535     0.999988108      12.5829594      98361.1404
       0.0517192222    0.0483191405    0.0444233524 5.24397076e-006    0.0444233524
       135.864726      151.976117      151.976117      146.494795      137.019546
       136.57758      126.636173      4.27645083      4.31545029       2.4139659
       0.685084829     0.683538224     0.683538224      1.26728929      1.13565613
       0.0496530254      929.862223      915.152558      2.67740518      2.68825666
       0.000203018976  0.000179880273 1.40597433e-005 1.40617153e-005      1494.92768
       1461.64307      493.839718      493.739969      5.01859076      4.97072011
       5.00772011      3.21158048      4.33025108      2739.89923      2739.7409
       571.58748      640.790061      2748.27297      69.2025816      2099.10917
       617.174567      576.526302      574.637673      532.215095
KEY POINT #12 (t plus 0 s with a Mixing Number of 35.5449):  36.74278043         0.040894
       0.00925          0.3937     0.7727272112      0.7744428647      1.013830827
       1                1      44.37054148       113638.555    0.06960802964
       0.05669326994    0.04825930734 5.369110399e-006    0.04825930734          39.9279
       126.0464525      111.3605831        40.254814      39.90993725      39.77263922
       36.10383451      4.178441517      4.232404205      2.127809291      0.6285635417
       0.6816640914     0.6816640914      4.345415173      1.560724542    0.03951391151
       992.2673163      949.9080109      0.8628299974     0.8281816502  0.0006536814121
       0.0002513677393 1.265866011e-005 1.322226654e-005      1531.278148
       1532.764912      477.8471204      487.9843209      1.500526546      1.430270643
       1.467270643    0.07356088776      0.074853381      2725.885401      2723.916656
       167.363289      467.1253442      2693.129181      299.7620551      2258.760057
       168.7292794      167.2867256      166.7161371      151.389944
KEY POINT #13 (t plus 10941.9759 s with a Mixing Number of 324.5116):  33.8222319
       0.040894         0.00925          0.3937      0.805616916      0.827282965
       0.995951535     0.995951535     0.999988108      12.5829594      98361.1404
       0.0517192222    0.0483191405    0.0444233524 5.24397076e-006    0.0444233524
       135.864726      151.976117      151.976117      146.494795      137.019546
       136.57758      126.636173      4.27645083      4.31545029       2.4139659
       0.685084829     0.683538224     0.683538224      1.26728929      1.13565613
       0.0496530254      929.862223      915.152558      2.67740518      2.68825666
       0.000203018976  0.000179880273 1.40597433e-005 1.40617153e-005      1494.92768
       1461.64307      493.839718      493.739969      5.01859076      4.97072011
       5.00772011      3.21158048      4.33025108      2739.89923      2739.7409
       571.58748      640.790061      2748.27297      69.2025816      2099.10917
       617.174567      576.526302      574.637673      532.215095
KEY POINT #14 (t plus 7383.8183 s with a Mixing Number of 152.1046):  34.41087195
       0.040894         0.00925          0.3937      0.7938741069      0.8074155397
       1.005154846              1               1      20.44412048      102990.2414
       0.05677762086    0.05195012748    0.04519649372 5.799062777e-006    0.04519649372
       110.9339614      139.7053262      134.7533076      125.5407513      111.6783634
       91.50775207      71.15887068      4.231376691      4.274564362      2.270772759
       0.6816401499     0.6849671802     0.6849671802      1.567080965      1.277929664
       0.04463899697      950.310315      930.7494492      1.707259845      1.683383111
       0.0002524439164   0.000204778734 1.346512889e-005 1.366341294e-005
       1533.637215      1496.564061      487.862322      491.56291      3.109605074
       3.058322128      3.095322128      1.479321997      2.361143755      2738.092542
       2737.67458      465.4355102      566.710063      2726.540985      101.2745527
       2171.382479      527.4163405      468.5845405      383.4956641      298.1040412
End
```

D.13 TEST #13 - T13_RCIC_060GPM_157KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T13_RCIC_060GPM_157kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1153.361 s, and ending (KEY POINT #11) at t
       plus 7513.9608 s, for a time period of 6360.5998 s.
Original Data Record Time:  8911.3997 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       3199.024 s, T_bulk = 81.1327 C and T_out = 77.3373 C
Stratification Beginning SP12 Temperature = 80.8037 C
Stratification Beginning Pressure = 21.7017 psia
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Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus 5571.0937 s, T_bulk = 111.7117 C and T_out = 97.7167 C
Stratification Ending SP12 Temperature = 111.5393 C
Stratification Ending Pressure = 38.1043 psia
Plume detected! Setting t_plume (KEY POINT #2) to 1018.6153 s.
At t = 1018.6153 s, the pool pressure is 16.1023 psia while the Smoothed Upper, Mid, SP8, Lower, and Outlet Temperatures are 53.4058, 53.5204, 55.521, 53.463, and 50.9301 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9 temperatures were 8.6421 +/- 2.3538 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 8.0558 +/- 1.9998 C.
Minimum Steam Quality: 0.4776 at t plus 975.4158 s
Maximum Steam Quality: 0.65776 at t plus 6062.2557 s
Time-Averaged Steam Quality: 0.57917 +/- 0.026335
Minimum Turbine Outlet Steam Quality: 0.53952 at t plus 8.7985 s
Maximum Turbine Outlet Steam Quality: 0.69331 at t plus 3889.8615 s
Time-Averaged Turbine Outlet Steam Quality: 0.62617 +/- 0.020513
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 6270.6127 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.95174 degrees/min at t plus 2358.5369 s and 0.48002 degrees/min at t plus 3233.0499 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.84057 degrees/min at t plus 1042.8176 s and 0.65574 degrees/min at t plus 3114.5481 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.20087 degrees/min at t plus 3010.8492 s and -0.28873 degrees/min at t plus 3236.3511 s, respectively
Max and min smoothed lower level changerates: 0.96347 degrees/min at t plus 5036.1781 s and 0.46431 degrees/min at t plus 3532.9571 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.33485 degrees/min at t plus 3504.9555 s and -0.23404 degrees/min at t plus 5851.4937 s, respectively
Max and min smoothed outlet level changerates: 2.52 degrees/min at t plus 5775.9884 s and 0.14181 degrees/min at t plus 5182.7804 s, respectively
Max and min smoothed lower-outlet level changerate differences: 0.79635 degrees/min at t plus 5036.1781 s and -1.7096 degrees/min at t plus 5772.3892 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.5381 degrees/min at t plus 1293.323 s and 0.12144 degrees/min at t plus 3350.1496 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.7968 degrees/min at t plus 1293.323 s and -0.68511 degrees/min at t plus 3350.1496 s, respectively
The mean steam flow rate was 66.3496 +/- 2.8728 g/s
The mean feedwater flow rate was 65.9029 +/- 5.1252 g/s
The mean water injection to steam flow rate was 37.2206 +/- 2.5764 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 9.7609 +/- 0.60457 C over the Stratification Period, beginning at 11.2459 C and ending at 11.3529 C
Mean Smoothed SP8-Upper Pool delta T is 9.0995 +/- 0.50194 C over the Stratification Period, beginning at 10.0585 C and ending at 10.3437 C
The stratification period begins and ends with Smoothed SP8 readings of 92.6317 and 122.9118 C, respectively
The stratification period begins and ends with condensing flows of 1.1417 and 1.9366 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 3.2953 and 3.1314 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1894.2557 +/- 19.3759 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.67833 and 19.5277 kg/s, respectively
The plume period had a mean steam enthalpy of 1875.6918 +/- 34.8119 kJ/kg.
Maximum Smoothed Top-Mid delta T is 2.0194 degrees C at t plus 3122.0476 s with T_upper = 82.4213 C and T_mid = 80.4018 C
At t plus 3122.0476 s, Smoothed SP8-SP9 is 11.2371 C and Smoothed SP8-Top is 9.2177 C, where Smoothed SP8 is 91.639 C and Pool P = 21.3521 psia
Maximum Smoothed Top-Lower delta T is 1.9689 degrees C at t plus 4804.5198 s with T_upper = 102.7278 C and T_low = 100.759 C
At t plus 4804.5198 s, Smoothed SP8-SP9 is 9.3617 C and Smoothed SP8-Top is 8.7014 C, where Smoothed SP8 is 111.4292 C and Pool P = 31.4083 psia
Maximum Smoothed Mid-Lower delta T is 1.3277 degrees C at t plus 4906.0786 s with T_mid = 103.3844 C and T_low = 102.0567 C

At t plus 4906.0786 s, Smoothed SP8-SP9 is 9.4573 C and Smoothed SP8-Top is 9.0328 C, where Smoothed SP8 is 112.8417 C and Pool P = 32.1988 psia
Maximum Smoothed Top-Outlet delta T is 14.7353 degrees C at t plus 5564.1933 s with T_upper = 112.4328 C and T_out = 97.6974 C
At t plus 5564.1933 s, Smoothed SP8-SP9 is 11.1986 C and Smoothed SP8-Top is 10.2377 C, where Smoothed SP8 is 122.6705 C and Pool P = 38.0501 psia
Maximum Smoothed Mid-Outlet delta T is 13.9066 degrees C at t plus 5545.6872 s with T_mid = 111.266 C and T_out = 97.3594 C
At t plus 5545.6872 s, Smoothed SP8-SP9 is 11.0086 C and Smoothed SP8-Top is 10.2369 C, where Smoothed SP8 is 122.2745 C and Pool P = 37.875 psia
Maximum Smoothed Lower-Outlet delta T is 13.8156 degrees C at t plus 5550.0124 s with T_low = 111.235 C and T_out = 97.4193 C
At t plus 5550.0124 s, Smoothed SP8-SP9 is 11.0193 C and Smoothed SP8-Top is 10.2016 C, where Smoothed SP8 is 122.3374 C and Pool P = 37.9125 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 12.063 degrees C at (KEY POINT #14) t plus 5602.2614 s with T_SP8 = 123.9847 C and T_SP9 = 111.9217 C and Pool P = 38.3914 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 10.8268 degrees C at t plus 5602.2614 s with T_SP8 = 123.9847 C and T_upper = 113.1578 C and Pool P = 38.3914 psia
Maximum Top-Mid delta T is 2.1806 degrees C at (KEY POINT #4) t plus 3055.3448 s ignoring SP 4, with temperatures of 81.0088 and 78.8282 C, respectively, at Set # 2, where Pool P = 21.0859 psia and T_outlet = 75.8334 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 3562.9558 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99986 C and a raw SP12 Reading of 85.8618 C.
Maximum Top-Lower delta T is 4.1874 degrees C at t plus 4900.5763 s, with temperatures of 104.0672 and 99.8798 C, respectively, at Set # 1, where Pool P = 32.1562 psia and T_outlet = 94.7165 C
Maximum Mid-Low delta T is 1.8741 degrees C at (KEY POINT #6) t plus 4154.1666 s ignoring SP 4, with temperatures of 93.7463 and 91.8721 C, respectively, at Set # 3, where Pool P = 26.8627 psia and T_outlet = 87.6395 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 4866.9784 s with a Smoothed Mid-Axis Mid-Low Delta T of 0.99958 C and a raw SP12 Reading of 102.8403 C.
Maximum Top-Outlet delta T is 15.804 degrees C at t plus 5504.6899 s, with temperatures of 112.6879 and 96.8839 C, respectively, at Set # 2, where Pool P = 37.4688 psia
Maximum Mid-Outlet delta T is 14.133 degrees C at t plus 5525.187 s ignoring SP 4, with temperatures of 111.0699 and 96.9369 C, respectively, at Set # 2, where Pool P = 37.6593 psia
Maximum Lower-Outlet delta T is 15.4438 degrees C at (KEY POINT #8) t plus 5577.996 s, with temperatures of 113.2595 and 97.8157 C, respectively, at Set # 1, where Pool P = 38.1593 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 5858.3221 s with a Smoothed Mid-Axis Low-Outlet Delta T of 5.1477 C and a raw SP12 Reading of 114.7856 C.
Minimum SP Pressure is 15.1175 psia at t plus 8.2015 s
Maximum SP Pressure is 46.8384 psia at t plus 6360.4188 s
Beginning SP Pressure is 15.1202 psia
Ending SP Pressure is 46.8359 psia
Time-Average SP Pressure is 24.7967 +/- 9.0597 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.5341 cm (cold) / 77.6896 cm (hot) at 14.6846 psia
Beginning Smoothed SP Level is 78.083 cm (cold) / 78.2655 cm (hot) at 15.1217 psia
Ending Smoothed SP Level is 87.1692 cm (cold) / 89.2987 cm (hot) at 46.854 psia
Minimum Smoothed Cold SP Level is 77.9959 cm at t plus 152.1007 s and 15.2129 psia
Minimum Smoothed Hot SP Level is 78.1933 cm at t plus 152.0007 s and 15.2128 psia
Maximum Smoothed Cold SP Level is 87.9222 cm at t plus 5655.5895 s and 38.943 psia
Maximum Smoothed Hot SP Level is 89.8589 cm at t plus 5809.3203 s and 40.4835 psia
SP 12 Temperature at the beginning is 39.8824 C, and at the end is 121.0224 C
At plume detection, the Mixing Number is 42.0839
The Mixing Number ranges from a minimum of 35.1057 at (KEY POINT #12) t plus 0 s to a maximum of 228.3876 at (KEY POINT #13) t plus 6360.4188 s; it had a mean value of 92.8401 +/- 54.1879 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,

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        Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
        Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
        Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
        (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
        Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
        Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 35.1057):  72.33733181        0.040894
        0.00925          0.3937     0.7808298517     0.7826553004     0.5701635263
        0.5701635263     0.9994595563      60.22142642      235717.3073    0.06956065388
        0.05811295749    0.05759980793    0.03741068084    0.09501048877      40.21931012
        104.1251698      104.1251698      40.29314309      40.24535798      40.34995192
        37.7428711      4.178533104      4.222036447      2.094496684     0.6289137279
        0.6793565299     0.6793565299      4.319516323      1.677844149    0.03826206615
        992.142015       955.353835     0.6852446514      1.201189279  0.0006501332037
        0.0002699773897 1.241042046e-005  1.25496209e-005      1531.709635
        1541.047548      474.3373526      465.3270028      1.172863986       1.04260398
        1.07960398    0.07471206981    0.07500619594      1720.455888      1716.829268
        168.5465894       436.516365       2682.03514      267.9697755      1283.939523
        168.8551029      168.6539255      169.0940743      158.2042309
KEY POINT #2 (t plus 1018.6153 s with a Mixing Number of 42.0839):  79.73348519
        0.040894          0.00925           0.3937     0.7841918275     0.7874161421
        0.5993320933     0.5993320933     0.9994839835      64.91581663      258437.5035
        0.06734944812     0.0576774946    0.06539776017    0.03932710609     0.1047248663
        53.52042977      106.3571517      106.3571517       55.5210319      53.40577199
        53.46302034      50.93012117      4.180410009      4.225109384      2.104282914
        0.6443243916     0.6801353528     0.6801353528      3.348067497      1.639860718
        0.03863344048      986.4247146      953.6986151     0.7365155459      1.228259758
        0.0005160358788  0.0002639759464 1.248689922e-005 1.261667173e-005
        1548.946681      1538.650869      475.4395294      467.1293617      1.266928058
        1.110210017      1.147210017     0.1467738362     0.1615909999      1792.393122
        1788.179059      224.1396908       445.950232      2685.491284      221.8105412
        1346.44289      232.5036316      223.6589235      223.9012346      213.3174734
KEY POINT #3 (t plus 3199.024 s with a Mixing Number of 73.1378):  78.60036489
        0.040894          0.00925           0.3937      0.827088748      0.835738498
        0.6383092986     0.6383092986     0.9994460014      54.12500339      249787.9652
        0.06241841506    0.05623046085    0.06703009744    0.03620648731     0.1032365847
        81.38583335      113.6942253      113.6942253      92.63173457       82.5732364
        81.9187923      77.45346932       4.19659286      4.236002636      2.139569338
        0.667931174     0.6822756111     0.6822756111      2.188587463      1.526441921
        0.03994831218      970.9629382      948.1025036     0.9274669913      1.452200646
        0.0003483363391  0.0002458577541 1.273889966e-005 1.286804718e-005
        1556.784316      1529.783517      478.9394326      470.9905107      1.620982322
        1.495943036      1.532943036     0.5013886686     0.7749584921      1896.750174
        1893.820658      340.8479071      477.0151241      2696.637393       136.167217
        1419.73505      388.1026639      345.8302348      343.0860691      324.3569745
KEY POINT #4 (t plus 3055.3448 s with a Mixing Number of 70.3489):  78.31319136
        0.040894          0.00925           0.3937      0.830282147      0.838630428
        0.6404936914     0.6404936914     0.9994639652      55.36415909      249433.7438
        0.06274486318    0.05637810396    0.06701230836    0.03584709221     0.1028594006
        79.60686911      112.9510548      112.9510548      90.82335278      81.16977481
        80.12884689      75.81162161      4.195078804      4.234842942      2.135768272
        0.6667496782     0.6820878177     0.6820878177      2.240716742       1.53718777
        0.03980828383        972.07481      948.6800611     0.9064710328      1.414510627
        0.0003561308945  0.0002475881788 1.271333871e-005 1.283923979e-005
        1557.2495      1530.748971      478.5937223      470.810054      1.581791161
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      1.453882874      1.490882874     0.4666496546     0.7240579203      1899.888654
      1896.823464      333.3803305      473.864664      2695.524017      140.4843335
      1426.02399      380.4919836      339.9365324      335.5716155      317.4698809
KEY POINT #5 (t plus 3562.9558 s with a Mixing Number of 82.2947):  78.6808018
      0.040894         0.00925          0.3937     0.8369041543     0.8468643326
      0.6399888069     0.6399888069     0.9994126283        50.952975      248554.3777
      0.06156371278    0.05581258119    0.06726035263    0.03608188089     0.1033422335
      86.00440224      115.7911657      115.7911657      94.89718631      86.7138773
      86.03850496      80.68099041      4.200828978       4.23934483      2.150581658
      0.6708021692     0.6827706522     0.6827706522       2.06293852      1.496956642
      0.04035209967      968.0029062      946.4599225     0.9888417085      1.544184649
      0.0003294167989  0.0002410934009 1.281105942e-005  1.2945146e-005
      1555.03717      1526.979729      479.903967      471.7494561      1.735879289
      1.617559047      1.654559047     0.6018410082     0.8428926143      1905.344695
      1902.748489      360.2493563      485.9094801      2699.759151      125.6601237
      1419.435215      397.6473007      363.2286584      360.3940252      337.9048486
KEY POINT #6 (t plus 4154.1666 s with a Mixing Number of 102.5386):  81.38557064
      0.040894         0.00925          0.3937     0.8570880547      0.869576376
      0.617949194      0.617949194     0.9992732327      45.34992461      253998.4652
      0.06009328646    0.05504216478    0.06733431293    0.03956046259     0.1068947755
      93.82451021      119.6326305      119.6326305      103.3755337      94.38922368
      93.152287      87.68911109      4.209016036      4.245740296      2.171883558
      0.6750293888     0.6835451175     0.6835451175      1.878029586      1.445977536
      0.04112603744      962.755382       943.401493        1.1097863      1.794613141
      0.0003011927617  0.0002327958885 1.294337442e-005 1.310315605e-005
      1550.389964      1521.543592      481.6284755      472.1421713      1.963650286
      1.852303519      1.889303519     0.8101344051      1.142596219      1865.731216
      1863.6746      393.1496361      502.2230786      2705.400192      109.0734426
      1363.508137      433.4050019      395.5254074      390.3218734      367.3511177
KEY POINT #7 (t plus 4866.9784 s with a Mixing Number of 133.2825):  81.41000556
      0.040894         0.00925          0.3937     0.8748354816     0.8905243483
      0.6326333563     0.6326333563     0.9992049156      40.04711567      250607.0048
      0.05835931681    0.05401772865    0.06884128129    0.03808558794     0.1069268692
      102.8573339      124.6933303      124.6933303      112.2008102      103.1502648
      101.7613684      94.49103047      4.220083409      4.254721139      2.202254919
      0.6789508406     0.6843070989     0.6843070989      1.700166089      1.384326371
      0.04221628403      956.3388347      939.2755753       1.28707563      2.032855655
      0.0002735323175  0.0002226478145 1.311787414e-005 1.328446813e-005
      1542.573287      1513.806246      483.8146524      474.198935      2.300412767
      2.198430767      2.235430767      1.122052566      1.543019073      1910.140167
      1908.536396      431.243703      523.7554192      2712.670947      92.5117162
      1386.384748      470.7351373      432.4786879      426.6207806      395.986527
KEY POINT #8 (t plus 5577.996 s with a Mixing Number of 173.6301):  81.43315424
      0.040894         0.00925          0.3937     0.8790444598     0.8976660309
      0.6341731268     0.6341731268       0.9990698      34.26702072      246753.8989
      0.05663957862    0.05287519518    0.06936528182    0.03759199173     0.1069572736
      111.6319282      130.2768597      130.2768597      123.184551      112.673121
      111.5669097      98.05870354      4.232544309      4.265395855      2.238921757
      0.681806881     0.6848123556     0.6848123556      1.556615732      1.322821267
      0.04351750298      949.7541727      934.5965236       1.50847082      2.376429364
      0.0002507501966  0.0002123799007 1.331056953e-005 1.349574383e-005
      1532.669484      1504.535297      486.1109031      475.7639829      2.725049909
      2.631772927      2.668772927       1.51414276      2.195435462      1926.738278
      1925.564049      468.3583703      547.5701947      2720.468724      79.21182438
      1379.168083      517.3636645      472.7648646      468.0844833      411.0455327
KEY POINT #9 (t plus 5571.0937 s with a Mixing Number of 173.2918):  81.62358086
      0.040894         0.00925          0.3937      0.879026001      0.897628266
      0.6325232183     0.6325232183     0.9990646122       34.3090466      247344.0243
      0.05665404493    0.05288614415    0.06936228922     0.0378450976     0.1072073868
      111.5588343      130.2236443      130.2236443      122.9117699      112.5680864
      111.4395269       97.8642083      4.232433409      4.265290191      2.238556344
      0.6817868628     0.6848091829     0.6848091829      1.557709495      1.323377645
      0.04350459683      949.8104096      934.6417449      1.506225132      2.379068758
      0.0002509255946  0.0002124735066 1.330873243e-005 1.349502874e-005
      1532.760811      1504.627208       486.0896      475.6783574      2.720722327
      2.627355227      2.664355227      1.510464933      2.176879609      1923.026279
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        1921.849169      468.0486825      547.3429201      2720.395559      79.29423764
        1375.683359      516.2035996      472.3198226      467.545037       410.2256526
KEY POINT #10 (t plus 5858.3221 s with a Mixing Number of 191.7071):  81.02958849
        0.040894         0.00925          0.3937     0.8788693232     0.8985765194
        0.6401204972     0.6401204972     0.9990311987     32.27462076      244020.2349
        0.05597880371    0.05239844336    0.06932533138    0.03710188421    0.1064272156
        114.9581923      132.5887006      132.5887006      126.431655       116.1818927
        115.1252293      109.4955955      4.237725288      4.270061184      2.255095843
        0.6826506447     0.6849199057     0.6849199057     1.508484717      1.2991736
        0.04408778845    947.1697943      932.6203503      1.608663353      2.510628679
        0.0002430001935  0.0002083880818 1.339038605e-005 1.357930007e-005
        1528.357819      1500.477477      487.025455       476.6055677      2.918515906
        2.828636144      2.865636144      1.689465301      2.426391369      1945.104613
        1944.062962      482.4596034      557.4494818      2723.625204      74.98987835
        1387.655132      531.1931038      487.645297       483.1687679      459.3386632
KEY POINT #11 (t plus 6360.5998 s with a Mixing Number of 228.3854):  81.73966194
        0.040894         0.00925          0.3937     0.8716921446     0.8929866852
        0.6442137836     0.6442137836     0.9989241853     29.1031679       243239.0575
        0.05476938413    0.05149722685    0.07000986484    0.0373499871     0.1073598519
        120.9853475      136.9310723      136.9310723      131.7821795      122.5583428
        121.8122331      118.482985       4.24778309       4.279229861      2.287067434
        0.6838517573     0.6849629318     0.6849629318     1.428871627      1.257392657
        0.04521069572    942.3648163      928.84709        1.811298623      2.808617337
        0.0002300344327  0.0002012669076 1.354033127e-005 1.374229028e-005
        1519.801814      1492.516971      488.6851829      477.8215237      3.311945067
        3.230471351      3.267471351      2.049442799      2.849798079      1964.132765
        1963.28577       508.0592448      576.0374656      2729.434893      67.97822077
        1388.095299      554.0296867      514.7419685      511.5735207      497.4396923
KEY POINT #12 (t plus 0 s with a Mixing Number of 35.1057):  72.33733181        0.040894
        0.00925          0.3937     0.7808298517     0.7826553004     0.5701635263
        0.5701635263     0.9994595563     60.22142642      235717.3073      0.06956065388
        0.05811295749    0.05759980793    0.03741068084    0.09501048877    40.21931012
        104.1251698      104.1251698      40.29314309      40.24535798      40.34995192
        37.7428711       4.178533104      4.222036447      2.094496684      0.6289137279
        0.6793565299     0.6793565299     4.319516323      1.677844149      0.03826206615
        992.142015       955.353835     0.6852446514     1.201189279  0.0006501332037
        0.0002699773897 1.241042046e-005  1.25496209e-005      1531.709635
        1541.047548      474.3373526      465.3270028      1.172863986      1.04260398
        1.07960398    0.07471206981    0.07500619594     1720.455888      1716.829268
        168.5465894      436.516365       2682.03514       267.9697755      1283.939523
        168.8551029      168.6539255      169.0940743      158.2042309
KEY POINT #13 (t plus 6360.4188 s with a Mixing Number of 228.3876):  81.79855667
        0.040894         0.00925          0.3937     0.8716961393     0.8929901776
        0.6436696067     0.6436696067     0.9989216584     29.10030622      243406.428
        0.05476972671    0.05149741168    0.07000448238    0.03743272404    0.1074372064
        120.9836511      136.9301854      136.9301854      131.7799441      122.5574967
        121.8084465      118.4774826      4.247780142      4.279227933      2.287060691
        0.6838514763     0.6849629441     0.6849629441     1.428892781      1.257400856
        0.04521045935    942.3661933      928.8478689      1.81125524       2.810917385
        0.0002300379033  0.0002012683142 1.354030064e-005 1.374273557e-005
        1519.804347      1492.518641      488.6848517      477.7961241      3.311860549
        3.230320229      3.267320229      2.049333322      2.849609453      1962.958661
        1962.111833      508.0520281      576.0336647      2729.433723      67.98163656
        1386.924996      554.0201351      514.7383612      511.55742        497.4163327
KEY POINT #14 (t plus 5602.2614 s with a Mixing Number of 175.1179):  80.96252231
        0.040894         0.00925          0.3937     0.87912557     0.8978501224
        0.6382605065     0.6382605065     0.9990809962     34.10470173      245253.7431
        0.05658221369    0.05283572866    0.06937591034    0.03696321809    0.1063391284
        111.9216594      130.4686336      130.4686336      123.984668       113.1578182
        111.7512014      98.73915934      4.232985513      4.26577728       2.240241172
        0.6818855132     0.6848235283     0.6848235283     1.552296009      1.3208208
        0.0435640952     949.5309532      934.4334583      1.516586021      2.373940196
        0.0002500571187  0.0002120432223 1.331719002e-005    1.349982e-005
        1532.305682      1504.203514      486.1875799      475.990379       2.740691674
        2.647693843      2.684693843      1.528793465      2.250608116      1936.073105
        1934.909974      469.5858831      548.389279       2720.732203      78.80339593
        1387.683826      520.7673299      474.8184728      468.8656627      413.9143411
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End
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D.14 TEST #14 - T14_RCIC_1ATM_157KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T14_RCIC_1ATM_157kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1430.7658 s, and ending (KEY POINT #11) at t
       plus 5973.2456 s, for a time period of 4542.4798 s.
Original Data Record Time:  7605.868 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2385.5384 s, T_bulk = 72.2546 C and T_out = 69.8949 C
Stratification Beginning SP12 Temperature = 72.1899 C
Stratification Beginning Pressure = 15.2821 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       3512.8539 s, T_bulk = 87.3483 C and T_out = 79.9994 C
Stratification Ending SP12 Temperature = 87.269 C
Stratification Ending Pressure = 15.3239 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 939.7137 s.
At t = 939.7137 s, the pool pressure is 15.2785 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 53.6278, 53.6193, 55.6206, 53.5167, and 50.472
       C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 7.7273 +/- 2.8802 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 7.0634 +/- 2.3856 C.
Minimum Steam Quality:  0.99376 at t plus 214.2033 s
Maximum Steam Quality:  1.0011 at t plus 2078.8349 s
Time-Averaged Steam Quality:  0.99814 +/- 0.0011321
Minimum Turbine Outlet Steam Quality:  1.0231 at t plus 301.6032 s
Maximum Turbine Outlet Steam Quality:  1.0314 at t plus 2843.8467 s
Time-Averaged Turbine Outlet Steam Quality:  1.0283 +/- 0.0013266
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 4452.4727 s; using 300 s smoothing
Max and min smoothed upper level changerates:  1.0549 degrees/min at t plus 2431.7411 s
       and 0.52368 degrees/min at t plus 3902.7412 s, respectively
Max and min smoothed mid (SP9) level changerates:  1.0083 degrees/min at t plus 3780.3622
       s and 0.69765 degrees/min at t plus 2892.1464 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.27929 degrees/min at t
       plus 2430.14 s and -0.41692 degrees/min at t plus 3819.5625 s, respectively
Max and min smoothed lower level changerates:  1.237 degrees/min at t plus 3544.1847 s
       and 0.13441 degrees/min at t plus 2964.9506 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.5982 degrees/min at t
       plus 2964.9506 s and -0.4986 degrees/min at t plus 3544.3577 s, respectively
Max and min smoothed outlet level changerates:  2.048 degrees/min at t plus 3586.2571 s
       and 0.16499 degrees/min at t plus 3041.1499 s, respectively
Max and min smoothed lower-outlet level changerate differences:  0.47951 degrees/min at t
       plus 3326.8523 s and -0.91416 degrees/min at t plus 3645.9575 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.5337 degrees/min at t plus 1436.8222
       s and -0.1319 degrees/min at t plus 2779.445 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.66698 degrees/min
       at t plus 1473.7233 s and -0.94887 degrees/min at t plus 2779.445 s, respectively
The mean steam flow rate was 66.7509 +/- 1.9931 g/s
The mean feedwater flow rate was 65.2437 +/- 10.6112 g/s
The mean water injection to steam flow rate was 0.0044022 +/- 0.036477 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 9.3352 +/- 1.4951 C over the
       Stratification Period, beginning at 11.7322 C and ending at 8.8525 C
Mean Smoothed SP8-Upper Pool delta T is 8.1288 +/- 1.2972 C over the Stratification
       Period, beginning at 10.5514 C and ending at 7.3814 C
The stratification period begins and ends with Smoothed SP8 readings of 84.2197 and
       96.0967 C, respectively
The stratification period begins and ends with condensing flows of 1.2354 and 2.5113 kg/s,
       respectively.
The stratification period begins and ends with condensing+cooling flows of 3.2204 and
       4.2691 kg/s, respectively.
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The stratification period had a mean sparger steam enthalpy of 2740.7147 +/- 0.47705 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.74581 and 19.6402 kg/s, respectively
The plume period had a mean steam enthalpy of 2746.5465 +/- 0.90679 kJ/kg.
Maximum Smoothed Top-Mid delta T is 2.1669 degrees C at t plus 3673.2361 s with T_upper = 91.3566 C and T_mid = 89.1897 C
At t plus 3673.2361 s, Smoothed SP8-SP9 is 9.1197 C and Smoothed SP8-Top is 6.9529 C, where Smoothed SP8 is 98.3095 C and Pool P = 15.3386 psia
Maximum Smoothed Top-Lower delta T is 2.3477 degrees C at t plus 3194.5517 s with T_upper = 84.2374 C and T_low = 81.8897 C
At t plus 3194.5517 s, Smoothed SP8-SP9 is 7.9919 C and Smoothed SP8-Top is 6.8497 C, where Smoothed SP8 is 91.0871 C and Pool P = 15.295 psia
Maximum Smoothed Mid-Lower delta T is 1.2055 degrees C at t plus 3194.4507 s with T_mid = 83.094 C and T_low = 81.8885 C
At t plus 3194.4507 s, Smoothed SP8-SP9 is 7.9967 C and Smoothed SP8-Top is 6.8546 C, where Smoothed SP8 is 91.0908 C and Pool P = 15.2951 psia
Maximum Smoothed Top-Outlet delta T is 8.6602 degrees C at t plus 3485.9544 s with T_upper = 88.4181 C and T_out = 79.7579 C
At t plus 3485.9544 s, Smoothed SP8-SP9 is 8.5905 C and Smoothed SP8-Top is 7.0794 C, where Smoothed SP8 is 95.4975 C and Pool P = 15.3088 psia
Maximum Smoothed Mid-Outlet delta T is 7.1662 degrees C at t plus 3498.4611 s with T_mid = 87.0714 C and T_out = 79.9052 C
At t plus 3498.4611 s, Smoothed SP8-SP9 is 8.6779 C and Smoothed SP8-Top is 7.2166 C, where Smoothed SP8 is 95.7493 C and Pool P = 15.3232 psia
Maximum Smoothed Lower-Outlet delta T is 8.0647 degrees C at t plus 3550.5561 s with T_low = 88.908 C and T_out = 80.8432 C
At t plus 3550.5561 s, Smoothed SP8-SP9 is 8.8533 C and Smoothed SP8-Top is 7.155 C, where Smoothed SP8 is 96.4661 C and Pool P = 15.317 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 11.7926 degrees C at (KEY POINT #14) t plus 2395.237 s with T_SP8 = 84.4204 C and T_SP9 = 72.6278 C and Pool P = 15.2815 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 10.7336 degrees C at t plus 2338.3387 s with T_SP8 = 83.3316 C and T_upper = 72.598 C and Pool P = 15.282 psia
Maximum Top-Mid delta T is 2.1893 degrees C at (KEY POINT #4) t plus 2815.9571 s ignoring SP 4, with temperatures of 79.5373 and 77.348 C, respectively, at Set # 2, where Pool P = 15.2813 psia and T_outlet = 73.9644 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 3033.9485 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99909 C and a raw SP12 Reading of 81.057 C.
Maximum Top-Lower delta T is 3.6819 degrees C at t plus 3204.9513 s, with temperatures of 84.7409 and 81.059 C, respectively, at Set # 1, where Pool P = 15.2932 psia and T_outlet = 76.6853 C
Maximum Mid-Low delta T is 1.5494 degrees C at (KEY POINT #6) t plus 2869.2461 s ignoring SP 4, with temperatures of 79.4408 and 77.8913 C, respectively, at Set # 2, where Pool P = 15.2926 psia and T_outlet = 74.8448 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 2869.2461 s with a Smoothed Mid-Axis Mid-Low Delta T of 0.87727 C and a raw SP12 Reading of 79.4408 C.
Maximum Top-Outlet delta T is 9.2384 degrees C at t plus 3509.7677 s, with temperatures of 89.2142 and 79.9758 C, respectively, at Set # 1, where Pool P = 15.3219 psia
Maximum Mid-Outlet delta T is 7.3478 degrees C at t plus 3482.1562 s ignoring SP 4, with temperatures of 86.9776 and 79.6297 C, respectively, at Set # 2, where Pool P = 15.3095 psia
Maximum Lower-Outlet delta T is 9.1259 degrees C at (KEY POINT #8) t plus 3468.7574 s, with temperatures of 88.6267 and 79.5008 C, respectively, at Set # 1, where Pool P = 15.3093 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 3622.2572 s with a Smoothed Mid-Axis Low-Outlet Delta T of 3.0404 C and a raw SP12 Reading of 88.3963 C.
Minimum SP Pressure is 14.8214 psia at t plus 0 s
Maximum SP Pressure is 16.1784 psia at t plus 4540.0857 s
Beginning SP Pressure is 14.8214 psia
Ending SP Pressure is 16.1773 psia
Time-Average SP Pressure is 15.3248 +/- 0.19934 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.5369 cm (cold) / 76.679 cm (hot) at 14.6967 psia
Beginning Smoothed SP Level is 77.0125 cm (cold) / 77.189 cm (hot) at 14.8271 psia
Ending Smoothed SP Level is 76.5917 cm (cold) / 77.5982 cm (hot) at 16.1809 psia

Minimum Smoothed Cold SP Level is 76.5896 cm at t plus 4506.6758 s and 16.0872 psia
Minimum Smoothed Hot SP Level is 77.189 cm at t plus 0 s and 14.8271 psia
Maximum Smoothed Cold SP Level is 77.2669 cm at t plus 253.9025 s and 15.039 psia
Maximum Smoothed Hot SP Level is 77.7039 cm at t plus 4414.0685 s and 15.9325 psia
SP 12 Temperature at the beginning is 40.3354 C, and at the end is 99.9414 C
At plume detection, the Mixing Number is 38.4286
The Mixing Number ranges from a minimum of 32.7622 at (KEY POINT #12) t plus 0 s to a maximum of 269.8203 at (KEY POINT #13) t plus 4542.4798 s; it had a mean value of 71.0913 +/- 48.8964 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 32.7622): 51.68433553 0.040894
0.00925 0.3937 0.7701249014 0.7718899222 1.024235576
1 1 83.92824409 157890.1249 0.06947577248
0.05831310271 0.06788409051 2.580138907e-006 0.06788409051 40.74070806
129.7014415 103.0954497 41.23768898 40.48075873 40.53160571
36.98498522 4.178535923 4.220655847 2.090122876 0.6295715819
0.6789768643 0.6789768643 4.273203676 1.695965174 0.03809500515
991.9390833 956.1099702 0.6625909544 0.6158391672 0.0006438349814
0.0002728299009 1.237517059e-005 1.338639271e-005 1532.577289
1542.104435 473.8231357 491.6751017 1.131454261 1.022295431
1.059295431 0.07681063294 0.07885807988 2741.962786 2734.918836
170.7234708 432.1664867 2680.430854 261.4430159 2309.7963
172.8001242 169.6357584 169.8513222 155.0354764
KEY POINT #2 (t plus 939.7137 s with a Mixing Number of 38.4286): 49.93733229
0.040894 0.00925 0.3937 0.7719410612 0.7749879592
1.025120957 1 1 78.85692072 151773.4879
0.06733265553 0.05813285873 0.06558951278 4.40988611e-006 0.06558951278
53.61931614 131.5413858 104.0228906 55.6205902 53.6278319
53.51666926 50.47203371 4.180451639 4.221898273 2.094058314
0.6444254045 0.6793193955 0.6793193955 3.34218182 1.67962685
0.03824535321 986.3730864 955.429152 0.6829667152 0.6333076331
0.0005152043504 0.000270258311 1.240691821e-005 1.345516463e-005
1549.028541 1541.153915 474.2864376 492.7253399 1.168695724
1.053611392 1.090611392 0.1474778971 0.1623605684 2744.510918
2738.292504 224.548243 436.0842365 2681.876064 211.5359935
2308.426681 232.9150807 224.5823906 224.1206724 211.3979466
KEY POINT #3 (t plus 2385.5384 s with a Mixing Number of 52.7606): 50.52048095
0.040894 0.00925 0.3937 0.7694142275 0.7748411098
1.026400347 1 1 80.54056473 152986.0769
0.06403569433 0.05816718617 0.06635544149 4.539657237e-006 0.06635544149
72.48753625 132.8034539 103.8464134 84.21972121 73.66834724
72.87503887 69.73709809 4.18972946 4.221660402 2.093303978
0.6615777318 0.6792550232 0.6792550232 2.47319225 1.682711672
0.038216578 976.3492833 955.5589976 0.679050752 0.6273104422

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      0.0003905285376  0.0002707442682 1.240087577e-005 1.350439589e-005
      1557.846882      1541.336725      474.1985031      493.5531724      1.16153237
      1.0535973        1.0905973      0.3471379438     0.5611966416     2747.390345
      2740.903563      303.501629       435.338657       2681.601446      131.8370279
      2312.051688      352.7093828      308.4480177      305.1266727      291.9857295
KEY POINT #4 (t plus 2815.9571 s with a Mixing Number of 60.755):  52.97387942
      0.040894         0.00925          0.3937       0.76962915      0.7760553945
      1.026688415            1                1         84.315753       160238.9813
      0.06296802301    0.05815273214    0.06957782448 4.625619141e-006    0.06957782448
      78.38588448      133.1923778      103.9207302      87.29106089      79.76984434
      79.61901279      73.96807416      4.194159106      4.221760489      2.093621323
      0.665894357     0.6792821773     0.6792821773      2.277826759      1.681411242
      0.03822868605     972.8109713      955.5043349      0.6806975815      0.6283215094
      0.000361643883  0.0002705394332 1.240342024e-005 1.351926858e-005
      1557.431108      1541.259852      474.2355464      493.7905376      1.16454452
      1.054047631      1.091047631      0.4439955205     0.6326458435      2748.770161
      2741.661015      328.2268588      435.6526248      2681.717113      107.425766
      2313.117536      365.6112619      334.0308412      333.4008543      309.710583
KEY POINT #5 (t plus 3033.9485 s with a Mixing Number of 66.0511):  51.08709283
      0.040894         0.00925          0.3937     0.7685845317     0.7754151755
      1.026475613            1                1       81.7122398       154700.2051
      0.0625113863     0.0581854147    0.06709965018 3.682968269e-006    0.06709965018
      80.8800474      132.8014496      103.7526712      88.14028669      81.72731111
      80.39914744      75.78873963      4.196250079      4.221534327      2.092904338
      0.6675766847     0.6792206757     0.6792206757      2.203224108      1.684354866
      0.03820132493     971.2601439      955.627913     0.6769780938     0.6252416655
      0.0003505084343  0.0002710030433 1.239766638e-005 1.350454302e-005
      1556.848326      1541.433461      474.1517506      493.5643481      1.157742069
      1.054519486      1.091519486     0.4912981595     0.6536906142      2747.610195
      2740.933305      338.6903954      434.942634       2681.455499      96.25223858
      2312.667561      369.1802963      342.2446925      336.6739489      317.3418075
KEY POINT #6 (t plus 2869.2461 s with a Mixing Number of 62.0954):  51.65704772
      0.040894         0.00925          0.3937     0.7690867632     0.7756043304
      1.026787801            1                1       82.54453613      156248.5741
      0.06285894018    0.05817432249    0.06784824972 4.603241341e-006    0.06784824972
      78.98321447      133.2015352      103.8097165      86.98020428      79.93021694
      80.19684936      74.74341286      4.194648064      4.221611025      2.093147445
      0.6663049238     0.6792415901     0.6792415901      2.259552713      1.683354547
      0.03821060431     972.4422902      955.5859803     0.6782387624     0.6258506604
      0.0003589219108  0.0002708455167 1.239961938e-005 1.351988856e-005
      1557.313033      1541.374625      474.1802046      493.8110579      1.160047378
      1.054203789      1.091203789      0.454960054     0.6250853515      2748.532983
      2741.719383      330.7323144      435.1836259      2681.544319      104.4513115
      2313.349357      364.3050337      334.703677       335.8251321      312.9600719
KEY POINT #7 (t plus 2869.2461 s with a Mixing Number of 62.0954):  51.65704772
      0.040894         0.00925          0.3937     0.7690867632     0.7756043304
      1.026787801            1                1       82.54453613      156248.5741
      0.06285894018    0.05817432249    0.06784824972 4.603241341e-006    0.06784824972
      78.98321447      133.2015352      103.8097165      86.98020428      79.93021694
      80.19684936      74.74341286      4.194648064      4.221611025      2.093147445
      0.6663049238     0.6792415901     0.6792415901      2.259552713      1.683354547
      0.03821060431     972.4422902      955.5859803     0.6782387624     0.6258506604
      0.0003589219108  0.0002708455167 1.239961938e-005 1.351988856e-005
      1557.313033      1541.374625      474.1802046      493.8110579      1.160047378
      1.054203789      1.091203789      0.454960054     0.6250853515      2748.532983
      2741.719383      330.7323144      435.1836259      2681.544319      104.4513115
      2313.349357      364.3050337      334.703677       335.8251321      312.9600719
KEY POINT #8 (t plus 3468.7574 s with a Mixing Number of 82.0868):  51.70324864
      0.040894         0.00925          0.3937      0.768460622     0.7761826512
      1.026211766            1                1       82.46212694      156673.4035
      0.06144618975    0.05817296579    0.06790893168  4.98967612e-006    0.06790893168
      86.63515218      132.5661697      103.8166933      95.08371201      88.11956258
      87.04263599      79.53904283      4.201570342      4.22162041       2.093177196
      0.6711412026     0.6792441452     0.6792441452      2.046843941      1.683232287
      0.03821173976     967.5634903      955.5808509     0.6783930763     0.6270399455
      0.0003269542558  0.0002708262622 1.239985824e-005 1.349528766e-005
      1554.628409      1541.367422      474.1836839      493.406188       1.160329582
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1.055964693 1.092964693 0.6167817197 0.8486996614 2747.235775
2740.435773 362.8553513 435.2131002 2681.55518 72.35774886
2312.022675 398.3898404 369.0919814 364.5689101 333.0691078
KEY POINT #9 (t plus 3512.8539 s with a Mixing Number of 84.3811): 51.77788195
0.040894 0.00925 0.3937 0.7684902086 0.776300988
1.026218457 1 1 82.55264555 156892.1765
0.06133252794 0.05817092476 0.06800695779 3.677493156e-006 0.06800695779
87.24420849 132.5832419 103.8271889 96.09673537 88.71534285
87.65512861 80.13347026 4.202173956 4.221634531 2.093221961
0.6714928657 0.679247988 0.679247988 2.031472139 1.683048395
0.03821344813 967.1627128 955.5731338 0.6786252752 0.6272443664
0.0003246222224 0.0002707973009 1.240021758e-005 1.349592282e-005
1554.324321 1541.356585 474.1889176 493.4156518 1.160754229
1.056235929 1.093235929 0.6315014598 0.880821321 2747.281348
2740.466408 365.4145494 435.2574404 2681.571519 69.84289097
2312.023907 402.6559429 371.5962837 367.1427942 335.5629582
KEY POINT #10 (t plus 3622.2572 s with a Mixing Number of 89.853): 51.94588295
0.040894 0.00925 0.3937 0.7684206672 0.7764638653
1.026259025 1 1 82.75674152 157370.1901
0.0610878574 0.0581655426 0.06822761643 5.246619366e-006 0.06822761643
88.55206712 132.6537889 103.8548646 97.34215296 90.45933632
90.10421011 85.1801 4.203496462 4.221671778 2.093340043
0.6722316632 0.6792581145 0.6792581145 1.999170155 1.682563688
0.03821795422 966.2960061 955.5527827 0.6792378644 0.6277419406
0.0003197113381 0.0002707209604 1.240116512e-005 1.349858532e-005
1553.627846 1541.327991 474.2027166 493.4568481 1.161874585
1.057005945 1.094005945 0.664103462 0.9216886986 2747.447358
2740.59868 370.911321 435.3743607 2681.614601 64.46303974
2312.072997 407.9024201 378.9290971 377.4383901 356.7479009
KEY POINT #11 (t plus 4542.4798 s with a Mixing Number of 269.8203): 53.67577785
0.040894 0.00925 0.3937 0.7659172293 0.775981586
1.026140655 1 1 81.67941967 162121.0012
0.0587272918 0.05789498517 0.07049972346 4.164687906e-006 0.07049972346
100.9566149 133.7946936 105.2438258 103.9708686 101.2145594
101.1894986 97.89145848 4.217840967 4.223562777 2.099348558
0.6781534697 0.6797543993 0.6797543993 1.734891258 1.658589558
0.03844659569 957.6727382 954.5270219 0.7105652181 0.6571906228
0.000278939518 0.0002669389822 1.244873914e-005 1.353937641e-005
1544.218921 1539.86433 474.8918945 493.9951316 1.21926012
1.115631999 1.152631999 1.049294316 1.166580326 2749.063671
2742.392143 423.1438127 441.2436562 2683.771009 18.09984352
2307.820015 2681.979561 424.230552 424.1274607 410.2262012
KEY POINT #12 (t plus 0 s with a Mixing Number of 32.7622): 51.68433553 0.040894
0.00925 0.3937 0.7701249014 0.7718899222 1.024235576
1 1 83.92824409 157890.1249 0.06947577248
0.05831310271 0.06788409051 2.580138907e-006 0.06788409051 40.74070806
129.7014415 103.0954497 41.23768898 40.48075873 40.53160571
36.98498522 4.178535923 4.220655847 2.090122876 0.6295715819
0.6789768643 0.6789768643 4.273203676 1.695965174 0.03809500515
991.9390833 956.1099702 0.6625909544 0.6158391672 0.0006438349814
0.0002728299009 1.237517059e-005 1.338639271e-005 1532.577289
1542.104435 473.8231357 491.6751017 1.131454261 1.022295431
1.059295431 0.07681063294 0.07885807988 2741.962786 2734.918836
170.7234708 432.1664867 2680.430854 261.4430159 2309.7963
172.8001242 169.6357584 169.8513222 155.0354764
KEY POINT #13 (t plus 4542.4798 s with a Mixing Number of 269.8203): 53.67577785
0.040894 0.00925 0.3937 0.7659172293 0.775981586
1.026140655 1 1 81.67941967 162121.0012
0.0587272918 0.05789498517 0.07049972346 4.164687906e-006 0.07049972346
100.9566149 133.7946936 105.2438258 103.9708686 101.2145594
101.1894986 97.89145848 4.217840967 4.223562777 2.099348558
0.6781534697 0.6797543993 0.6797543993 1.734891258 1.658589558
0.03844659569 957.6727382 954.5270219 0.7105652181 0.6571906228
0.000278939518 0.0002669389822 1.244873914e-005 1.353937641e-005
1544.218921 1539.86433 474.8918945 493.9951316 1.21926012
1.115631999 1.152631999 1.049294316 1.166580326 2749.063671

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        2742.392143      423.1438127      441.2436562      2683.771009      18.09984352
        2307.820015      2681.979561      424.230552       424.1274607      410.2262012
KEY POINT #14 (t plus 2395.237 s with a Mixing Number of 52.9243):  50.57137136
        0.040894         0.00925          0.3937      0.7694394345      0.774889854
        1.026380278              1                1      80.61290731      153149.2242
        0.06401050738    0.05816678764    0.0664222828 5.645138864e-006    0.0664222828
        72.62779138      132.782976       103.8484626      84.42041609      73.88128596
        73.01216781      69.73578283      4.189826386      4.22166316       2.093312722
        0.6616859656     0.6792557729     0.6792557729     2.468209944      1.682675786
        0.03821691169      976.2672766      955.5574906     0.6790961194     0.6273892238
        0.0003897965523  0.0002707386161 1.240094593e-005 1.350359867e-005
        1557.853204      1541.334608      474.1995248      493.5398765      1.161615343
        1.053597868      1.090597868     0.3492143222     0.5656493406     2747.359968
        2740.861527      304.0892669      435.3473144      2681.604636      131.2580476
        2312.012654      353.5521705      309.3403669      305.7012489      291.9802213
End
```

D.15 TEST #15 - T15_SRV_STD_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T15_SRV_STD_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1538.266 s, and ending (KEY POINT #11) at t
        plus 9618.7952 s, for a time period of 8080.5292 s.
Original Data Record Time:  10602.6104 s
No Bulk Pool to Outlet Thermal Stratification Detected (KEY POINT #3), 0 0 0 0 0 0.
No Bulk Pool to Outlet Destratification Detected (KEY POINT #9), 0 0 0 0 0 0.
No Plume detected, setting t_plume (KEY POINT #2) to the end at 8080.5292 s.
At t = 8080.5292 s, the pool pressure is 38.995 psia while the Smoothed Upper, Mid, SP8,
        Lower, and Outlet Temperatures are 113.9352, 113.6785, 113.6174, 113.7767, and
        111.2981 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
        temperatures were -0.06107 +/- 0 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
        temperatures were -0.31777 +/- 0 C.
Minimum Steam Quality:  1.0008 at t plus 8031.3254 s
Maximum Steam Quality:  1.0186 at t plus 2039.1306 s
Time-Averaged Steam Quality:  1.0121 +/- 0.003617
SRV Alignment, no RCIC Turbine 0 0 0 0 0 0
Smoothed Changerates may not fully include test beginning and end periods, analysis
        ending at t plus 7990.525 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.67294 degrees/min at t plus 3934.67 s
        and 0.40502 degrees/min at t plus 5918.7955 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.85564 degrees/min at t plus 4650.683
        s and 0.30064 degrees/min at t plus 6144.3034 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.20593 degrees/min at t
        plus 6144.3034 s and -0.28496 degrees/min at t plus 4650.683 s, respectively
Max and min smoothed lower level changerates:  0.73554 degrees/min at t plus 5980.7921 s
        and 0.41167 degrees/min at t plus 3522.9535 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.33374 degrees/min at t
        plus 4650.576 s and -0.40538 degrees/min at t plus 6006.2955 s, respectively
Max and min smoothed outlet level changerates:  0.68425 degrees/min at t plus 2884.259 s
        and 0.33409 degrees/min at t plus 3384.5526 s, respectively
Max and min smoothed lower-outlet level changerate differences:  0.17619 degrees/min at t
        plus 5981.0961 s and -0.20986 degrees/min at t plus 3580.0628 s, respectively
Max and min smoothed hot (SP8) level changerates:  0.71209 degrees/min at t plus
        3518.9583 s and 0.33654 degrees/min at t plus 6098.3988 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.20466 degrees/min
        at t plus 3757.6609 s and -0.31041 degrees/min at t plus 4680.6757 s,
        respectively
The mean steam flow rate was 45.6995 +/- 1.6437 g/s
The mean feedwater flow rate was 45.557 +/- 1.6933 g/s
The mean water injection to steam flow rate was 0.0051655 +/- 0.036299 g/s
No stratification; 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.
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At plume detection, the condensing and condensing+cooling flows are 1.4959 and -421.5113
        kg/s, respectively
The plume period had a mean steam enthalpy of 2730.9264 +/- 0 kJ/kg.
Maximum Smoothed Top-Mid delta T is 0.75278 degrees C at t plus 3958.9644 s with T_upper
        = 77.3937 C and T_mid = 76.641 C
At t plus 3958.9644 s, Smoothed SP8-SP9 is 0.67974 C and Smoothed SP8-Top is -0.073033 C,
        where Smoothed SP8 is 77.3207 C and Pool P = 20.4281 psia
Maximum Smoothed Top-Lower delta T is 1.5446 degrees C at t plus 5365.3899 s with T_upper
        = 90.2976 C and T_low = 88.753 C
At t plus 5365.3899 s, Smoothed SP8-SP9 is -1.831 C and Smoothed SP8-Top is -0.31464 C,
        where Smoothed SP8 is 89.9829 C and Pool P = 24.807 psia
Maximum Smoothed Mid-Lower delta T is 3.1441 degrees C at t plus 5400.9889 s with T_mid =
        92.2263 C and T_low = 89.0821 C
At t plus 5400.9889 s, Smoothed SP8-SP9 is -1.8159 C and Smoothed SP8-Top is -0.19133 C,
        where Smoothed SP8 is 90.4104 C and Pool P = 24.9471 psia
Maximum Smoothed Top-Outlet delta T is 3.3265 degrees C at t plus 4961.4818 s with
        T_upper = 86.6919 C and T_out = 83.3655 C
At t plus 4961.4818 s, Smoothed SP8-SP9 is -1.145 C and Smoothed SP8-Top is -0.34236 C,
        where Smoothed SP8 is 86.3496 C and Pool P = 23.3866 psia
Maximum Smoothed Mid-Outlet delta T is 4.7304 degrees C at t plus 5401.0859 s with T_mid
        = 92.2267 C and T_out = 87.4963 C
At t plus 5401.0859 s, Smoothed SP8-SP9 is -1.8152 C and Smoothed SP8-Top is -0.19126 C,
        where Smoothed SP8 is 90.4115 C and Pool P = 24.9469 psia
Maximum Smoothed Lower-Outlet delta T is 3.0461 degrees C at t plus 1714.6251 s with
        T_low = 57.1912 C and T_out = 54.1451 C
At t plus 1714.6251 s, Smoothed SP8-SP9 is -0.47117 C and Smoothed SP8-Top is -0.078093 C,
        where Smoothed SP8 is 56.0294 C and Pool P = 16.4601 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 0.68119 degrees C at (KEY POINT #14)
        t plus 3958.6604 s with T_SP8 = 77.3176 C and T_SP9 = 76.6364 C and Pool P =
        20.427 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 0.55772 degrees C at t plus
        6036.9973 s with T_SP8 = 96.0226 C and T_upper = 95.4649 C and Pool P = 27.5682
        psia
Maximum Top-Mid delta T is 2.2723 degrees C at (KEY POINT #4) t plus 5678.2898 s ignoring
        SP 4, with temperatures of 93.496 and 91.2238 C, respectively, at Set # 2, where
        Pool P = 26.0339 psia and T_outlet = 89.8876 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 6044.7987 s with a Smoothed Mid-
        Axis Top-Mid Delta T of 0.99938 C and a raw SP12 Reading of 94.4687 C.
Maximum Top-Lower delta T is 2.4311 degrees C at t plus 5753.7931 s, with temperatures of
        94.0925 and 91.6614 C, respectively, at Set # 2, where Pool P = 26.3566 psia and
        T_outlet = 90.6283 C
Maximum Mid-Low delta T is 2.149 degrees C at (KEY POINT #6) t plus 180.9034 s ignoring
        SP 4, with temperatures of 43.6847 and 41.5356 C, respectively, at Set # 2, where
        Pool P = 15.2104 psia and T_outlet = 40.409 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 180.9034 s with a Smoothed Mid-
        Axis Mid-Low Delta T of 0.14214 C and a raw SP12 Reading of 43.6847 C.
Maximum Top-Outlet delta T is 3.8744 degrees C at t plus 4976.6807 s, with temperatures
        of 87.3875 and 83.5131 C, respectively, at Set # 1, where Pool P = 23.4261 psia
Maximum Mid-Outlet delta T is 3.887 degrees C at t plus 3502.3553 s ignoring SP 4, with
        temperatures of 73.7224 and 69.8355 C, respectively, at Set # 2, where Pool P =
        19.3279 psia
Maximum Lower-Outlet delta T is 4.0989 degrees C at (KEY POINT #8) t plus 3541.4566 s,
        with temperatures of 74.6185 and 70.5196 C, respectively, at Set # 1, where Pool
        P = 19.4227 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 3831.5592 s with a Smoothed
        Mid-Axis Low-Outlet Delta T of 1.3659 C and a raw SP12 Reading of 74.9839 C.
Minimum SP Pressure is 15.1088 psia at t plus 1.0001 s
Maximum SP Pressure is 38.9981 psia at t plus 8080.2302 s
Beginning SP Pressure is 15.1193 psia
Ending SP Pressure is 38.995 psia
Time-Average SP Pressure is 22.7706 +/- 6.8216 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.0129 cm (cold) / 76.146 cm (hot) at 14.6981 psia
Beginning Smoothed SP Level is 76.5224 cm (cold) / 76.69 cm (hot) at 15.113 psia
Ending Smoothed SP Level is 79.3506 cm (cold) / 80.7706 cm (hot) at 39.0016 psia
Minimum Smoothed Cold SP Level is 76.2505 cm at t plus 4578.9729 s and 22.1529 psia
Minimum Smoothed Hot SP Level is 76.6787 cm at t plus 198.2033 s and 15.219 psia
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Maximum Smoothed Cold SP Level is 80.6387 cm at t plus 6970.5107 s and 32.1146 psia
Maximum Smoothed Hot SP Level is 81.8884 cm at t plus 6985.9156 s and 32.2023 psia
SP 12 Temperature at the beginning is 40.2622 C, and at the end is 112.9122 C
At plume detection, the Mixing Number is 195.3685
The Mixing Number ranges from a minimum of 32.4148 at (KEY POINT #12) t plus 0 s to a
       maximum of 195.3685 at (KEY POINT #13) t plus 8080.5292 s; it had a mean value of
       81.9616 +/- 46.0899 over the test period.
Key Points have Data Dumps of the following for each Key Point:  Sparger Massflux (kg/m2-
       s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet
       Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1,
       Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1,
       Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat
       Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,
       Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
       Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
       Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
       (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
       Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
       Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
       Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
       Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
       Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
       Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
       Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
       Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
       Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
       Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
       Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
       Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
       Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
       Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 32.4148):  33.55182244         0.040894
       0.00925          0.3937     0.7652243623     0.7668997726      1.015870168
       1                1      57.74794494      105981.3929    0.06955889984
       0.05879671561    0.04406818678 1.839331257e-006    0.04406818678       40.2300938
       118.0485361      100.5970626       39.9570382      40.11766023      41.23101032
       38.87105828      4.178533141      4.217402518       2.07986903     0.6289273713
       0.6780018637     0.6780018637      4.318308822      1.741579006    0.03770055929
       992.1307755      957.9247558      0.6101525993     0.5810288639  0.0006499655559
       0.0002799812934 1.228973993e-005 1.294631246e-005       1531.727723
       1544.538309      472.5607081      484.4735547      1.035980073      1.042002762
       1.079002762    0.07475496621    0.07367530141      2715.633756      2712.298931
       168.5915961      421.6186176      2676.513373      253.0270215      2294.015138
       167.4506237      168.1202823      172.7755478      162.9184026
KEY POINT #2 (t plus 8080.5292 s with a Mixing Number of 195.3685):  36.82799728
       0.040894          0.00925          0.3937     0.7935061475     0.8077063997
       1.005470095                1                1      25.57441478      111676.9483
       0.05623358903    0.05310204147    0.04837123425 8.544358399e-006    0.04837123425
       113.678492      134.5574126      129.1731795      113.6174221      113.9351938
       113.776728      111.2981221      4.235716719      4.263220091      2.231406392
       0.6823377877     0.6847401125     0.6847401125       1.52657253      1.334474092
       0.04325184706      948.1577854      935.5319428      1.462443396      1.440287214
       0.0002459177967  0.0002143375009  1.32724701e-005 1.348572058e-005
       1530.038224      1506.427662      485.6667753      489.6155469      2.636431467
       2.689068211      2.726068211      1.620144448      1.616895565      2731.504134
       2730.850083      477.0278822      542.8577658       2718.94667      65.82988358
       2188.646368      476.7692114      478.1140272      477.4452816      466.9543239
KEY POINT #3 (t plus 8080.5292 s with a Mixing Number of 195.3685):  36.82799728
       0.040894          0.00925          0.3937     0.7935061475     0.8077063997
       1.005470095                1                1      25.57441478      111676.9483
       0.05623358903    0.05310204147    0.04837123425 8.544358399e-006    0.04837123425
       113.678492      134.5574126      129.1731795      113.6174221      113.9351938
       113.776728      111.2981221      4.235716719      4.263220091      2.231406392
       0.6823377877     0.6847401125     0.6847401125       1.52657253      1.334474092
       0.04325184706      948.1577854      935.5319428      1.462443396      1.440287214
       0.0002459177967  0.0002143375009  1.32724701e-005 1.348572058e-005
       1530.038224      1506.427662      485.6667753      489.6155469      2.636431467
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2.689068211 2.726068211 1.620144448 1.616895565 2731.504134
2730.850083 477.0278822 542.8577658 2718.94667 65.82988358
2188.646368 476.7692114 478.1140272 477.4452816 466.9543239
KEY POINT #4 (t plus 5678.2898 s with a Mixing Number of 103.4476): 35.761256
0.040894 0.00925 0.3937 0.7821444864 0.7913360181
1.013120626 1 1 37.29900747 109544.1864
0.06004540175 0.05576334802 0.04697013736 6.585544827e-006 0.04697013736
94.07662257 129.7422211 116.0375963 92.98676881 92.90841221
91.56097603 89.99737093 4.209316204 4.239744441 2.151904
0.6751490465 0.6828254629 0.6828254629 1.872504458 1.493570594
0.04040040562 962.5691675 946.2656363 0.9962651249 0.9589067486
0.0003003384726 0.0002405446947 1.281954291e-005 1.3350054e-005
1550.193323 1526.642571 480.0162515 489.5441399 1.749809034
1.794954505 1.831954505 0.817736807 0.7852932384 2730.553453
2729.162237 394.2064324 486.9552264 2700.124076 92.74879398
2243.598227 389.6195667 389.2885347 383.6222231 377.049705
KEY POINT #5 (t plus 6044.7987 s with a Mixing Number of 115.1503): 35.92716371
0.040894 0.00925 0.3937 0.7915825059 0.8017350244
1.012014591 1 1 35.30662708 109911.6328
0.05944053984 0.05539098731 0.0471880466 6.604680018e-006 0.0471880466
97.24791458 130.3509709 117.8972057 96.07147321 95.55059515
95.11499599 93.44987066 4.213020881 4.242806876 2.162076764
0.6766311273 0.6832163576 0.6832163576 1.806489448 1.468537378
0.04077082211 960.3552305 944.7910535 1.053749771 1.017718067
0.0002901307698 0.0002364775931 1.288358167e-005 1.336715137e-005
1547.710565 1524.046935 480.8562711 489.5646117 1.857904784
1.903239769 1.940239769 0.918542338 0.8800081974 2730.639422
2729.392864 407.5694596 494.8500079 2702.864473 87.28054836
2235.789414 402.6139199 400.4190498 398.5875199 391.5815792
KEY POINT #6 (t plus 180.9034 s with a Mixing Number of 33.148): 33.23039871
0.040894 0.00925 0.3937 0.7649774413 0.7667936222
1.017320634 1 1 57.15347246 104428.6649
0.06923962653 0.05876693718 0.04364601714 4.768104543e-006 0.04364601714
42.18651832 119.8091053 100.7513252 41.82716732 41.70396736
42.96699292 40.40062134 4.178557388 4.217599462 2.080487747
0.6313759588 0.678064283 0.678064283 4.148720663 1.738693019
0.03772447515 991.3665264 957.8135181 0.6132891097 0.5814874851
0.0006268676586 0.0002795300137 1.229501074e-005 1.301293975e-005
1534.908721 1544.393438 472.6392575 485.6049565 1.041675199
1.048727235 1.085727235 0.0828980668 0.0813474899 2719.071926
2715.805406 176.7671833 422.2696472 2676.756268 245.5024639
2296.802279 175.2656169 174.7493208 180.0300361 169.3103241
KEY POINT #7 (t plus 180.9034 s with a Mixing Number of 33.148): 33.23039871
0.040894 0.00925 0.3937 0.7649774413 0.7667936222
1.017320634 1 1 57.15347246 104428.6649
0.06923962653 0.05876693718 0.04364601714 4.768104543e-006 0.04364601714
42.18651832 119.8091053 100.7513252 41.82716732 41.70396736
42.96699292 40.40062134 4.178557388 4.217599462 2.080487747
0.6313759588 0.678064283 0.678064283 4.148720663 1.738693019
0.03772447515 991.3665264 957.8135181 0.6132891097 0.5814874851
0.0006268676586 0.0002795300137 1.229501074e-005 1.301293975e-005
1534.908721 1544.393438 472.6392575 485.6049565 1.041675199
1.048727235 1.085727235 0.0828980668 0.0813474899 2719.071926
2715.805406 176.7671833 422.2696472 2676.756268 245.5024639
2296.802279 175.2656169 174.7493208 180.0300361 169.3103241
KEY POINT #8 (t plus 3541.4566 s with a Mixing Number of 57.3728): 34.50061791
0.040894 0.00925 0.3937 0.7635368906 0.7688516703
1.017902958 1 1 48.42890934 106507.6921
0.06392259955 0.05755200661 0.04531436933 7.081764497e-006 0.04531436933
73.11688288 126.3396472 106.9982346 72.95975306 72.88947597
73.3049675 70.59705352 4.190105063 4.226012498 2.107172788
0.6620762699 0.6803479425 0.6803479425 2.450804953 1.629267886
0.03874249727 975.9846459 953.2190997 0.7518045389 0.7125085028
0.0003872503856 0.0002622966815 1.250888321e-005 1.324663262e-005
1557.920538 1537.936026 475.7529268 488.9278303 1.29506641
1.339138946 1.376138946 0.3565371776 0.3541705808 2728.887412

2726.542053 306.1617137 448.6612356 2686.478505 142.499522
2280.226176 305.5033318 305.2074935 306.9512793 295.6106832
KEY POINT #9 (t plus 8080.5292 s with a Mixing Number of 195.3685): 36.82799728
0.040894 0.00925 0.3937 0.7935061475 0.8077063997
1.005470095 1 1 25.57441478 111676.9483
0.05623358903 0.05310204147 0.04837123425 8.544358399e-006 0.04837123425
113.678492 134.5574126 129.1731795 113.6174221 113.9351938
113.776728 111.2981221 4.235716719 4.263220091 2.231406392
0.6823377877 0.6847401125 0.6847401125 1.52657253 1.334474092
0.04325184706 948.1577854 935.5319428 1.462443396 1.440287214
0.0002459177967 0.0002143375009 1.32724701e-005 1.348572058e-005
1530.038224 1506.427662 485.6667753 489.6155469 2.636431467
2.689068211 2.726068211 1.620144448 1.616895565 2731.504134
2730.850083 477.0278822 542.8577658 2718.94667 65.82988358
2188.646368 476.7692114 478.1140272 477.4452816 466.9543239
KEY POINT #10 (t plus 3831.5592 s with a Mixing Number of 60.8046): 34.70579838
0.040894 0.00925 0.3937 0.7634351623 0.7691326628
1.017520698 1 1 47.06630177 106991.2331
0.06347681424 0.05734861253 0.04558386085 4.053825826e-006 0.04558386085
75.58695426 126.8972779 108.0353399 75.91332896 75.77629346
75.8695081 73.63971545 4.191894021 4.22749301 2.111924069
0.6639233239 0.6806814122 0.6806814122 2.366861963 1.612421284
0.03892122342 974.5188688 952.4395163 0.7770835446 0.7374466126
0.0003748698926 0.0002596208188 1.254446299e-005 1.326518891e-005
1557.861238 1536.75489 476.2568891 489.1248792 1.341676101
1.386264217 1.423264217 0.3955302184 0.4009412916 2729.444691
2727.229454 316.517565 453.0482398 2688.070308 136.5306748
2276.396451 317.8857336 317.3098998 317.7034799 308.3614513
KEY POINT #11 (t plus 8080.5292 s with a Mixing Number of 195.3685): 36.82799728
0.040894 0.00925 0.3937 0.7935061475 0.8077063997
1.005470095 1 1 25.57441478 111676.9483
0.05623358903 0.05310204147 0.04837123425 8.544358399e-006 0.04837123425
113.678492 134.5574126 129.1731795 113.6174221 113.9351938
113.776728 111.2981221 4.235716719 4.263220091 2.231406392
0.6823377877 0.6847401125 0.6847401125 1.52657253 1.334474092
0.04325184706 948.1577854 935.5319428 1.462443396 1.440287214
0.0002459177967 0.0002143375009 1.32724701e-005 1.348572058e-005
1530.038224 1506.427662 485.6667753 489.6155469 2.636431467
2.689068211 2.726068211 1.620144448 1.616895565 2731.504134
2730.850083 477.0278822 542.8577658 2718.94667 65.82988358
2188.646368 476.7692114 478.1140272 477.4452816 466.9543239
KEY POINT #12 (t plus 0 s with a Mixing Number of 32.4148): 33.55182244 0.040894
0.00925 0.3937 0.7652243623 0.7668997726 1.015870168
1 1 57.74794494 105981.3929 0.06955889984
0.05879671561 0.04406818678 1.839331257e-006 0.04406818678 40.2300938
118.0485361 100.5970626 39.9570382 40.11766023 41.23101032
38.87105828 4.178533141 4.217402518 2.07986903 0.6289273713
0.6780018637 0.6780018637 4.318308822 1.741579006 0.03770055929
992.1307755 957.9247558 0.6101525993 0.5810288639 0.0006499655559
0.0002799812934 1.228973993e-005 1.294631246e-005 1531.727723
1544.538309 472.5607081 484.4735547 1.035980073 1.042002762
1.079002762 0.07475496621 0.07367530141 2715.633756 2712.298931
168.5915961 421.6186176 2676.513373 253.0270215 2294.015138
167.4506237 168.1202823 172.7755478 162.9184026
KEY POINT #13 (t plus 8080.5292 s with a Mixing Number of 195.3685): 36.82799728
0.040894 0.00925 0.3937 0.7935061475 0.8077063997
1.005470095 1 1 25.57441478 111676.9483
0.05623358903 0.05310204147 0.04837123425 8.544358399e-006 0.04837123425
113.678492 134.5574126 129.1731795 113.6174221 113.9351938
113.776728 111.2981221 4.235716719 4.263220091 2.231406392
0.6823377877 0.6847401125 0.6847401125 1.52657253 1.334474092
0.04325184706 948.1577854 935.5319428 1.462443396 1.440287214
0.0002459177967 0.0002143375009 1.32724701e-005 1.348572058e-005
1530.038224 1506.427662 485.6667753 489.6155469 2.636431467
2.689068211 2.726068211 1.620144448 1.616895565 2731.504134
2730.850083 477.0278822 542.8577658 2718.94667 65.82988358
2188.646368 476.7692114 478.1140272 477.4452816 466.9543239

```
KEY POINT #14 (t plus 3958.6604 s with a Mixing Number of 62.3619):  34.80153111
       0.040894          0.00925           0.3937     0.7633234248     0.7691920613
       1.017264298              1                1      46.43733665      107243.0228
       0.06328649215    0.05725372688     0.0457095997 2.663509935e-006    0.0457095997
       76.63643658      127.0723494      108.518331       77.3176262      77.38820582
       76.76706078      74.67350222      4.192692033      4.228190764      2.114169298
       0.6646827353     0.6808323184     0.6808323184      2.332705774      1.604695727
       0.03900543883      973.8865081      952.0748345     0.7890895551     0.7494736244
       0.0003698123407  0.0002583915374 1.256103916e-005 1.327054923e-005
       1557.762919      1536.194466      476.490303       489.159937      1.363849315
       1.408566135      1.445566135     0.4131522933      0.424940232      2729.529375
       2727.372949      320.9190948      455.0918716      2688.809384      134.1727767
       2274.437504      323.7752947      324.0698903      321.4682139      312.6956707
End
```

D.16 TEST #16 - T16_SRV_15PSIG_107KW_RESULTS_RCICLAND.TXT

Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T16_SRV_15PSIG_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1804.5682 s, and ending (KEY POINT #11) at t plus 9924.8937 s, for a time period of 8120.3254 s.
Original Data Record Time: 13185.4462 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus 4231.266 s, T_bulk = 79.2303 C and T_out = 76.3907 C
Stratification Beginning SP12 Temperature = 80.0208 C
Stratification Beginning Pressure = 37.4766 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus 8090.7348 s, T_bulk = 112.3248 C and T_out = 110.841 C
Stratification Ending SP12 Temperature = 112.169 C
Stratification Ending Pressure = 56.6525 psia
No Plume detected, setting t_plume (KEY POINT #2) to the end at 8120.3254 s.
At t = 8120.3254 s, the pool pressure is 56.8624 psia while the Smoothed Upper, Mid, SP8, Lower, and Outlet Temperatures are 113.3683, 114.6837, 112.8655, 112.7627, and 111.0746 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9 temperatures were 0 +/- 0 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 0 +/- 0 C.
Minimum Steam Quality: 0.99716 at t plus 7987.1248 s
Maximum Steam Quality: 1.0095 at t plus 1713.328 s
Time-Averaged Steam Quality: 1.0045 +/- 0.0025327
SRV Alignment, no RCIC Turbine 0 0 0 0 0 0
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 8030.3263 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.72163 degrees/min at t plus 53.8991 s and 0.45607 degrees/min at t plus 6218.6987 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.83863 degrees/min at t plus 4348.8677 s and 0.34817 degrees/min at t plus 5146.4804 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.21007 degrees/min at t plus 4507.9698 s and -0.27599 degrees/min at t plus 4348.7697 s, respectively
Max and min smoothed lower level changerates: 0.83297 degrees/min at t plus 4.2992 s and 0.36669 degrees/min at t plus 3169.2613 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.43272 degrees/min at t plus 4374.4682 s and -0.24998 degrees/min at t plus 5146.4804 s, respectively
Max and min smoothed outlet level changerates: 1.1122 degrees/min at t plus 57.8013 s and 0.3044 degrees/min at t plus 4362.5705 s, respectively
Max and min smoothed lower-outlet level changerate differences: 0.22513 degrees/min at t plus 4273.5674 s and -0.39386 degrees/min at t plus 64.8997 s, respectively
Max and min smoothed hot (SP8) level changerates: 0.75423 degrees/min at t plus 19.1991 s and 0.38328 degrees/min at t plus 7257.4121 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.233 degrees/min at t plus 4508.1699 s and -0.25396 degrees/min at t plus 4348.7697 s, respectively
The mean steam flow rate was 45.4994 +/- 1.2376 g/s

The mean feedwater flow rate was 45.4051 +/- 1.7748 g/s
The mean water injection to steam flow rate was 0.0060864 +/- 0.028913 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is -0.87944 +/- 0.46871 C over the Stratification Period, beginning at -0.056923 C and ending at -1.8143 C
Mean Smoothed SP8-Upper Pool delta T is -0.0098849 +/- 0.30891 C over the Stratification Period, beginning at -0.50933 C and ending at -0.57295 C
The stratification period begins and ends with Smoothed SP8 readings of 78.8443 and 112.5171 C, respectively
The stratification period begins and ends with condensing flows of 0.4716 and 0.82366 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of -458.1989 and -13.948 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2734.6286 +/- 1.1606 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.83007 and -13.9142 kg/s, respectively
The plume period had a mean steam enthalpy of 0 +/- 0 kJ/kg.
Maximum Smoothed Top-Mid delta T is 0.63772 degrees C at t plus 4590.3736 s with T_upper = 82.7355 C and T_mid = 82.0978 C
At t plus 4590.3736 s, Smoothed SP8-SP9 is 0.27001 C and Smoothed SP8-Top is -0.36771 C, where Smoothed SP8 is 82.3678 C and Pool P = 38.6346 psia
Maximum Smoothed Top-Lower delta T is 2.0334 degrees C at t plus 5081.2796 s with T_upper = 87.2368 C and T_low = 85.2035 C
At t plus 5081.2796 s, Smoothed SP8-SP9 is -0.8101 C and Smoothed SP8-Top is -0.23583 C, where Smoothed SP8 is 87.001 C and Pool P = 40.3947 psia
Maximum Smoothed Mid-Lower delta T is 3.2759 degrees C at t plus 5752.889 s with T_mid = 94.6954 C and T_low = 91.4195 C
At t plus 5752.889 s, Smoothed SP8-SP9 is -1.2971 C and Smoothed SP8-Top is 0.35431 C, where Smoothed SP8 is 93.3984 C and Pool P = 43.1819 psia
Maximum Smoothed Top-Outlet delta T is 4.3631 degrees C at t plus 4529.7711 s with T_upper = 82.323 C and T_out = 77.9599 C
At t plus 4529.7711 s, Smoothed SP8-SP9 is -0.24088 C and Smoothed SP8-Top is -0.32871 C, where Smoothed SP8 is 81.9943 C and Pool P = 38.4438 psia
Maximum Smoothed Mid-Outlet delta T is 4.6953 degrees C at t plus 4433.2716 s with T_mid = 82.0683 C and T_out = 77.373 C
At t plus 4433.2716 s, Smoothed SP8-SP9 is -1.1271 C and Smoothed SP8-Top is -0.357 C, where Smoothed SP8 is 80.9412 C and Pool P = 38.1157 psia
Maximum Smoothed Lower-Outlet delta T is 3.715 degrees C at t plus 0.49802 s with T_low = 39.8273 C and T_out = 36.1124 C
At t plus 0.49802 s, Smoothed SP8-SP9 is 0.047538 C and Smoothed SP8-Top is 0.026447 C, where Smoothed SP8 is 39.0603 C and Pool P = 30.2156 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 0.31735 degrees C at (KEY POINT #14) t plus 5592.4859 s with T_SP8 = 91.9144 C and T_SP9 = 91.5971 C and Pool P = 42.4639 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 0.64225 degrees C at t plus 6470.1021 s with T_SP8 = 99.5712 C and T_upper = 98.929 C and Pool P = 46.6315 psia
Maximum Top-Mid delta T is 2.3661 degrees C at (KEY POINT #4) t plus 4645.7487 s ignoring SP 4, with temperatures of 84.038 and 81.6718 C, respectively, at Set # 2, where Pool P = 38.8241 psia and T_outlet = 79.2743 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 4645.7487 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.57623 C and a raw SP12 Reading of 81.6718 C.
Maximum Top-Lower delta T is 3.0432 degrees C at t plus 4739.1611 s, with temperatures of 85.4137 and 82.3706 C, respectively, at Set # 2, where Pool P = 39.1513 psia and T_outlet = 80.4038 C
Maximum Mid-Low delta T is 2.9603 degrees C at (KEY POINT #6) t plus 3673.2651 s ignoring SP 4, with temperatures of 75.8089 and 72.8486 C, respectively, at Set # 2, where Pool P = 35.8901 psia and T_outlet = 70.8769 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 3704.1579 s with a Smoothed Mid-Axis Mid-Low Delta T of 0.99877 C and a raw SP12 Reading of 74.7418 C.
Maximum Top-Outlet delta T is 5.2852 degrees C at t plus 4532.0722 s, with temperatures of 83.2471 and 77.9619 C, respectively, at Set # 2, where Pool P = 38.4589 psia
Maximum Mid-Outlet delta T is 5.151 degrees C at t plus 4566.0692 s ignoring SP 4, with temperatures of 83.4165 and 78.2655 C, respectively, at Set # 2, where Pool P = 38.5583 psia
Maximum Lower-Outlet delta T is 5.5323 degrees C at (KEY POINT #8) t plus 75.4013 s, with temperatures of 43.0812 and 37.5489 C, respectively, at Set # 1, where Pool P = 30.2572 psia

Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 2134.6321 s with a Smoothed Mid-Axis Low-Outlet Delta T of 1.8435 C and a raw SP12 Reading of 58.9462 C.
Minimum SP Pressure is 30.2003 psia at t plus 0 s
Maximum SP Pressure is 56.8624 psia at t plus 8120.3254 s
Beginning SP Pressure is 30.2003 psia
Ending SP Pressure is 56.8624 psia
Time-Average SP Pressure is 39.143 +/- 7.6325 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 75.864 cm (cold) / 76.0054 cm (hot) at 14.8335 psia
Beginning Smoothed SP Level is 76.1925 cm (cold) / 76.3493 cm (hot) at 30.2028 psia
Ending Smoothed SP Level is 75.4925 cm (cold) / 76.703 cm (hot) at 56.8681 psia
Minimum Smoothed Cold SP Level is 75.4925 cm at t plus 8120.3254 s and 56.8681 psia
Minimum Smoothed Hot SP Level is 76.3412 cm at t plus 619.4104 s and 30.6902 psia
Maximum Smoothed Cold SP Level is 76.1962 cm at t plus 18.402 s and 30.22 psia
Maximum Smoothed Hot SP Level is 76.8705 cm at t plus 6885.0088 s and 48.9007 psia
SP 12 Temperature at the beginning is 40.8347 C, and at the end is 112.3775 C
At plume detection, the Mixing Number is 149.394
The Mixing Number ranges from a minimum of 38.282 at (KEY POINT #12) t plus 22.3013 s to a maximum of 149.394 at (KEY POINT #13) t plus 8120.3254 s; it had a mean value of 74.5955 +/- 30.9504 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11

KEY POINT #1 (t plus 0 s with a Mixing Number of 38.319): 44.3605796 0.040894
0.00925 0.3937 0.7619251712 0.7634931761 1.008895731
1 1 38.89162781 135791.2244 0.06975803883
0.05468051817 0.05826480248 4.655889213e-006 0.05826480248 39.00329936
130.4961371 121.4252109 39.05288599 39.02386558 39.80849208
36.09512009 4.178305368 4.248848022 2.182336481 0.6274129077
0.6838484018 0.6838484018 4.429792284 1.423454114 0.04150282888
992.6414177 941.9525758 1.170171265 1.140711431 0.0006651760972
0.0002291037043 1.30051637e-005 1.3359343e-005 1529.779916
1518.876755 482.414109 488.8587796 2.077990093 2.082409074
2.119409074 0.07000915884 0.0701958067 2729.063701 2727.551142
163.557849 509.8447015 2707.99697 346.2868525 2219.218999
163.7650371 163.6422701 166.9237764 151.4119666

KEY POINT #2 (t plus 8120.3254 s with a Mixing Number of 149.394): 36.05060298
0.040894 0.00925 0.3937 0.7549249485 0.7670296859
1.000077362 1 1 17.19319712 107347.7353
0.05603351208 0.05034345021 0.04735017623 3.520047177e-006 0.04735017623
114.68371 142.5019146 142.4396297 112.8654742 113.3683238
112.7627435 111.0745672 4.237013257 4.291658164 2.330629777
0.682650637 0.6847223067 0.6847223067 1.512223791 1.208944387
0.04673548864 947.430694 923.9451567 2.097329326 2.096950483
0.0002436434516 0.000192883766 1.373055124e-005 1.373343698e-005
1528.970363 1481.796563 490.68042 490.7298621 3.871551464

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      3.920919676      3.957919676      1.674395619      1.577328432      2737.032759
      2736.737153      481.3747075      599.6799517      2736.571839      118.3052442
      2137.352807      473.6734652      475.8015689      473.2397961      466.0975831
KEY POINT #3 (t plus 4231.266 s with a Mixing Number of 66.7237):  34.66401947
      0.040894         0.00925          0.3937     0.7607574256     0.7669364495
      1.007213958             1                1      25.02758509      104896.7706
      0.06287391566    0.05334869101    0.0455289869 9.280096401e-006    0.0455289869
      78.90126658      135.1255766      127.970421      78.84434366      79.35367094
      78.26095509      76.32027532      4.194245032      4.260886288      2.223367241
      0.6663301568     0.6846459339     0.6846459339      2.261737997      1.347449409
      0.04296713243     972.5529778      936.5454348      1.413578331      1.385314838
      0.000359317165  0.0002165102978 1.323095527e-005   1.3513766e-005
      1557.613485      1508.456586      485.1772753      490.3688854      2.542536727
      2.584100982      2.621100982     0.4534424971     0.4523908719      2733.626594
      2733.000214       330.510699      537.7251631      2717.277018      207.2144641
      2195.901431      330.2719516      332.4069234      327.8266823      319.693133
KEY POINT #4 (t plus 4645.7487 s with a Mixing Number of 72.9754):  34.70463831
      0.040894         0.00925          0.3937     0.7602938458     0.7670203497
      1.006531353             1                1      24.21679677      104930.7215
      0.06200605114    0.05311620872    0.04558233716 5.506747764e-006    0.04558233716
      83.62109029      135.5458062      129.1041718       82.773193      83.24570834
      81.77420787      79.31345218      4.198339977      4.263085143      2.230940902
      0.6694161291     0.6847351453     0.6847351453      2.125861818      1.335210683
      0.04323537711     969.5846057      935.5902579      1.459603524      1.433254417
      0.0003389640184  0.0002144610418 1.327008806e-005 1.352522367e-005
      1556.247371      1506.545012      485.6388454      490.3402974      2.630969279
      2.676991766      2.713991766     0.5480890733     0.5299630445      2733.651741
      2733.065287       350.32365      542.5632049      2718.851182      192.2395549
      2191.088536      346.7642168      348.7463923      342.5727819      332.2520069
KEY POINT #5 (t plus 4645.7487 s with a Mixing Number of 72.9754):  34.70463831
      0.040894         0.00925          0.3937     0.7602938458     0.7670203497
      1.006531353             1                1      24.21679677      104930.7215
      0.06200605114    0.05311620872    0.04558233716 5.506747764e-006    0.04558233716
      83.62109029      135.5458062      129.1041718       82.773193      83.24570834
      81.77420787      79.31345218      4.198339977      4.263085143      2.230940902
      0.6694161291     0.6847351453     0.6847351453      2.125861818      1.335210683
      0.04323537711     969.5846057      935.5902579      1.459603524      1.433254417
      0.0003389640184  0.0002144610418 1.327008806e-005 1.352522367e-005
      1556.247371      1506.545012      485.6388454      490.3402974      2.630969279
      2.676991766      2.713991766     0.5480890733     0.5299630445      2733.651741
      2733.065287       350.32365      542.5632049      2718.851182      192.2395549
      2191.088536      346.7642168      348.7463923      342.5727819      332.2520069
KEY POINT #6 (t plus 3673.2651 s with a Mixing Number of 60.9434):  34.61197423
      0.040894         0.00925          0.3937     0.7613488802     0.7667555898
      1.007876458             1                1      25.99946616      104883.3109
      0.06379776266     0.0536196849    0.04546062879 7.070678646e-006    0.04546062879
      73.81029683      134.5068858      126.6456292       73.4131548      73.79269719
      73.37367683       70.8173745      4.190348755      4.258360145      2.214693565
      0.662662452     0.6845234818     0.6845234818      2.426556342      1.362083784
      0.04265924547     975.6267938      937.6546293      1.361285975      1.331464168
      0.0003837360252  0.0002189524378 1.318523506e-005 1.349520779e-005
      1558.132115       1510.65084      484.6314988       490.301495      2.442278696
      2.474988281      2.511988281     0.3671409591     0.3610357534      2733.297935
      2732.621962      309.1592966      532.0752014        2715.4249      222.9159049
      2201.222733      307.4951892       309.084172      307.3312331      296.6261677
KEY POINT #7 (t plus 3704.1579 s with a Mixing Number of 61.1823):  34.61104682
      0.040894         0.00925          0.3937     0.7613384345     0.7667932694
      1.007903245             1                1      25.94696822      104854.2599
      0.06375703166    0.05360575853    0.04545941069 1.746221588e-006    0.04545941069
      74.03625184      134.5999512      126.7137957      73.67496524      74.12457573
      73.6263206       71.06364561      4.190510126      4.258488999       2.21513525
      0.6628328385     0.6845302626     0.6845302626      2.418798119      1.361321858
      0.0426749426      975.4932672      937.5977387       1.36393804      1.333966113
      0.0003825927571  0.0002188255057 1.318758738e-005 1.349858508e-005
      1558.130979      1510.538978      484.6597501      490.3480588      2.447357707
      2.480508184      2.517508184     0.3706532225     0.3650508229      2733.447783
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    2732.774538      310.1065918      532.3658314      2715.520531      222.2592397
    2201.081951      308.5926634      310.475342       308.3902887      297.6580904
KEY POINT #8 (t plus 75.4013 s with a Mixing Number of 38.5306):  35.84753478
    0.040894         0.00925          0.3937     0.7619300031     0.7635534098
    1.006665033            1               1      31.18277905      110459.3638
    0.06962218757    0.05466964447    0.04708345906 8.512448644e-006    0.04708345906
    39.84075866      128.2544348      121.4790054      39.88009177      40.05476643
    41.13794352      37.62064287      4.178281142      4.248942516      2.182655297
    0.6284865432     0.6838569353     0.6838569353      4.352806436      1.422790105
    0.0415142935      992.3253655      941.9088815      1.172023539      1.149801811
    0.0006547381991  0.0002289945975 1.300701836e-005 1.327138811e-005
    1531.235389      1518.795463      482.4374957      487.2908765      2.081503528
    2.086313022      2.123313022    0.07321963494    0.07337349706      2723.696655
    2722.724289      167.0573453      510.073514       2708.074541      343.0161687
    2213.623141      167.2216901      167.9500231      172.4789326      157.7866087
KEY POINT #9 (t plus 8090.7348 s with a Mixing Number of 147.9155):  36.02949803
    0.040894         0.00925          0.3937     0.7550560711     0.7671243342
    1.000214567            1               1      17.25080472      107281.7565
    0.05610369207    0.05037223553    0.04732245622 2.324124466e-006    0.04732245622
    114.3313645      142.4916385      142.3028669      112.5170855      113.0900366
    112.5507349      110.8058416      4.236453363      4.291338399      2.329507541
    0.6825665827     0.6847322427     0.6847322427      1.517199454      1.210089552
    0.04669624114     947.7065634      924.0684223      2.089814952      2.088671694
    0.0002444473143  0.0001930836619  1.37258289e-005 1.373383827e-005
    1529.439585      1482.071005      490.632386       490.7819983      3.856792884
    3.906146188      3.943146188      1.65521275       1.559267689      2737.154086
    2736.856495      479.8808592      599.0920887      2736.397901      119.2112295
    2138.061997      472.1973717      474.6220424      472.341129       464.9594918
KEY POINT #10 (t plus 2134.6321 s with a Mixing Number of 48.8233):  33.81595212
    0.040894         0.00925          0.3937     0.7611930161     0.7647329173
    1.008730144            1               1      27.68407982      102958.5529
    0.06630684574    0.05420962155    0.04441510433 7.477659779e-006    0.04441510433
    59.60374331      132.5717101      123.7493822      59.26162889      59.4047838
    60.25577366      57.45699693      4.182313381      4.252996931      2.196386318
    0.6504981401     0.6841870551     0.6841870551      3.016653988      1.395379004
    0.04200664226     983.4643334      940.0534782      1.252383649      1.221700181
    0.0004691967411   0.000224477061 1.308531229e-005 1.343132268e-005
    1553.837945      1515.298177      483.4143702      489.7155489      2.234267875
    2.249921914      2.286921914     0.1958284513     0.1927402068     2731.228402
    2730.461994      249.672399       519.7354234      2711.329065      270.0630244
    2211.492978      248.2415944      248.8388668      252.400994       240.700297
KEY POINT #11 (t plus 8120.3254 s with a Mixing Number of 149.394):  36.05060298
    0.040894         0.00925          0.3937     0.7549249485     0.7670296859
    1.000077362            1               1      17.19319712      107347.7353
    0.05603351208    0.05034345021    0.04735017623 3.520047177e-006    0.04735017623
    114.68371      142.5019146      142.4396297      112.8654742      113.3683238
    112.7627435      111.0745672      4.237013257      4.291658164      2.330629777
    0.682650637     0.6847223067     0.6847223067      1.512223791      1.208944387
    0.04673548864      947.430694      923.9451567      2.097329326      2.096950483
    0.0002436434516   0.000192883766 1.373055124e-005 1.373343698e-005
    1528.970363      1481.796563      490.68042        490.7298621      3.871551464
    3.920919676      3.957919676      1.674395619      1.577328432      2737.032759
    2736.737153      481.3747075      599.6799517      2736.571839      118.3052442
    2137.352807      473.6734652      475.8015689      473.2397961      466.0975831
KEY POINT #12 (t plus 22.3013 s with a Mixing Number of 38.282):  36.6914694
    0.040894         0.00925          0.3937     0.7619590862     0.7635292677
    1.007897604            1               1      32.05781871      112649.4464
    0.06970160672    0.05467669584    0.04819191356  2.16703663e-006    0.04819191356
    39.35146379      129.4865925      121.4441215      39.40436703      39.37962795
    40.26817108      36.79941125      4.17829328       4.248881232      2.182448522
    0.6278607088     0.6838514054     0.6838514054      4.397524187      1.423220614
    0.04150685803     992.5106521      941.9372172      1.170822132       1.14459189
    0.0006608039379  0.0002290653385 1.300581568e-005 1.331973656e-005
    1530.39036      1518.848187      482.4223314      488.1566911      2.079224632
    2.083779135      2.120779135    0.07132879089    0.07153117641      2726.411661
    2725.383957       165.012706      509.9251362      2708.024241      344.9124302
    2216.486525      165.2337512      165.1288748       168.844563      154.3549489
```

```
KEY POINT #13 (t plus 8120.3254 s with a Mixing Number of 149.394):  36.05060298
       0.040894          0.00925          0.3937     0.7549249485     0.7670296859
       1.000077362             1              1      17.19319712      107347.7353
       0.05603351208    0.05034345021    0.04735017623 3.520047177e-006    0.04735017623
       114.68371      142.5019146      142.4396297      112.8654742      113.3683238
       112.7627435      111.0745672      4.237013257      4.291658164      2.330629777
       0.682650637     0.6847223067     0.6847223067      1.512223791      1.208944387
       0.04673548864       947.430694      923.9451567      2.097329326      2.096950483
       0.0002436434516   0.000192883766 1.373055124e-005 1.373343698e-005
       1528.970363      1481.796563       490.68042      490.7298621      3.871551464
       3.920919676      3.957919676      1.674395619      1.577328432      2737.032759
       2736.737153      481.3747075      599.6799517      2736.571839      118.3052442
       2137.352807      473.6734652      475.8015689      473.2397961      466.0975831
KEY POINT #14 (t plus 5592.4859 s with a Mixing Number of 85.9426):  35.04969306
       0.040894          0.00925          0.3937     0.7597075376     0.7678458401
       1.004927473             1              1      22.36067903      105656.9768
       0.06051505711    0.05248947684    0.04603554465 6.715335324e-006    0.04603554465
       91.5970835      136.9333324      132.1480642      91.91443568      91.78281763
       90.01722745      88.77808657      4.206296146      4.269160595      2.25196782
       0.6739678965     0.6849039643     0.6849039643      1.927273843      1.303603043
       0.04397763579      964.322973      932.9987604      1.589165351      1.567698629
       0.0003088039103  0.0002091378087 1.337517207e-005 1.356580693e-005
       1552.147511      1501.260648      486.8527913      490.4025514      2.880808083
       2.928103659      2.965103659     0.7454841034     0.7544236136      2734.207032
       2733.707032      383.8599958      555.5656104      2723.026925      171.7056147
       2178.641422      385.1949282      384.6399588      377.2173891      372.0115948
End
```

D.17 TEST #17 - T17_SRV_040GPM_107KW_RESULTS_RCICLAND

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T17_SRV_040GPM_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1293.96 s, and ending (KEY POINT #11) at t
       plus 9270.4892 s, for a time period of 7976.5292 s.
Original Data Record Time:  10608.8688 s
No Bulk Pool to Outlet Thermal Stratification Detected (KEY POINT #3), 0 0 0 0 0 0.
No Bulk Pool to Outlet Destratification Detected (KEY POINT #9), 0 0 0 0 0 0.
No Plume detected, setting t_plume (KEY POINT #2) to the end at 7976.5292 s.
At t = 7976.5292 s, the pool pressure is 39.2167 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 114.1334, 113.6103, 113.9301, 113.9931, and
       111.3755 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 0.31976 +/- 0 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were -0.20334 +/- 0 C.
Minimum Steam Quality:  0.54714 at t plus 260.4069 s
Maximum Steam Quality:  0.66868 at t plus 7043.8149 s
Time-Averaged Steam Quality:  0.62281 +/- 0.017019
SRV Alignment, no RCIC Turbine 0 0 0 0 0 0
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 7886.5311 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.68281 degrees/min at t plus 3745.7582 s
       and 0.4432 degrees/min at t plus 5974.6967 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.95905 degrees/min at t plus
       4086.4667 s and 0.22503 degrees/min at t plus 4339.9722 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.3626 degrees/min at t
       plus 4339.0702 s and -0.37952 degrees/min at t plus 4086.5717 s, respectively
Max and min smoothed lower level changerates:  0.69827 degrees/min at t plus 354.9033 s
       and 0.43452 degrees/min at t plus 1469.6221 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.46939 degrees/min at t
       plus 4086.7678 s and -0.33822 degrees/min at t plus 6067.198 s, respectively
Max and min smoothed outlet level changerates:  0.6995 degrees/min at t plus 140.8331 s
       and 0.43417 degrees/min at t plus 7886.5311 s, respectively
```

Max and min smoothed lower-outlet level changerate differences: 0.18835 degrees/min at t plus 6795.9107 s and -0.22695 degrees/min at t plus 174.131 s, respectively
Max and min smoothed hot (SP8) level changerates: 0.71818 degrees/min at t plus 3673.8631 s and 0.37784 degrees/min at t plus 5962.099 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.39401 degrees/min at t plus 4352.871 s and -0.45096 degrees/min at t plus 4086.4667 s, respectively
The mean steam flow rate was 45.4368 +/- 1.5584 g/s
The mean feedwater flow rate was 45.4096 +/- 1.8535 g/s
The mean water injection to steam flow rate was 25.2988 +/- 1.393 g/s
No stratification; 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.
At plume detection, the condensing and condensing+cooling flows are 1.4353 and 79.7442 kg/s, respectively
The plume period had a mean steam enthalpy of 1941.8787 +/- 0 kJ/kg.
Maximum Smoothed Top-Mid delta T is 0.81069 degrees C at t plus 3974.4663 s with T_upper = 78.2015 C and T_mid = 77.3909 C
At t plus 3974.4663 s, Smoothed SP8-SP9 is 0.84176 C and Smoothed SP8-Top is 0.031068 C, where Smoothed SP8 is 78.2326 C and Pool P = 20.8347 psia
Maximum Smoothed Top-Lower delta T is 1.6336 degrees C at t plus 5590.9928 s with T_upper = 92.9533 C and T_low = 91.3196 C
At t plus 5590.9928 s, Smoothed SP8-SP9 is -1.0293 C and Smoothed SP8-Top is -0.17535 C, where Smoothed SP8 is 92.7779 C and Pool P = 26.2245 psia
Maximum Smoothed Mid-Lower delta T is 3.3877 degrees C at t plus 5450.2627 s with T_mid = 93.6139 C and T_low = 90.2262 C
At t plus 5450.2627 s, Smoothed SP8-SP9 is -2.1005 C and Smoothed SP8-Top is -0.3024 C, where Smoothed SP8 is 91.5134 C and Pool P = 25.6546 psia
Maximum Smoothed Top-Outlet delta T is 3.0184 degrees C at t plus 7357.3518 s with T_upper = 108.7063 C and T_out = 105.6879 C
At t plus 7357.3518 s, Smoothed SP8-SP9 is 0.11895 C and Smoothed SP8-Top is -0.27525 C, where Smoothed SP8 is 108.4311 C and Pool P = 35.1172 psia
Maximum Smoothed Mid-Outlet delta T is 4.538 degrees C at t plus 5233.7844 s with T_mid = 91.7864 C and T_out = 87.2485 C
At t plus 5233.7844 s, Smoothed SP8-SP9 is -2.2896 C and Smoothed SP8-Top is -0.31589 C, where Smoothed SP8 is 89.4968 C and Pool P = 24.8112 psia
Maximum Smoothed Lower-Outlet delta T is 2.9942 degrees C at t plus 37.9032 s with T_low = 41.8297 C and T_out = 38.8355 C
At t plus 37.9032 s, Smoothed SP8-SP9 is -0.14483 C and Smoothed SP8-Top is -0.030138 C, where Smoothed SP8 is 40.6916 C and Pool P = 15.2966 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 0.97769 degrees C at (KEY POINT #14) t plus 3980.4617 s with T_SP8 = 78.4417 C and T_SP9 = 77.464 C and Pool P = 20.8494 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 0.46431 degrees C at t plus 6124.1983 s with T_SP8 = 97.6052 C and T_upper = 97.1409 C and Pool P = 28.5451 psia
Maximum Top-Mid delta T is 2.2389 degrees C at (KEY POINT #4) t plus 5334.6861 s ignoring SP 4, with temperatures of 91.0129 and 88.774 C, respectively, at Set # 2, where Pool P = 25.1932 psia and T_outlet = 88.1581 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5404.9902 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99933 C and a raw SP12 Reading of 89.5265 C.
Maximum Top-Lower delta T is 2.3759 degrees C at t plus 5319.7893 s, with temperatures of 90.9802 and 88.6043 C, respectively, at Set # 2, where Pool P = 25.1397 psia and T_outlet = 87.9369 C
Maximum Mid-Low delta T is 2.1496 degrees C at (KEY POINT #6) t plus 4358.1713 s ignoring SP 4, with temperatures of 82.1053 and 79.9557 C, respectively, at Set # 2, where Pool P = 21.8926 psia and T_outlet = 79.1919 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 4433.0736 s with a Smoothed Mid-Axis Mid-Low Delta T of 0.99946 C and a raw SP12 Reading of 80.7469 C.
Maximum Top-Outlet delta T is 3.665 degrees C at t plus 4479.0722 s, with temperatures of 83.781 and 80.1159 C, respectively, at Set # 1, where Pool P = 22.2457 psia
Maximum Mid-Outlet delta T is 3.0686 degrees C at t plus 66.2048 s ignoring SP 4, with temperatures of 42.296 and 39.2273 C, respectively, at Set # 2, where Pool P = 15.3084 psia
Maximum Lower-Outlet delta T is 4.2403 degrees C at (KEY POINT #8) t plus 35.1 s, with temperatures of 42.9654 and 38.7251 C, respectively, at Set # 2, where Pool P = 15.2961 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 2193.2344 s with a Smoothed Mid-Axis Low-Outlet Delta T of 1.4128 C and a raw SP12 Reading of 60.5726 C.
Minimum SP Pressure is 15.2692 psia at t plus 1.4001 s

Maximum SP Pressure is 39.2167 psia at t plus 7976.5292 s
Beginning SP Pressure is 15.2811 psia
Ending SP Pressure is 39.2167 psia
Time-Average SP Pressure is 22.9872 +/- 6.8327 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 74.814 cm (cold) / 74.9452 cm (hot) at 14.9175 psia
Beginning Smoothed SP Level is 75.2856 cm (cold) / 75.443 cm (hot) at 15.2779 psia
Ending Smoothed SP Level is 75.0084 cm (cold) / 76.1964 cm (hot) at 39.2105 psia
Minimum Smoothed Cold SP Level is 74.904 cm at t plus 6507.4032 s and 30.3669 psia
Minimum Smoothed Hot SP Level is 75.443 cm at t plus 0 s and 15.2779 psia
Maximum Smoothed Cold SP Level is 75.4621 cm at t plus 1367.2252 s and 16.3113 psia
Maximum Smoothed Hot SP Level is 76.1964 cm at t plus 7976.5292 s and 39.2105 psia
SP 12 Temperature at the beginning is 39.9796 C, and at the end is 112.8916 C
At plume detection, the Mixing Number is 192.4433
The Mixing Number ranges from a minimum of 33.8083 at (KEY POINT #12) t plus 0 s to a maximum of 192.4433 at (KEY POINT #13) t plus 7976.5292 s; it had a mean value of 83.5955 +/- 44.2463 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 33.8083): 50.12938618 0.040894
0.00925 0.3937 0.7528563591 0.7544304604 0.6339620523
0.6339620523 0.9996286857 51.59902969 165337.2121 0.0694713448
0.05874002223 0.04350587777 0.02233588559 0.06584176336 40.76788089
100.8907057 100.8907057 40.37117962 40.34389474 41.23095727
38.5208094 4.178528368 4.217777849 2.081048383 0.6296074045
0.6781204287 0.6781204287 4.270594197 1.736093478 0.03774613291
991.9239027 957.7129192 0.6161343253 0.971518001 0.0006434795916
0.0002791233904 1.229977354e-005 1.239884895e-005 1532.627249
1544.261926 472.7101615 466.1469446 1.046843153 1.053375998
1.090375998 0.07692138097 0.07531815379 1854.545453 1851.882993
170.8397624 422.8578976 2676.975617 252.0181353 1431.687556
169.1821349 169.0666188 172.7763308 161.4558779
KEY POINT #2 (t plus 7976.5292 s with a Mixing Number of 192.4433): 56.17967301
0.040894 0.00925 0.3937 0.7500839052 0.7619635972
0.6426819198 0.6426819198 0.9991270532 24.5843645 170760.9938
0.05624714134 0.05306480774 0.04797946276 0.02580896789 0.07378843065
113.6103235 129.3544977 129.3544977 113.9300846 114.1334239
113.9931474 111.3754945 4.235605435 4.263575278 2.232631942
0.682321851 0.6847529111 0.6847529111 1.527550863 1.332543209
0.0432952004 948.2117565 935.378623 1.469926382 2.285178981
0.0002460761155 0.0002140135407 1.3278729e-005 1.345395981e-005
1530.131305 1506.118777 485.7400711 475.8881603 2.650827298
2.703469061 2.740469061 1.616518267 1.633585566 1942.432848
1941.828457 476.7401793 543.631774 2719.197385 66.89159473
1398.801074 478.0946386 478.9548174 478.363074 467.2828109

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KEY POINT #3 (t plus 7976.5292 s with a Mixing Number of 192.4433):  56.17967301
       0.040894         0.00925          0.3937     0.7500839052     0.7619635972
       0.6426819198     0.6426819198     0.9991270532     24.5843645      170760.9938
       0.05624714134    0.05306480774    0.04797946276    0.02580896789    0.07378843065
       113.6103235      129.3544977      129.3544977      113.9300846      114.1334239
       113.9931474      111.3754945      4.235605435      4.263575278      2.232631942
       0.682321851     0.6847529111     0.6847529111      1.527550863      1.332543209
       0.0432952004      948.2117565      935.378623      1.469926382      2.285178981
       0.0002460761155  0.0002140135407   1.3278729e-005 1.345395981e-005
       1530.131305      1506.118777      485.7400711      475.8881603      2.650827298
       2.703469061      2.740469061      1.616518267      1.633585566      1942.432848
       1941.828457      476.7401793      543.631774      2719.197385      66.89159473
       1398.801074      478.0946386      478.9548174      478.363074      467.2828109
KEY POINT #4 (t plus 5334.6861 s with a Mixing Number of 99.7083):  54.25240425
       0.040894         0.00925          0.3937     0.7507975347     0.7584153876
       0.6452652591     0.6452652591     0.999440258      36.30292687       171823.21
       0.06043452311    0.05597360292    0.04652234197    0.02473474363     0.0712570856
       92.02334606      114.9842772      114.9842772      90.29023173      90.78299163
       89.27643107      88.22256387      4.207029458      4.238046482      2.146293592
       0.674122184     0.6825862385     0.6825862385      1.917734372      1.508158726
       0.04019519401     963.9778607      947.0942344      0.9648477596      1.494436095
       0.000307292187  0.0002429063475 1.278328668e-005 1.291209621e-005
       1551.630185      1528.072454      479.5347391      471.6614755      1.69090318
       1.737216603      1.774216603     0.7575120101     0.7095953074      1913.760411
       1912.442509      385.561477      482.4861135      2698.561402      96.92463656
       1431.274298      378.2718437      380.3427943      374.0105883      369.5841092
KEY POINT #5 (t plus 5404.9902 s with a Mixing Number of 102.7697):  53.82059697
       0.040894         0.00925          0.3937     0.7507997433     0.7585299234
       0.652501607      0.652501607     0.9994519882      36.0445655      170343.5445
       0.06025336381    0.05590626541    0.04661718436    0.02407274982    0.07068993418
       92.98056635      115.3218799      115.3218799      90.99839499      91.46546546
       89.9795097      88.84690616      4.20808621      4.238587832      2.148079972
       0.6746071326     0.6826643202     0.6826643202      1.896395927      1.503450183
       0.04026060878      963.3232131      946.8291811      0.9748288314      1.493168144
       0.0003040152113  0.0002421447515 1.279490591e-005 1.292059232e-005
       1550.975875      1527.617355      479.6895173      472.0180874      1.709603574
       1.75589938      1.79289938     0.7851117111     0.7288597209      1930.603042
       1929.303831      389.5904706      483.9183177      2699.063075      94.3278471
       1446.684724      381.2514915      383.2147565      376.9680979      372.2098665
KEY POINT #6 (t plus 4358.1713 s with a Mixing Number of 75.3645):  54.67402517
       0.040894         0.00925          0.3937     0.7514032021     0.7575945704
       0.6246071155     0.6246071155     0.9994672338      40.53106705      175205.4572
       0.06229657407    0.05684033085    0.04557932702    0.02623153086    0.07181085789
       82.0476541      110.6165314      110.6165314      81.83229453      82.00810886
       81.00692813      79.26028285      4.197173367      4.231283364      2.124167092
       0.6683597806     0.6814556121     0.6814556121      2.169631025      1.571994267
       0.03937864681      970.535461      950.4786724      0.8430073815      1.348941174
       0.0003454930233  0.0002531724357 1.263309274e-005 1.276124397e-005
       1556.580845      1533.684292      477.4947143      469.4735401      1.463704935
       1.509691768      1.546691768      0.514854123      0.5104395239      1857.259679
       1855.616912      343.6265806      463.9739644      2692.003253      120.3473838
       1393.285715      342.7226995      343.4592576      339.2603781      331.9358983
KEY POINT #7 (t plus 4433.0736 s with a Mixing Number of 75.6308):  54.29467976
       0.040894         0.00925          0.3937     0.7512428689     0.7575495421
       0.6299302753     0.6299302753     0.9994740156      40.20075329      173872.3543
       0.0622580703    0.05677906285    0.04561064281    0.02570196899    0.0713126118
       82.25656023      110.9266647      110.9266647      82.32744863      82.52847342
       81.59878823      79.88303086      4.197356093      4.231749004      2.125678991
       0.6684944412      0.681543306      0.681543306      2.163743021      1.567276474
       0.03943483953      970.4036267      950.2411056      0.8512243898      1.350588617
       0.0003446098329  0.0002524173311 1.264374867e-005 1.276986582e-005
       1556.515325      1533.302927      477.6418446      469.7590943      1.47896148
       1.524973374      1.561973374     0.5191669743     0.5206373239      1869.875133
       1868.259032      344.5046241      465.2874057      2692.472987      120.7827816
       1404.587727      344.8021703      345.6446305      341.7453385      334.549558
KEY POINT #8 (t plus 35.1 s with a Mixing Number of 33.8362):  50.0357969
       0.040894         0.00925          0.3937     0.7529085841      0.754511668
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      0.6351511729     0.6351511729     0.9996302092      51.54803113      165020.7774
      0.06946402147    0.05873424631    0.04346514513    0.02225369466    0.06571883978
      40.81281894      100.9206106      100.9206106      40.66917311      40.69535222
      41.77008306       38.8036868      4.178528201      4.217816178       2.08116887
      0.6296640236      0.678132444      0.678132444      4.266644952      1.735536719
      0.03775078581      991.9065273      957.6913236      0.6167461841     0.9706635889
      0.0006429423706   0.000279036285 1.230079548e-005 1.239943182e-005
      1532.701655      1544.233633      472.725366       466.1918895       1.04795473
      1.054664677      1.091664677    0.07710483701    0.07651973639     1857.296544
      1854.639344      171.0276513      422.9841139      2677.022666      251.9564626
      1434.31243      170.4274232      170.5353094      175.0291991      162.6380131
KEY POINT #9 (t plus 7976.5292 s with a Mixing Number of 192.4433):  56.17967301
      0.040894         0.00925          0.3937     0.7500839052     0.7619635972
      0.6426819198     0.6426819198     0.9991270532       24.5843645      170760.9938
      0.05624714134    0.05306480774    0.04797946276    0.02580896789    0.07378843065
      113.6103235      129.3544977      129.3544977      113.9300846      114.1334239
      113.9931474      111.3754945      4.235605435      4.263575278      2.232631942
      0.682321851     0.6847529111     0.6847529111      1.527550863      1.332543209
      0.0432952004      948.2117565       935.378623      1.469926382      2.285178981
      0.0002460761155  0.0002140135407   1.3278729e-005 1.345395981e-005
      1530.131305      1506.118777      485.7400711      475.8881603      2.650827298
      2.703469061      2.740469061      1.616518267      1.633585566      1942.432848
      1941.828457      476.7401793      543.631774       2719.197385      66.89159473
      1398.801074      478.0946386      478.9548174      478.363074       467.2828109
KEY POINT #10 (t plus 2193.2344 s with a Mixing Number of 47.0246):  52.17352204
      0.040894         0.00925          0.3937     0.7543079779     0.7579059799
      0.6291173029     0.6291173029     0.9995786535      48.06750095      170470.8514
      0.066038608    0.05813129421    0.04416979509    0.02435681083    0.06852660592
      61.15088819      104.0309321      104.0309321      60.82611083      60.97325424
      61.95657075      59.90772076      4.183223487      4.221909128      2.094092748
      0.651909271     0.6793223197     0.6793223197      2.941354697      1.679486553
      0.03824666627      982.6188598      955.4232321     0.6831455893       1.08542198
      0.0004583777086  0.0002702362051 1.240719356e-005 1.251582891e-005
      1554.561164      1541.145563      474.290442       467.2250648         1.169023
      1.193455899      1.230455899     0.2103262481     0.2072094273      1851.281689
      1848.971204      256.0551051      436.1182111      2681.888573      180.0631059
      1415.163478      254.6965131      255.310606       259.4271064      250.860295
KEY POINT #11 (t plus 7976.5292 s with a Mixing Number of 192.4433):  56.17967301
      0.040894         0.00925          0.3937     0.7500839052     0.7619635972
      0.6426819198     0.6426819198     0.9991270532       24.5843645      170760.9938
      0.05624714134    0.05306480774    0.04797946276    0.02580896789    0.07378843065
      113.6103235      129.3544977      129.3544977      113.9300846      114.1334239
      113.9931474      111.3754945      4.235605435      4.263575278      2.232631942
      0.682321851     0.6847529111     0.6847529111      1.527550863      1.332543209
      0.0432952004      948.2117565       935.378623      1.469926382      2.285178981
      0.0002460761155  0.0002140135407   1.3278729e-005 1.345395981e-005
      1530.131305      1506.118777      485.7400711      475.8881603      2.650827298
      2.703469061      2.740469061      1.616518267      1.633585566      1942.432848
      1941.828457      476.7401793      543.631774       2719.197385      66.89159473
      1398.801074      478.0946386      478.9548174      478.363074       467.2828109
KEY POINT #12 (t plus 0 s with a Mixing Number of 33.8083):  50.12938618         0.040894
      0.00925          0.3937     0.7528563591     0.7544304604     0.6339620523
      0.6339620523     0.9996286857      51.59902969      165337.2121     0.0694713448
      0.05874002223    0.04350587777    0.02233588559    0.06584176336      40.76788089
      100.8907057      100.8907057      40.37117962      40.34389474      41.23095727
      38.5208094      4.178528368      4.217777849      2.081048383     0.6296074045
      0.6781204287     0.6781204287      4.270594197      1.736093478    0.03774613291
      991.9239027      957.7129192     0.6161343253      0.971518001  0.0006434795916
      0.0002791233904 1.229977354e-005 1.239884895e-005      1532.627249
      1544.261926      472.7101615      466.1469446      1.046843153      1.053375998
      1.090375998    0.07692138097    0.07531815379      1854.545453      1851.882993
      170.8397624      422.8578976      2676.975617      252.0181353      1431.687556
      169.1821349      169.0666188      172.7763308      161.4558779
KEY POINT #13 (t plus 7976.5292 s with a Mixing Number of 192.4433):  56.17967301
      0.040894         0.00925          0.3937     0.7500839052     0.7619635972
      0.6426819198     0.6426819198     0.9991270532       24.5843645      170760.9938
      0.05624714134    0.05306480774    0.04797946276    0.02580896789    0.07378843065
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        113.6103235      129.3544977      129.3544977      113.9300846      114.1334239
        113.9931474      111.3754945      4.235605435      4.263575278      2.232631942
        0.682321851     0.6847529111     0.6847529111      1.527550863      1.332543209
        0.0432952004      948.2117565      935.378623      1.469926382      2.285178981
        0.0002460761155  0.0002140135407   1.3278729e-005 1.345395981e-005
        1530.131305      1506.118777      485.7400711      475.8881603      2.650827298
        2.703469061      2.740469061      1.616518267      1.633585566      1942.432848
        1941.828457      476.7401793      543.631774      2719.197385      66.89159473
        1398.801074      478.0946386      478.9548174      478.363074      467.2828109
KEY POINT #14 (t plus 3980.4617 s with a Mixing Number of 67.0049):  54.64255574
        0.040894         0.00925          0.3937     0.7518824927     0.7575617031
        0.6202431615     0.6202431615     0.9994828597      42.16615786      175839.2358
        0.06313603771    0.05713596494    0.04530919487    0.02646032993     0.0717695248
        77.46396161      109.1170387      109.1170387      78.44165054      78.24171987
        77.61427918      75.86111253      4.193334941      4.229063011      2.116981426
        0.6652714964     0.6810155132     0.6810155132      2.306377689      1.595223333
        0.03911070479      973.3843067      951.6213538      0.804180629      1.295886524
        0.0003659062197  0.0002568823954 1.258159206e-005 1.270792985e-005
        1557.657078      1535.490695      476.7784976      468.804458      1.391752657
        1.437490787      1.474490787     0.4275091251     0.4450096653      1843.847072
        1842.069087      324.3912386      457.6256205      2689.723534      133.2343819
        1386.221452      328.4913988      327.6515221      325.0230215      317.6760301
End
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D.18 TEST #18 - T18_RCIC_040GPM_5PSIG_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T18_RCIC_040GPM_5PSIG_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2293.3752 s, and ending (KEY POINT #11) at t
        plus 12088.8404 s, for a time period of 9795.4652 s.
Original Data Record Time:  12302.8907 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
        1982.3314 s, T_bulk = 58.5026 C and T_out = 55.4772 C
Stratification Beginning SP12 Temperature = 58.2541 C
Stratification Beginning Pressure = 22.3129 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
        9093.7441 s, T_bulk = 124.2146 C and T_out = 74.0387 C
Stratification Ending SP12 Temperature = 124.0978 C
Stratification Ending Pressure = 56.6903 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1230.3204 s.
At t = 1230.3204 s, the pool pressure is 21.3758 psia while the Smoothed Upper, Mid, SP8,
        Lower, and Outlet Temperatures are 51.8606, 51.9174, 53.9194, 51.4822, and
        49.1627 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
        temperatures were 11.73 +/- 3.3179 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
        temperatures were 10.8065 +/- 3.3094 C.
Minimum Steam Quality:  0.5303 at t plus 496.5104 s
Maximum Steam Quality:  0.62165 at t plus 9735.4608 s
Time-Averaged Steam Quality:  0.57748 +/- 0.013594
Minimum Turbine Outlet Steam Quality:  0.55749 at t plus 8845.6419 s
Maximum Turbine Outlet Steam Quality:  0.64313 at t plus 3092.2499 s
Time-Averaged Turbine Outlet Steam Quality:  0.59945 +/- 0.015505
Smoothed Changerates may not fully include test beginning and end periods, analysis
        ending at t plus 9705.5561 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.75388 degrees/min at t plus 3086.1495 s
        and 0.31817 degrees/min at t plus 7940.7272 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.8232 degrees/min at t plus 3997.0676
        s and 0.38956 degrees/min at t plus 8838.7445 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.30759 degrees/min at t
        plus 3074.5479 s and -0.1367 degrees/min at t plus 3988.6651 s, respectively
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Max and min smoothed lower level changerates: 3.8238 degrees/min at t plus 6689.0096 s and -0.18939 degrees/min at t plus 2754.7436 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.74664 degrees/min at t plus 2754.7436 s and -3.3495 degrees/min at t plus 6689.1076 s, respectively
Max and min smoothed outlet level changerates: 8.4472 degrees/min at t plus 9544.2519 s and -0.0095086 degrees/min at t plus 4174.2698 s, respectively
Max and min smoothed lower-outlet level changerate differences: 3.771 degrees/min at t plus 6689.0096 s and -8.0785 degrees/min at t plus 9544.3519 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.2169 degrees/min at t plus 2102.3343 s and 0.14263 degrees/min at t plus 7715.9323 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.64281 degrees/min at t plus 2102.2332 s and -0.46345 degrees/min at t plus 3952.0621 s, respectively
The mean steam flow rate was 44.354 +/- 0.79696 g/s
The mean feedwater flow rate was 44.7858 +/- 1.5546 g/s
The mean water injection to steam flow rate was 25.2901 +/- 0.98695 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 12.5745 +/- 2.1425 C over the Stratification Period, beginning at 5.9419 C and ending at 12.8045 C
Mean Smoothed SP8-Upper Pool delta T is 11.577 +/- 2.4081 C over the Stratification Period, beginning at 5.3039 C and ending at 11.9126 C
The stratification period begins and ends with Smoothed SP8 readings of 64.6552 and 137.1192 C, respectively
The stratification period begins and ends with condensing flows of 0.40796 and 1.0804 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 4.2936 and 1.6224 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1845.7967 +/- 14.0432 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.36153 and 12.8033 kg/s, respectively
The plume period had a mean steam enthalpy of 1842.4117 +/- 18.0727 kJ/kg.
Maximum Smoothed Top-Mid delta T is 2.3152 degrees C at t plus 3859.4738 s with T_upper = 78.877 C and T_mid = 76.5617 C
At t plus 3859.4738 s, Smoothed SP8-SP9 is 11.2703 C and Smoothed SP8-Top is 8.955 C, where Smoothed SP8 is 87.832 C and Pool P = 26.7631 psia
Maximum Smoothed Top-Lower delta T is 23.601 degrees C at t plus 6321.6076 s with T_upper = 104.6449 C and T_low = 81.0439 C
At t plus 6321.6076 s, Smoothed SP8-SP9 is 15.589 C and Smoothed SP8-Top is 14.9928 C, where Smoothed SP8 is 119.6377 C and Pool P = 38.7688 psia
Maximum Smoothed Mid-Lower delta T is 23.2666 degrees C at t plus 6419.1012 s with T_mid = 105.0506 C and T_low = 81.7839 C
At t plus 6419.1012 s, Smoothed SP8-SP9 is 15.0117 C and Smoothed SP8-Top is 14.689 C, where Smoothed SP8 is 120.0623 C and Pool P = 39.349 psia
Maximum Smoothed Top-Outlet delta T is 52.1601 degrees C at t plus 8870.0403 s with T_upper = 123.6082 C and T_out = 71.4482 C
At t plus 8870.0403 s, Smoothed SP8-SP9 is 12.9399 C and Smoothed SP8-Top is 12.064 C, where Smoothed SP8 is 135.6722 C and Pool P = 55.0355 psia
Maximum Smoothed Mid-Outlet delta T is 51.3068 degrees C at t plus 8854.8674 s with T_mid = 122.695 C and T_out = 71.3882 C
At t plus 8854.8674 s, Smoothed SP8-SP9 is 12.9333 C and Smoothed SP8-Top is 12.1744 C, where Smoothed SP8 is 135.6283 C and Pool P = 54.9258 psia
Maximum Smoothed Lower-Outlet delta T is 51.3038 degrees C at t plus 8880.6419 s with T_low = 122.8081 C and T_out = 71.5042 C
At t plus 8880.6419 s, Smoothed SP8-SP9 is 12.8885 C and Smoothed SP8-Top is 12.0253 C, where Smoothed SP8 is 135.6816 C and Pool P = 55.1138 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 15.8154 degrees C at (KEY POINT #14) t plus 6158.7983 s with T_SP8 = 118.4086 C and T_SP9 = 102.5932 C and Pool P = 37.777 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 15.2997 degrees C at t plus 6160.8984 s with T_SP8 = 118.4286 C and T_upper = 103.1289 C and Pool P = 37.7912 psia
Maximum Top-Mid delta T is 3.686 degrees C at (KEY POINT #4) t plus 3171.4504 s ignoring SP 4, with temperatures of 72.4749 and 68.7889 C, respectively, at Set # 2, where Pool P = 24.7844 psia and T_outlet = 61.4629 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5155.9869 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.2287 C and a raw SP12 Reading of 91.7815 C.

Maximum Top-Lower delta T is 26.4864 degrees C at t plus 6562.0293 s, with temperatures of 107.4192 and 80.9328 C, respectively, at Set # 1, where Pool P = 40.2082 psia and T_outlet = 67.8515 C
Maximum Mid-Low delta T is 25.5094 degrees C at (KEY POINT #6) t plus 6461.5086 s ignoring SP 4, with temperatures of 105.4071 and 79.8977 C, respectively, at Set # 2, where Pool P = 39.5973 psia and T_outlet = 67.7397 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6842.5854 s with a Smoothed Mid-Axis Mid-Low Delta T of 8.5 C and a raw SP12 Reading of 108.3202 C.
Maximum Top-Outlet delta T is 52.6892 degrees C at t plus 8851.6463 s, with temperatures of 124.0125 and 71.3233 C, respectively, at Set # 1, where Pool P = 54.9046 psia
Maximum Mid-Outlet delta T is 51.3416 degrees C at t plus 8933.5669 s ignoring SP 4, with temperatures of 123.208 and 71.8663 C, respectively, at Set # 2, where Pool P = 55.5032 psia
Maximum Lower-Outlet delta T is 52.5639 degrees C at (KEY POINT #8) t plus 8855.2395 s, with temperatures of 123.9 and 71.336 C, respectively, at Set # 1, where Pool P = 54.9214 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 9598.482 s with a Smoothed Mid-Axis Low-Outlet Delta T of 17.5024 C and a raw SP12 Reading of 127.6277 C.
Minimum SP Pressure is 20.3417 psia at t plus 2.9012 s
Maximum SP Pressure is 62.4423 psia at t plus 9795.4652 s
Beginning SP Pressure is 20.3467 psia
Ending SP Pressure is 62.4423 psia
Time-Average SP Pressure is 34.691 +/- 12.6508 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 74.2544 cm (cold) / 74.3712 cm (hot) at 14.5332 psia
Beginning Smoothed SP Level is 75.1509 cm (cold) / 75.3115 cm (hot) at 20.3517 psia
Ending Smoothed SP Level is 74.1134 cm (cold) / 75.6196 cm (hot) at 62.4487 psia
Minimum Smoothed Cold SP Level is 74.1134 cm at t plus 9795.4652 s and 62.4487 psia
Minimum Smoothed Hot SP Level is 75.2763 cm at t plus 1118.417 s and 21.2624 psia
Maximum Smoothed Cold SP Level is 75.1509 cm at t plus 0 s and 20.3517 psia
Maximum Smoothed Hot SP Level is 76.148 cm at t plus 7518.321 s and 46.0056 psia
SP 12 Temperature at the beginning is 40.213 C, and at the end is 129.2164 C
At plume detection, the Mixing Number is 42.2698
The Mixing Number ranges from a minimum of 36.222 at (KEY POINT #12) t plus 0 s to a maximum of 260.3999 at (KEY POINT #13) t plus 9785.1607 s; it had a mean value of 108.8314 +/- 66.2355 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 36.222): 52.76468011 0.040894
0.00925 0.3937 0.7515091528 0.7531146312 0.6050730556
0.6050730556 0.999415092 37.49292817 168772.7785 0.06954332551
0.05677306544 0.04476071544 0.02454233904 0.06930305448 40.32582647
110.9570116 110.9570116 40.76744926 40.33593478 40.09774496
37.83389418 4.17844343 4.231794686 2.12582741 0.6290673997
0.6815518258 0.6815518258 4.309705995 1.566816402 0.03944035246

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992.1141674      950.2178368     0.8520319101      1.407323532  0.0006488290651
0.0002523436648 1.264479144e-005 1.278499322e-005      1531.947297
1533.265467      477.6562229     468.9109494      1.480461343      1.403200816
1.440200816    0.07513671459    0.07691962071      1814.381662      1812.975943
169.0236034      465.4159357     2692.518919      296.3923323      1348.965727
170.8688989      169.0643351     168.0721724      158.6167365
KEY POINT #2 (t plus 1230.3204 s with a Mixing Number of 42.2698):  52.0906176
0.040894         0.00925          0.3937     0.7502096506     0.7528176804
0.5935700442     0.5935700442     0.9993587929      34.78639476      165854.3753
0.06762094672    0.05649997055    0.04302077204    0.02539694416     0.0684177162
51.91741515      112.3367199      112.3367199      53.91938496      51.86059758
51.48217706      49.16265223      4.1798902       4.233894008      2.132665808
0.6426370069     0.6819276816     0.6819276816      3.445107128      1.546190968
0.03969372788     987.1886184     949.1556771     0.8894071631      1.497442261
0.0005296678208  0.0002490356207 1.269221447e-005 1.284375955e-005
1547.454741      1531.535796      478.3064259      468.9377934       1.5499843
1.47394635       1.51094635      0.135755174     0.1496320673      1792.179094
1790.969001      217.4700042      471.2610506      2694.60093      253.7910464
1320.918044      225.8385542      217.2310547      215.6523279      205.9617419
KEY POINT #3 (t plus 1982.3314 s with a Mixing Number of 46.8624):  52.3264424
0.040894         0.00925          0.3937     0.7496183736     0.7529292316
0.6064813184     0.6064813184     0.9993688239      34.40522607      166125.6246
0.0664606698    0.05626186163    0.04377747781    0.02494997928    0.06872745709
58.71326721      113.5362686      113.5362686      64.65515013      59.35124136
58.60858789      55.56461088      4.182106714      4.235755069      2.138757025
0.6496013232     0.6822362389     0.6822362389      3.06189967      1.528712691
0.03991841652     983.8914697     948.2254614     0.9229717817      1.520886458
0.000475600986  0.0002462236791 1.273346623e-005 1.288083967e-005
1553.143295      1529.989963      478.8661225      469.80924      1.612586508
1.538681686      1.575681686     0.1878767461     0.2465735571      1823.951414
1822.767694      245.8883805      476.3454349      2696.401055      230.4570544
1347.605979      270.7457745      248.5551076      245.4521201      232.7276004
KEY POINT #4 (t plus 3171.4504 s with a Mixing Number of 56.2566):  51.69709649
0.040894         0.00925          0.3937     0.7490999287      0.753929576
0.6294760704     0.6294760704      0.999371713      32.23134998      162900.8037
0.06461201551    0.05567116217    0.04453307062    0.02336778061    0.06790085123
69.26309121      116.4986708      116.4986708      80.53164729      71.27458867
66.9994323      61.56002695      4.187470534      4.24049601      2.154394207
0.6590474917     0.6829261193     0.6829261193      2.592566571      1.487278919
0.04049127446     978.2320887     945.9014187      1.010275517      1.603938294
0.0004080326015  0.0002395242485 1.283541742e-005 1.297784305e-005
1557.592277      1526.007448      480.2257309      471.6064267      1.776117619
1.708591182      1.745591182     0.3021953466     0.4844470892      1882.285085
1881.246225      290.0492135      488.9121113      2700.805746      198.8628979
1393.372973      337.2804507      298.4722013      280.5732484      257.815013
KEY POINT #5 (t plus 5155.9869 s with a Mixing Number of 92.5799):  53.71804838
0.040894         0.00925          0.3937      0.749398725     0.7573067173
0.6056770497     0.6056770497     0.9991176132      25.55000728      165272.4517
0.06042067269    0.05408661936    0.04512834816    0.02542689497    0.07055524312
92.0966101      124.3546559      124.3546559      104.9156401      93.07861651
76.058082      65.96201707      4.207002574      4.254099893      2.200138491
0.6741857559     0.6842651881     0.6842651881      1.916103521      1.388269148
0.04214073054     963.9561021      939.555113      1.274540677      2.102467048
0.0003070617805  0.0002233008799 1.310619083e-005 1.329166384e-005
1551.675079      1514.344071      483.6714355      472.9710335      2.276500021
2.215254601      2.252254601     0.7595954913      1.20549443      1849.324169
1848.671366      385.9064671      522.312907      2712.190267      136.4064399
1327.011262      439.9340188      390.0370008      318.5607054      276.2764204
KEY POINT #6 (t plus 6461.5086 s with a Mixing Number of 131.8983):  53.46216869
0.040894         0.00925          0.3937     0.7503277041     0.7604731456
0.5994419734     0.5994419734     0.9988987337      20.82077733      161294.5433
0.05787202096    0.05271838963    0.04491676803    0.02530239338     0.0702191614
105.3615128      131.0383788      131.0383788      120.288319      105.8451777
82.79744937      67.63750421      4.223365462      4.266916384      2.244184779
0.6798840588     0.6848543155     0.6848543155      1.656500027      1.31491946
0.04370327611     954.511881      933.948082      1.540903065      2.567731638
0.0002666659971  0.0002110489603 1.333685957e-005 1.355459324e-005
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1540.05907 1503.212647 486.4145154 474.3443489 2.787592236
2.730781236 2.767781236 1.224227959 2.004861527 1852.459414
1852.025909 441.855093 550.8231708 2721.513239 108.9680778
1301.636243 505.06378 443.8966932 346.871704 283.3322265
KEY POINT #7 (t plus 6842.5854 s with a Mixing Number of 143.5885): 53.44464421
0.040894 0.00925 0.3937 0.7499933898 0.7608223736
0.5967605765 0.5967605765 0.9988256854 19.68338381 160358.2795
0.05727347934 0.05233553777 0.04485873077 0.02533741335 0.07019614412
108.4178295 132.8929693 132.8929693 123.1415126 108.944909
101.788765 68.08001361 4.227676722 4.270686216 2.257268275
0.6808922353 0.6849296639 0.6849296639 1.60621196 1.296135968
0.04416425453 952.2237576 932.3585687 1.622239053 2.715216282
0.000258689896 0.0002078733786 1.340089184e-005 1.362926371e-005
1536.641433 1499.934013 487.1442281 474.625866 2.944786551
2.889093773 2.926093773 1.359210804 2.192499249 1851.295826
1850.908391 454.7811876 558.7505793 2724.0374 103.9693917
1292.545247 517.1985464 457.008468 426.7879466 285.1977505
KEY POINT #8 (t plus 8855.2395 s with a Mixing Number of 217.4416): 53.59732816
0.040894 0.00925 0.3937 0.7445837006 0.7581435906
0.5783710604 0.5783710604 0.9983618045 14.92555043 156400.3352
0.05442332735 0.05040869386 0.04435257002 0.02604411476 0.07039668478
122.6959867 142.1296004 142.1296004 135.6014957 123.4574126
122.5108574 71.38917344 4.250687486 4.290934121 2.328088738
0.6841425449 0.6847445423 0.6847445423 1.407882248 1.211544447
0.04664662094 940.9926621 924.2244745 2.080325925 3.590978331
0.0002265967911 0.0001933374935 1.371984606e-005 1.401409489e-005
1517.303636 1482.418098 490.571421 475.3391738 3.838160135
3.787193691 3.824193691 2.162291771 3.187187558 1835.029108
1834.806336 515.3669704 598.3473839 2736.177295 82.98041348
1236.681724 570.3836764 518.6028835 514.5813315 299.1280342
KEY POINT #9 (t plus 9093.7441 s with a Mixing Number of 227.8435): 52.95697315
0.040894 0.00925 0.3937 0.7433211508 0.7571459813
0.584638398 0.584638398 0.9983541436 14.47622164 154121.6572
0.05409475097 0.05017292378 0.0442225693 0.02533304986 0.06955561916
124.3146646 143.2491369 143.2491369 137.1192057 125.2065683
124.3554662 73.99019627 4.253608969 4.293562846 2.33731474
0.6843626487 0.6846593865 0.6846593865 1.388670886 1.202223723
0.04696926883 939.6639775 923.2139076 2.142252416 3.658204086
0.0002234230962 0.0001917087943 1.375850254e-005 1.405138316e-005
1514.778405 1480.163573 490.9631637 475.8910314 3.959842132
3.909265563 3.946265563 2.273689775 3.329912274 1851.244139
1851.034578 522.2582534 603.1604938 2737.597932 80.90224045
1248.083645 576.8841985 526.0516081 522.4330527 310.0342795
KEY POINT #10 (t plus 9598.482 s with a Mixing Number of 252.117): 52.92000917
0.040894 0.00925 0.3937 0.7416060474 0.7562838915
0.5830641499 0.5830641499 0.9982295185 13.53180363 152912.7757
0.05339200594 0.04965047897 0.04345591392 0.02605115541 0.06950706933
127.7589045 145.7220203 145.7220203 140.0380176 128.7217117
127.5223088 109.9905303 4.260048079 4.299509921 2.358184416
0.6847328886 0.6844237681 0.6844237681 1.349699366 1.18229064
0.04769913948 936.799885 920.9627663 2.284284302 3.910787551
0.0002169420458 0.0001882046628 1.384388115e-005 1.415258368e-005
1509.191338 1475.084991 491.8101999 476.161607 4.239632945
4.189879246 4.226879246 2.526308966 3.618899425 1854.100837
1853.917727 536.9388971 613.8030318 2740.695408 76.86413462
1240.297805 589.4028385 541.040222 535.9322779 461.5310928
KEY POINT #11 (t plus 9795.4652 s with a Mixing Number of 259.8183): 51.72469055
0.040894 0.00925 0.3937 0.7411337341 0.756196195
0.6159925389 0.6159925389 0.9984151184 13.62148318 149465.4793
0.05311087228 0.04944211224 0.04361402283 0.02432307145 0.06793709428
129.1301663 146.7052917 146.7052917 140.6548324 130.1935858
129.3593922 122.1926531 4.262698901 4.301929409 2.366670028
0.6848431493 0.6843119708 0.6843119708 1.334872212 1.174607993
0.04799599633 935.6454547 920.0604015 2.342813974 3.797287701
0.0002144599257 0.0001868460018 1.387782599e-005 1.415196008e-005
1506.886177 1473.028141 492.1399982 478.2670724 4.355202288
4.305684537 4.342684537 2.633025755 3.68248233 1926.51408

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       1926.328535      542.7901942      618.0390723      2741.911328      75.24887813
       1308.475008      592.0543914      547.3231733      543.7685808      513.2682337
KEY POINT #12 (t plus 0 s with a Mixing Number of 36.222):  52.76468011        0.040894
       0.00925          0.3937     0.7515091528     0.7531146312     0.6050730556
       0.6050730556      0.999415092      37.49292817      168772.7785    0.06954332551
       0.05677306544    0.04476071544    0.02454233904    0.06930305448      40.32582647
       110.9570116      110.9570116      40.76744926      40.33593478      40.09774496
       37.83389418       4.17844343      4.231794686       2.12582741     0.6290673997
       0.6815518258     0.6815518258      4.309705995      1.566816402    0.03944035246
       992.1141674      950.2178368     0.8520319101      1.407323532  0.0006488290651
       0.0002523436648 1.264479144e-005 1.278499322e-005      1531.947297
       1533.265467      477.6562229      468.9109494      1.480461343      1.403200816
       1.440200816    0.07513671459    0.07691962071      1814.381662      1812.975943
       169.0236034      465.4159357      2692.518919      296.3923323      1348.965727
       170.8688989      169.0643351      168.0721724      158.6167365
KEY POINT #13 (t plus 9785.1607 s with a Mixing Number of 260.3999):  51.74140049
       0.040894          0.00925           0.3937     0.7411436975     0.7561729883
       0.6149525009     0.6149525009     0.9984103122      13.62078479       149522.399
       0.05311043647     0.0494529417    0.04358562604    0.02437341568    0.06795904172
       129.1322892      146.6542296      146.6542296      140.6065885      130.1436053
       129.3193349      121.3943417      4.26270482      4.301802985      2.366226743
       0.6848429028     0.6843180295     0.6843180295      1.334849921      1.175003628
       0.0479804865       935.643341       920.107364      2.339745188      3.798709201
       0.0002144559695  0.0001869160838 1.387606326e-005 1.415114288e-005
       1506.881008      1473.135478      492.1229697      478.1997158      4.349139071
       4.299345754      4.336345754      2.633193752         3.677477      1924.181732
       1923.996207      542.7988128      617.8190292      2741.848406      75.02021643
       1306.362703      591.8471471      547.1095911      543.5973839      509.8758441
KEY POINT #14 (t plus 6158.7983 s with a Mixing Number of 122.2445):  53.58642998
       0.040894          0.00925           0.3937     0.7506215003     0.7602838265
       0.5989624003     0.5989624003     0.9989441851      21.76334013      162374.7186
       0.05841055933    0.05303298505    0.04490998741    0.02547238331    0.07038237071
       102.5931548      129.5094145      129.5094145      118.4085544      103.1366084
       79.9245741      67.19995392      4.219637216      4.263879449      2.233681876
       0.6788739532     0.6847635562     0.6847635562      1.704851597      1.330898646
       0.04333233121      956.5488801      935.2475171      1.476344166      2.462233722
       0.0002742840875  0.0002137374897 1.328407663e-005 1.349571834e-005
       1542.92399      1505.854244      485.8025911      473.9644874      2.663177461
       2.605274472      2.642274472      1.111697425      1.888566995      1847.580827
       1847.107184      430.1592052      544.2931338      2719.411387      114.1339286
       1303.287693      497.0752165      432.4513127      334.8062553      281.4902488
End
```

D.19 TEST #19 - T19_RCIC_060GPM_10PSIG_157KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T19_RCIC_060GPM_10PSIG_157kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1562.9654 s, and ending (KEY POINT #11) at t
       plus 9930.279 s, for a time period of 8367.3136 s.
Original Data Record Time:  12570.196 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       1817.726 s, T_bulk = 63.5184 C and T_out = 61.0907 C
Stratification Beginning SP12 Temperature = 63.0883 C
Stratification Beginning Pressure = 27.9113 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       8052.6366 s, T_bulk = 143.7795 C and T_out = 100.9486 C
Stratification Ending SP12 Temperature = 143.6292 C
Stratification Ending Pressure = 90.0382 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 977.4179 s.
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At t = 977.4179 s, the pool pressure is 26.2677 psia while the Smoothed Upper, Mid, SP8, Lower, and Outlet Temperatures are 52.5632, 52.5913, 54.5922, 52.1931, and 50.1472 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9 temperatures were 10.3152 +/- 2.4872 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 9.5672 +/- 2.2434 C.
Minimum Steam Quality: 0.46159 at t plus 24.6014 s
Maximum Steam Quality: 0.62296 at t plus 8312.4384 s
Time-Averaged Steam Quality: 0.57724 +/- 0.024579
Minimum Turbine Outlet Steam Quality: 0.50224 at t plus 24.6014 s
Maximum Turbine Outlet Steam Quality: 0.64181 at t plus 5723.5894 s
Time-Averaged Turbine Outlet Steam Quality: 0.6064 +/- 0.017981
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 8277.4324 s; using 300 s smoothing
Max and min smoothed upper level changerates: 1.0485 degrees/min at t plus 3744.2612 s and 0.57296 degrees/min at t plus 8071.8257 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.89356 degrees/min at t plus 3566.455 s and 0.6142 degrees/min at t plus 8277.4324 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.18101 degrees/min at t plus 3742.358 s and -0.14213 degrees/min at t plus 4372.6661 s, respectively
Max and min smoothed lower level changerates: 2.1414 degrees/min at t plus 6183.7447 s and 0.36535 degrees/min at t plus 3723.1569 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.51078 degrees/min at t plus 3584.654 s and -1.3795 degrees/min at t plus 6183.7447 s, respectively
Max and min smoothed outlet level changerates: 3.9767 degrees/min at t plus 8277.4324 s and 0.095299 degrees/min at t plus 4771.5739 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.9678 degrees/min at t plus 6183.7447 s and -3.2617 degrees/min at t plus 8277.4324 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.5222 degrees/min at t plus 1188.518 s and 0.34887 degrees/min at t plus 3078.3591 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.71814 degrees/min at t plus 1188.416 s and -0.49016 degrees/min at t plus 3078.3591 s, respectively
The mean steam flow rate was 66.4463 +/- 2.7975 g/s
The mean feedwater flow rate was 65.7438 +/- 3.2557 g/s
The mean water injection to steam flow rate was 37.4107 +/- 1.2069 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.0932 +/- 1.3118 C over the Stratification Period, beginning at 6.6113 C and ending at 9.6765 C
Mean Smoothed SP8-Upper Pool delta T is 10.2638 +/- 1.2045 C over the Stratification Period, beginning at 6.3678 C and ending at 8.7407 C
The stratification period begins and ends with Smoothed SP8 readings of 70.2703 and 153.4088 C, respectively
The stratification period begins and ends with condensing flows of 0.57821 and 1.8257 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 5.7013 and 3.228 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1895.6166 +/- 37.4531 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.4916 and 19.3001 kg/s, respectively
The plume period had a mean steam enthalpy of 1886.6736 +/- 43.499 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.6842 degrees C at t plus 3878.1568 s with T_upper = 92.3293 C and T_mid = 90.645 C
At t plus 3878.1568 s, Smoothed SP8-SP9 is 11.4917 C and Smoothed SP8-Top is 9.8075 C, where Smoothed SP8 is 102.1368 C and Pool P = 36.7666 psia
Maximum Smoothed Top-Lower delta T is 11.4166 degrees C at t plus 5839.994 s with T_upper = 119.3305 C and T_low = 107.9139 C
At t plus 5839.994 s, Smoothed SP8-SP9 is 12.188 C and Smoothed SP8-Top is 11.3573 C, where Smoothed SP8 is 130.6878 C and Pool P = 55.7996 psia
Maximum Smoothed Mid-Lower delta T is 10.5867 degrees C at t plus 5840.189 s with T_mid = 118.5027 C and T_low = 107.9161 C
At t plus 5840.189 s, Smoothed SP8-SP9 is 12.1911 C and Smoothed SP8-Top is 11.362 C, where Smoothed SP8 is 130.6939 C and Pool P = 55.7988 psia
Maximum Smoothed Top-Outlet delta T is 44.1627 degrees C at t plus 7965.3256 s with T_upper = 143.6504 C and T_out = 99.4877 C
At t plus 7965.3256 s, Smoothed SP8-SP9 is 9.9502 C and Smoothed SP8-Top is 9.1254 C, where Smoothed SP8 is 152.7758 C and Pool P = 88.4678 psia

Maximum Smoothed Mid-Outlet delta T is 43.3991 degrees C at t plus 7946.2255 s with T_mid = 142.6606 C and T_out = 99.2615 C
At t plus 7946.2255 s, Smoothed SP8-SP9 is 9.9636 C and Smoothed SP8-Top is 9.2904 C, where Smoothed SP8 is 152.6242 C and Pool P = 88.0969 psia
Maximum Smoothed Lower-Outlet delta T is 43.1981 degrees C at t plus 7902.172 s with T_low = 142.1085 C and T_out = 98.9104 C
At t plus 7902.172 s, Smoothed SP8-SP9 is 9.8854 C and Smoothed SP8-Top is 9.1188 C, where Smoothed SP8 is 152.0529 C and Pool P = 87.3107 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 12.8996 degrees C at (KEY POINT #14) t plus 5771.8891 s with T_SP8 = 130.4885 C and T_SP9 = 117.589 C and Pool P = 54.9304 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 12.2537 degrees C at t plus 5776.9894 s with T_SP8 = 130.5475 C and T_upper = 118.2938 C and Pool P = 54.992 psia
Maximum Top-Mid delta T is 2.6964 degrees C at (KEY POINT #4) t plus 3722.1679 s ignoring SP 4, with temperatures of 90.0487 and 87.3522 C, respectively, at Set # 2, where Pool P = 35.745 psia and T_outlet = 81.1528 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 4471.4658 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99976 C and a raw SP12 Reading of 99.3178 C.
Maximum Top-Lower delta T is 14.3408 degrees C at t plus 5914.5933 s, with temperatures of 120.7682 and 106.4274 C, respectively, at Set # 1, where Pool P = 56.7833 psia and T_outlet = 90.951 C
Maximum Mid-Low delta T is 11.9707 degrees C at (KEY POINT #6) t plus 5914.9903 s ignoring SP 4, with temperatures of 119.5086 and 107.5379 C, respectively, at Set # 2, where Pool P = 56.7908 psia and T_outlet = 90.9463 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6331.0191 s with a Smoothed Mid-Axis Mid-Low Delta T of 3.9892 C and a raw SP12 Reading of 124.8209 C.
Maximum Top-Outlet delta T is 44.8581 degrees C at t plus 7986.8248 s, with temperatures of 144.6075 and 99.7494 C, respectively, at Set # 1, where Pool P = 88.8269 psia
Maximum Mid-Outlet delta T is 43.7058 degrees C at t plus 7963.6295 s ignoring SP 4, with temperatures of 142.9239 and 99.2181 C, respectively, at Set # 2, where Pool P = 88.44 psia
Maximum Lower-Outlet delta T is 44.398 degrees C at (KEY POINT #8) t plus 7839.3234 s, with temperatures of 142.6222 and 98.2242 C, respectively, at Set # 1, where Pool P = 86.1685 psia
Low-Outlet Reconvergence NOT Detected, setting t to (KEY POINT #10) t plus 8367.3136 s with a Smoothed Mid-Axis Low-Outlet Delta T of 30.2375 C and a raw SP12 Reading of 146.9219 C.
Minimum SP Pressure is 25.1354 psia at t plus 2.4041 s
Maximum SP Pressure is 95.8621 psia at t plus 8367.3136 s
Beginning SP Pressure is 25.1386 psia
Ending SP Pressure is 95.8621 psia
Time-Average SP Pressure is 46.6136 +/- 20.7647 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.4768 cm (cold) / 77.6285 cm (hot) at 24.7303 psia
Beginning Smoothed SP Level is 77.6315 cm (cold) / 77.805 cm (hot) at 25.1392 psia
Ending Smoothed SP Level is 76.7495 cm (cold) / 78.9524 cm (hot) at 95.881 psia
Minimum Smoothed Cold SP Level is 76.7495 cm at t plus 8367.3136 s and 95.881 psia
Minimum Smoothed Hot SP Level is 77.8038 cm at t plus 7.6994 s and 25.1443 psia
Maximum Smoothed Cold SP Level is 79.3754 cm at t plus 3681.4596 s and 35.4827 psia
Maximum Smoothed Hot SP Level is 80.3559 cm at t plus 4141.9669 s and 38.6242 psia
SP 12 Temperature at the beginning is 39.7868 C, and at the end is 146.9219 C
At plume detection, the Mixing Number is 44.8991
The Mixing Number ranges from a minimum of 38.5793 at (KEY POINT #12) t plus 0 s to a maximum of 364.5022 at (KEY POINT #13) t plus 8367.3136 s; it had a mean value of 130.9166 +/- 91.5009 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal

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        Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 38.5793):  72.81053655        0.040894
        0.00925         0.3937     0.7763149194     0.7780497256     0.5049946991
        0.5049946991     0.9989265291      35.52012539       227191.511    0.06959656899
        0.0555025919    0.05389813965    0.04173387349    0.09563201313      39.99842105
        117.3406139      117.3406139      40.14561299       40.0124062      39.45363492
        37.77736682      4.178365689      4.241881551      2.15899585     0.6286689885
        0.68310356       0.68310356      4.338919393      1.475935104    0.04065885631
        992.2547945      945.2339703       1.03627021      2.049838951  0.0006528255947
        0.000237681442 1.286441078e-005 1.310574532e-005       1531.44724
        1524.8333      480.6062045      466.2487016      1.82499369      1.733286485
        1.770286485    0.07383805876    0.07441947837      1609.564356      1608.302676
        167.684814       492.486422      2702.046753      324.801608      1117.077934
        168.2998356      167.7417424      165.4100932      158.409974
KEY POINT #2 (t plus 977.4179 s with a Mixing Number of 44.8991):  76.95510896
        0.040894        0.00925          0.3937     0.7775474692     0.7805787059
        0.6009053106     0.6009053106     0.9992360427      42.58789869       240447.618
        0.06750697625    0.05518458277    0.06445752253    0.03661812309     0.1010756456
        52.59131065      118.9248547      118.9248547      54.59221236      52.56317261
        52.19306303      50.14715086      4.179990087      4.244535058      2.167847073
        0.6433765599     0.6834152229     0.6834152229      3.403595254      1.455086969
        0.04098004163      986.8907583      943.9697768      1.08664878       1.80697126
        0.0005238752629  0.0002342844556 1.291898521e-005 1.308809899e-005
        1548.180464      1522.573935      481.3149136      471.2479437      1.919944658
        1.810692277      1.847692277     0.1402978144     0.1545602529      1826.117384
        1824.303655      220.3157138      499.2153945      2704.368581      278.8996807
        1326.90199      228.6800282      220.1966411      218.6526081      210.105341
KEY POINT #3 (t plus 1817.726 s with a Mixing Number of 52.4256):  79.29764602
        0.040894        0.00925          0.3937     0.7820357705     0.7864915692
        0.5913236611     0.5913236611      0.999160226      40.94359691      246344.7843
        0.06560113769    0.05482233464    0.06496938297    0.03918303623     0.1041524192
        63.6589847      120.7230649      120.7230649      70.27026837      63.90242294
        63.287292      61.12937194      4.184262426      4.247621256      2.178202665
        0.6542482559     0.6837339879     0.6837339879      2.825385952      1.432184117
        0.04135403222      981.3332029      942.5217535      1.146210604       1.93675329
        0.0004417753103  0.0002305367873 1.298095803e-005 1.316365575e-005
        1555.914819      1519.931088      482.1078405      471.3554594      2.032573468
        1.924378055      1.961378055     0.2357675444     0.3156714975      1809.520358
        1807.84398      266.609297      506.8586423      2706.982572      240.2493453
        1302.661715       294.28469      267.6265082      265.055571      256.0315725
KEY POINT #4 (t plus 3722.1679 s with a Mixing Number of 81.5971):  79.32857287
        0.040894        0.00925          0.3937     0.7937336583     0.8027849379
        0.6215741868     0.6215741868     0.9990771039      34.73750021      241653.4996
        0.06111335493    0.05331198012    0.06720166946     0.0369913702     0.1041930397
        88.41597612      128.1496189      128.1496189      100.2171246       89.5115766
        85.86422604      81.15772623      4.203043862      4.261231552      2.224555042
        0.672232069     0.6846609893     0.6846609893      2.002340813      1.345497669
        0.04300923724      966.4499608      936.3948258      1.420774138      2.283658076
        0.0003202530717  0.0002161839256 1.323714018e-005 1.342443898e-005
        1553.97554      1508.156511      485.2505683      474.6664091      2.556351154
        2.464478344      2.501478344     0.6606468727      1.022063181      1894.129411
        1892.922717      370.4486701      538.4896775      2717.526497      168.0410075
        1355.639733      420.1263531      375.0528285      359.7282265      339.9724888
KEY POINT #5 (t plus 4471.4658 s with a Mixing Number of 103.1226):  81.43349434
        0.040894        0.00925          0.3937      0.791611241     0.8026756863
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    0.6142517558    0.6142517558    0.9989142903    31.02671626    244756.0522
    0.05904902476   0.05237398043   0.06839565118   0.03856206907   0.1069577202
    99.2877467     132.7070468     132.7070468     110.3717995     100.2375781
    93.18814251     86.30720838     4.215318663     4.270303985     2.255939606
    0.6775660644    0.6849238225    0.6849238225    1.766341343     1.297990074
    0.04411749092    958.9550425     932.5185764     1.613932761     2.624624973
    0.0002839199235  0.0002081875966 1.339447228e-005 1.360596107e-005
    1546.123433     1500.266354     487.0716963     475.4445297     2.928711291
    2.841160886     2.878160886     0.9886717321    1.451757244     1889.283119
    1888.320462     416.2364599     557.9555234     2723.785619     141.7190635
    1331.327596     463.0412552     420.239593      390.5485686     361.6220441
KEY POINT #6 (t plus 5914.9903 s with a Mixing Number of 168.7475):  79.68681832
    0.040894        0.00925         0.3937     0.7737611506    0.7884311874
    0.6238189869    0.6238189869    0.998592485     23.07503558     232471.5817
    0.05507184902   0.05011631875   0.06861987713   0.03604369515   0.1046635723
    119.4851953     143.5175886     143.5175886     131.591717      120.4794908
    109.6339443     90.82062783     4.24499573      4.294199029     2.339547633
    0.6836388345    0.6846369702    0.6846369702    1.447785354     1.200016591
    0.04704735345    943.6143225     922.970791      2.157319173     3.453377918
    0.000233159785  0.0001913222274 1.376777162e-005 1.401768218e-005
    1522.198802     1479.618812     491.0563338     478.1545984     3.989476493
    3.915371094     3.952371094     1.954479689     2.833763118     1935.841339
    1935.308881     501.7371396     604.315083      2737.936897     102.5779434
    1331.526255     553.2627931     505.957565      459.9996739     380.6753925
KEY POINT #7 (t plus 6331.0191 s with a Mixing Number of 195.5917):  80.0313916
    0.040894        0.00925         0.3937     0.7723095843    0.788290749
    0.6148827979    0.6148827979    0.9983994061    20.93343065     231114.4682
    0.05398526425   0.0494007913    0.06833378054   0.03678236686   0.1051161474
    124.8528483     146.9000832     146.9000832     136.9128705     125.3684585
    122.4921146     92.35819441     4.254500969     4.30241248      2.368363704
    0.684450813     0.6842886038    0.6842886038    1.382404707     1.173102054
    0.04805525768    939.2392543     919.8811469     2.354550393     3.823137876
    0.0002223969469  0.0001865791275 1.388455039e-005 1.416096427e-005
    1514.007854     1472.618149     492.2048595     478.2347559     4.378394552
    4.307237868     4.344237868     2.311746471     3.310210917     1924.880548
    1924.44234     524.5752002     618.8785529     2742.151136     94.30335264
    1306.001995     576.0273854     526.7679289     514.5378835     387.1725976
KEY POINT #8 (t plus 7839.3234 s with a Mixing Number of 310.7128):  80.08352496
    0.040894        0.00925         0.3937     0.7694573951    0.7898622627
    0.599910522     0.599910522     0.9976780292    15.18754201     223359.6711
    0.05053929282   0.0468383351    0.06775733249   0.03742728876   0.1051846213
    141.5084911     158.856689      158.856689      151.6803286     142.3138903
    141.1922651     98.26690132     4.288874988     4.33457939      2.480259683
    0.6849273456    0.6820900019    0.6820900019    1.21673436      1.090025568
    0.05198796368    924.8873871     908.5651216     3.170675228     5.272974713
    0.0001943107779  0.0001715265715 1.429707965e-005 1.466216194e-005
    1484.186655     1445.88451      495.8847928     478.7549843     6.003726082
    5.941201364     5.978201364     3.771961959     4.979342109     1921.986218
    1921.755557     595.8203968     670.6066048     2756.165877     74.78620792
    1251.379613     639.572395      599.2742874     594.4654343     412.1727711
KEY POINT #9 (t plus 8052.6366 s with a Mixing Number of 330.0555):  78.80713126
    0.040894        0.00925         0.3937     0.7688517644    0.7898626279
    0.6098309328    0.6098309328    0.9976751016    14.58319735     218986.5199
    0.05007103976   0.04646971078   0.06761386833   0.03589429091   0.1035081592
    143.7322339     160.5577931     160.5577931     153.4087757     144.668108
    143.4586956     101.2222109     4.294074004     4.339582912     2.497440094
    0.6847623832    0.6816561858    0.6816561858    1.198196806     1.079581421
    0.05259627153    922.8824404     906.9046366     3.303186397     5.403967964
    0.0001910726503  0.0001695792818 1.435572926e-005 1.471660825e-005
    1479.723847     1441.834425     496.3598993     479.5779191     6.269577405
    6.208367333     6.245367333     4.013299298     5.212211277     1946.686941
    1946.474271     605.3805013     677.9999394     2758.042561     72.61943808
    1268.687002     647.0497258     609.3991501     604.2071589     424.649904
KEY POINT #10 (t plus 8367.3136 s with a Mixing Number of 364.5022):  79.72467577
    0.040894        0.00925         0.3937     0.7674952806    0.7895238661
    0.59314993      0.59314993     0.9973513239    13.53927026     219635.8454
    0.04937725751   0.04593659539   0.06631105697   0.03840223868   0.1047132956
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       147.0109947      163.0100651      163.0100651      155.7523384      147.9401601
       146.9383346       116.460199      4.302029248      4.346996735      2.522757896
       0.6844218955     0.6809783186     0.6809783186      1.172184666      1.065072664
       0.05349549556      919.8871402      904.4884942      3.501981274      5.888402718
       0.0001864861453  0.0001668488467  1.44402571e-005 1.484393809e-005
       1472.940711      1435.889656      497.0234113       478.578568      6.669232043
       6.610764292      6.647764292      4.391644125      5.541777215      1917.875904
       1917.692592      619.4979421      688.6738562      2760.694224      69.17591412
       1229.202048      657.2031318      623.4952203      619.1864955      489.1001965
KEY POINT #11 (t plus 8367.3136 s with a Mixing Number of 364.5022):  79.72467577
       0.040894          0.00925          0.3937     0.7674952806     0.7895238661
       0.59314993       0.59314993     0.9973513239      13.53927026      219635.8454
       0.04937725751    0.04593659539    0.06631105697    0.03840223868     0.1047132956
       147.0109947      163.0100651      163.0100651      155.7523384      147.9401601
       146.9383346       116.460199      4.302029248      4.346996735      2.522757896
       0.6844218955     0.6809783186     0.6809783186      1.172184666      1.065072664
       0.05349549556      919.8871402      904.4884942      3.501981274      5.888402718
       0.0001864861453  0.0001668488467  1.44402571e-005 1.484393809e-005
       1472.940711      1435.889656      497.0234113       478.578568      6.669232043
       6.610764292      6.647764292      4.391644125      5.541777215      1917.875904
       1917.692592      619.4979421      688.6738562      2760.694224      69.17591412
       1229.202048      657.2031318      623.4952203      619.1864955      489.1001965
KEY POINT #12 (t plus 0 s with a Mixing Number of 38.5793):  72.81053655         0.040894
       0.00925          0.3937     0.7763149194     0.7780497256     0.5049946991
       0.5049946991     0.9989265291      35.52012539       227191.511    0.06959656899
       0.0555025919    0.05389813965    0.04173387349    0.09563201313      39.99842105
       117.3406139      117.3406139      40.14561299       40.0124062      39.45363492
       37.77736682      4.178365689      4.241881551       2.15899585     0.6286689885
       0.68310356       0.68310356      4.338919393      1.475935104    0.04065885631
       992.2547945      945.2339703       1.03627021      2.049838951  0.0006528255947
       0.000237681442 1.286441078e-005 1.310574532e-005       1531.44724
       1524.8333       480.6062045      466.2487016       1.82499369      1.733286485
       1.770286485    0.07383805876    0.07441947837      1609.564356      1608.302676
       167.684814       492.486422      2702.046753       324.801608      1117.077934
       168.2998356      167.7417424      165.4100932       158.409974
KEY POINT #13 (t plus 8367.3136 s with a Mixing Number of 364.5022):  79.72467577
       0.040894          0.00925          0.3937     0.7674952806     0.7895238661
       0.59314993       0.59314993     0.9973513239      13.53927026      219635.8454
       0.04937725751    0.04593659539    0.06631105697    0.03840223868     0.1047132956
       147.0109947      163.0100651      163.0100651      155.7523384      147.9401601
       146.9383346       116.460199      4.302029248      4.346996735      2.522757896
       0.6844218955     0.6809783186     0.6809783186      1.172184666      1.065072664
       0.05349549556      919.8871402      904.4884942      3.501981274      5.888402718
       0.0001864861453  0.0001668488467  1.44402571e-005 1.484393809e-005
       1472.940711      1435.889656      497.0234113       478.578568      6.669232043
       6.610764292      6.647764292      4.391644125      5.541777215      1917.875904
       1917.692592      619.4979421      688.6738562      2760.694224      69.17591412
       1229.202048      657.2031318      623.4952203      619.1864955      489.1001965
KEY POINT #14 (t plus 5771.8891 s with a Mixing Number of 160.3724):  79.14939848
       0.040894          0.00925          0.3937     0.7747234185     0.7889714186
       0.6307992806     0.6307992806     0.9986762411      23.89015418      231775.9558
       0.05545280872    0.05036139336    0.06871958306    0.03523812243     0.1039577055
       117.5889727      142.3543834      142.3543834      130.4885297      118.2786811
       108.1468163      90.26843581      4.241808375      4.291458782      2.329930027
       0.6832730897     0.6847285235     0.6847285235      1.472542469      1.209657853
       0.04671101666      945.1303017      924.0219993      2.092642964      3.313055156
       0.0002371980423  0.0001930083167 1.372760774e-005 1.396493217e-005
       1524.916967      1481.967676      490.6504887      478.3039009      3.862346893
       3.787023739      3.824023739      1.839619628      2.742318628      1947.996893
       1947.426154      493.6816808      599.3135225      2736.463441      105.6318417
       1348.68337      548.5472712      496.6064785       453.702534      378.3435409
End
```

D.20 TEST #20 - T20_RCIC_1ATM_57KW_RESULTS_RCICLAND.TXT

```
Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T20_RCIC_1ATM_57kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2078.8719 s, and ending (KEY POINT #11) at t
       plus 15071.183 s, for a time period of 12992.3111 s.
Original Data Record Time:  16478.1055 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       3224.9565 s, T_bulk = 55.6078 C and T_out = 53.3852 C
Stratification Beginning SP12 Temperature = 55.1982 C
Stratification Beginning Pressure = 15.2659 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       9485.4535 s, T_bulk = 84.6456 C and T_out = 72.0563 C
Stratification Ending SP12 Temperature = 84.473 C
Stratification Ending Pressure = 15.2377 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 3609.5595 s.
At t = 3609.5595 s, the pool pressure is 15.2627 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 57.7168, 57.5261, 59.5267, 57.8725, and
       54.7286 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 8.806 +/- 3.1575 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 8.3013 +/- 3.0427 C.
Minimum Steam Quality:  0.97248 at t plus 9593.6557 s
Maximum Steam Quality:  1.0121 at t plus 3353.8528 s
Time-Averaged Steam Quality:  1.0071 +/- 0.0016623
Minimum Turbine Outlet Steam Quality:  0.98382 at t plus 9593.6557 s
Maximum Turbine Outlet Steam Quality:  1.0223 at t plus 7911.0285 s
Time-Averaged Turbine Outlet Steam Quality:  1.0174 +/- 0.001815
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 12902.313 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.43333 degrees/min at t plus 6973.0108 s
       and 0.17699 degrees/min at t plus 10060.8655 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.41556 degrees/min at t plus
       7391.1157 s and 0.19428 degrees/min at t plus 9587.5544 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.17726 degrees/min at t
       plus 6984.6155 s and -0.14667 degrees/min at t plus 10060.2654 s, respectively
Max and min smoothed lower level changerates:  0.97015 degrees/min at t plus 8625.0393 s
       and 0.015747 degrees/min at t plus 6981.0123 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.32911 degrees/min at t
       plus 7505.4203 s and -0.74234 degrees/min at t plus 8625.0393 s, respectively
Max and min smoothed outlet level changerates:  2.3129 degrees/min at t plus 9708.6583 s
       and 0.0086426 degrees/min at t plus 8791.7409 s, respectively
Max and min smoothed lower-outlet level changerate differences:  0.86828 degrees/min at t
       plus 8625.0393 s and -2.015 degrees/min at t plus 9712.8585 s, respectively
Max and min smoothed hot (SP8) level changerates:  0.91653 degrees/min at t plus
       4862.8791 s and 0.01821 degrees/min at t plus 10660.5738 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.67911 degrees/min
       at t plus 4862.8791 s and -0.33511 degrees/min at t plus 7275.6182 s,
       respectively
The mean steam flow rate was 23.8957 +/- 0.78305 g/s
The mean feedwater flow rate was 23.4546 +/- 1.129 g/s
The mean water injection to steam flow rate was 0.0061292 +/- 0.028436 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 8.3634 +/- 3.5149 C over the
       Stratification Period, beginning at 1.4895 C and ending at 11.8254 C
Mean Smoothed SP8-Upper Pool delta T is 7.8799 +/- 3.3771 C over the Stratification
       Period, beginning at 1.3073 C and ending at 11.237 C
The stratification period begins and ends with Smoothed SP8 readings of 57.1592 and
       97.016 C, respectively
The stratification period begins and ends with condensing flows of 0.27341 and 0.79128
       kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 9.2413 and
       1.1347 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2719.8569 +/- 1.0362 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.28485 and 6.8534
       kg/s, respectively
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The plume period had a mean steam enthalpy of 2720.5284 +/- 0.99922 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.2573 degrees C at t plus 9710.4554 s with T_upper = 86.967 C and T_mid = 85.7096 C
At t plus 9710.4554 s, Smoothed SP8-SP9 is 12.0289 C and Smoothed SP8-Top is 10.7715 C, where Smoothed SP8 is 97.7385 C and Pool P = 15.2362 psia
Maximum Smoothed Top-Lower delta T is 5.8466 degrees C at t plus 8446.8371 s with T_upper = 81.5142 C and T_low = 75.6676 C
At t plus 8446.8371 s, Smoothed SP8-SP9 is 10.7535 C and Smoothed SP8-Top is 10.2588 C, where Smoothed SP8 is 91.7731 C and Pool P = 15.2527 psia
Maximum Smoothed Mid-Lower delta T is 5.5273 degrees C at t plus 8413.5322 s with T_mid = 80.9039 C and T_low = 75.3766 C
At t plus 8413.5322 s, Smoothed SP8-SP9 is 10.9349 C and Smoothed SP8-Top is 10.6334 C, where Smoothed SP8 is 91.8389 C and Pool P = 15.2511 psia
Maximum Smoothed Top-Outlet delta T is 13.7148 degrees C at t plus 9344.5995 s with T_upper = 85.2301 C and T_out = 71.5153 C
At t plus 9344.5995 s, Smoothed SP8-SP9 is 11.7886 C and Smoothed SP8-Top is 11.0087 C, where Smoothed SP8 is 96.2388 C and Pool P = 15.2535 psia
Maximum Smoothed Mid-Outlet delta T is 13.0456 degrees C at t plus 9490.0518 s with T_mid = 85.2391 C and T_out = 72.1936 C
At t plus 9490.0518 s, Smoothed SP8-SP9 is 11.8117 C and Smoothed SP8-Top is 11.243 C, where Smoothed SP8 is 97.0508 C and Pool P = 15.2373 psia
Maximum Smoothed Lower-Outlet delta T is 13.4754 degrees C at t plus 9517.4554 s with T_low = 85.9246 C and T_out = 72.4492 C
At t plus 9517.4554 s, Smoothed SP8-SP9 is 11.778 C and Smoothed SP8-Top is 10.9618 C, where Smoothed SP8 is 96.9436 C and Pool P = 15.2513 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 12.523 degrees C at (KEY POINT #14) t plus 9195.649 s with T_SP8 = 96.2987 C and T_SP9 = 83.7756 C and Pool P = 15.252 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 11.8167 degrees C at t plus 9195.649 s with T_SP8 = 96.2987 C and T_upper = 84.4819 C and Pool P = 15.252 psia
Maximum Top-Mid delta T is 1.6034 degrees C at (KEY POINT #4) t plus 7125.1135 s ignoring SP 4, with temperatures of 74.8059 and 73.2025 C, respectively, at Set # 2, where Pool P = 15.2521 psia and T_outlet = 67.3946 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 7477.7207 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99983 C and a raw SP12 Reading of 75.609 C.
Maximum Top-Lower delta T is 7.1289 degrees C at t plus 8778.7421 s, with temperatures of 82.7181 and 75.5892 C, respectively, at Set # 1, where Pool P = 15.2497 psia and T_outlet = 70.9883 C
Maximum Mid-Low delta T is 5.7523 degrees C at (KEY POINT #6) t plus 8537.5383 s ignoring SP 4, with temperatures of 81.3109 and 75.5585 C, respectively, at Set # 2, where Pool P = 15.2508 psia and T_outlet = 70.5233 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 8712.5413 s with a Smoothed Mid-Axis Mid-Low Delta T of 1.9158 C and a raw SP12 Reading of 81.9018 C.
Maximum Top-Outlet delta T is 14.0029 degrees C at t plus 9366.9518 s, with temperatures of 85.5923 and 71.5894 C, respectively, at Set # 1, where Pool P = 15.2516 psia
Maximum Mid-Outlet delta T is 12.7364 degrees C at t plus 9408.5561 s ignoring SP 4, with temperatures of 84.3102 and 71.5738 C, respectively, at Set # 2, where Pool P = 15.2498 psia
Maximum Lower-Outlet delta T is 13.9535 degrees C at (KEY POINT #8) t plus 9344.9515 s, with temperatures of 85.3905 and 71.437 C, respectively, at Set # 1, where Pool P = 15.2459 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 9780.3604 s with a Smoothed Mid-Axis Low-Outlet Delta T of 4.65 C and a raw SP12 Reading of 85.7542 C.
Minimum SP Pressure is 14.783 psia at t plus 0.30002 s
Maximum SP Pressure is 15.4698 psia at t plus 12978.0143 s
Beginning SP Pressure is 14.7935 psia
Ending SP Pressure is 15.4565 psia
Time-Average SP Pressure is 15.2425 +/- 0.089631 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 78.0448 cm (cold) / 78.2002 cm (hot) at 14.562 psia
Beginning Smoothed SP Level is 78.4526 cm (cold) / 78.6366 cm (hot) at 14.7971 psia
Ending Smoothed SP Level is 77.9517 cm (cold) / 79.0159 cm (hot) at 15.4623 psia
Minimum Smoothed Cold SP Level is 77.8984 cm at t plus 12557.7043 s and 15.3311 psia
Minimum Smoothed Hot SP Level is 78.6231 cm at t plus 2607.2411 s and 15.2673 psia
Maximum Smoothed Cold SP Level is 78.4575 cm at t plus 552.1106 s and 14.9821 psia
Maximum Smoothed Hot SP Level is 79.0175 cm at t plus 12983.6136 s and 15.4577 psia

SP 12 Temperature at the beginning is 40.0183 C, and at the end is 99.9748 C
At plume detection, the Mixing Number is 44.626
The Mixing Number ranges from a minimum of 33.6287 at (KEY POINT #12) t plus 0 s to a maximum of 648.6732 at (KEY POINT #13) t plus 12992.3111 s; it had a mean value of 102.0038 +/- 103.016 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 33.6287): 17.2933 0.040894
0.00925 0.3937 0.784525937 0.786366053 1.01229275
1 1 28.3878995 55108.5536 0.0695240922 0.0585842657
0.0227136507 3.16566909e-006 0.0227136507 40.444008 115.132806
101.696401 40.4559645 40.5916857 40.741424 38.0774187
4.17853687 4.21881729 2.0843193 0.629197093 0.678440305
0.678440305 4.29935352 1.72121457 0.0378722462 992.050873
957.129682 0.632792924 0.609263471 0.000647389461 0.000276793532
1.23273139e-005 1.28327122e-005 1532.08343 1543.49029 473.118764
482.37706 1.07713425 1.02022112 1.05722112 0.0756103015
0.0756583575 2706.73038 2705.92451 169.483515 426.258826
2678.24146 256.775311 2280.47156 169.533476 170.099088
170.727871 159.600179
KEY POINT #2 (t plus 3609.5595 s with a Mixing Number of 44.626): 17.6877954
0.040894 0.00925 0.3937 0.782805323 0.78647775
1.01680787 1 1 28.5614993 55413.2951
0.0666651005 0.058408531 0.0232317954 2.82251833e-006 0.0232317954
57.5261171 120.990061 102.603615 59.5267408 57.7167549
57.8724946 54.7286332 4.18175496 4.22000463 2.08806454
0.648411116 0.678790963 0.678790963 3.1237276 1.70475793
0.0380161442 984.466475 956.469453 0.651987975 0.619363298
0.000484356381 0.000274211613 1.23583417e-005 1.30532701e-005 1552.23681
1542.59824 473.576262 486.106589 1.11210592 1.05259368
1.08959368 0.177705036 0.195129704 2718.28873 2717.47297
240.88278 430.08934 2679.66244 189.20656 2288.19939
249.249673 241.67855 242.332788 229.19115
KEY POINT #3 (t plus 3224.9565 s with a Mixing Number of 43.0069): 17.6790675
0.040894 0.00925 0.3937 0.782900198 0.786370198
1.01706937 1 1 28.5780136 55338.9464
0.0669833021 0.0584084091 0.0232203318 1.00468258e-005 0.0232203318
55.6697176 121.280299 102.604243 57.1592349 55.8518934
56.1314889 53.3122207 4.181095 4.22000546 2.08806716
0.646546402 0.678791203 0.678791203 3.22446412 1.70474663
0.0380162447 985.382803 956.468994 0.652001442 0.618892448
0.000498617151 0.000274209838 1.23583632e-005 1.30643576e-005 1550.80887
1542.59762 473.576578 486.296562 1.11213048 1.05263245
1.08963245 0.162741467 0.174658158 2718.87889 2718.06219

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      233.120403      430.091995      2679.66342      196.971592       2288.7869
      239.348597      233.880659      235.052675      223.269762
KEY POINT #4 (t plus 7125.1135 s with a Mixing Number of 65.4321):  19.3663978
      0.040894         0.00925          0.3937     0.781215775     0.787245886
      1.0188561              1               1      31.6163766      60292.8642
      0.0638095721    0.0584360899     0.025436533 6.74370361e-006     0.025436533
      73.7447575      123.127464      102.461472      85.8643987      74.5248556
      72.7134464      67.4676162      4.19061334      4.21981741      2.08747334
      0.662538022     0.678736687     0.678736687      2.42910434      1.70731586
      0.0379934646     975.607366      956.573142      0.648949546      0.61270564
      0.000384042586  0.000274613282 1.23534791e-005 1.31353765e-005       1557.8745
      1542.73962      473.504763      487.522866      1.10656537      1.05163231
      1.08863231     0.366127476     0.598566082      2722.86501      2721.86541
      308.769439      429.489098      2679.44011      120.719659      2293.37591
      359.616927      312.037375      304.449451      282.482799
KEY POINT #5 (t plus 7477.7207 s with a Mixing Number of 70.4269):  19.1265364
      0.040894         0.00925          0.3937     0.780976524     0.787300683
      1.01891859             1               1      31.2414957      59535.2177
      0.0634069343     0.058437558    0.0251214902  9.1296261e-006    0.0251214902
      75.9726387      123.189733      102.453898      87.0332637      76.6520416
      73.3854076      68.6203986      4.19225972      4.21980745      2.08744189
      0.664186042     0.678733788     0.678733788      2.35433221      1.70745236
      0.0379922575     974.277464      956.578665      0.648787974     0.612438262
      0.00037300041  0.000274634714   1.235322e-005 1.31377798e-005      1557.76743
      1542.74714      473.500951      487.564465       1.1062708      1.05160254
      1.08860254     0.401931268     0.626370466      2722.97056      2721.99453
      318.10744      429.457116      2679.42826      111.349676      2293.51344
      364.527783      320.954486      307.265045      287.309332
KEY POINT #6 (t plus 8537.5383 s with a Mixing Number of 87.2294):  18.6051333
      0.040894         0.00925          0.3937     0.780760613     0.787901895
      1.01787411             1               1       30.315501        58112.162
      0.062415268    0.0584424294    0.0244366603 4.71361171e-006    0.0244366603
      81.4029424      122.006838      102.428768      92.4599335      81.7418222
      76.6387626      70.4925607      4.19670556       4.2197744      2.08733755
      0.667918589     0.678724164     0.678724164      2.18810242      1.70790546
      0.0379882535      970.92815      956.596987     0.648252095     0.613835214
      0.000348243226  0.000274705849 1.23523603e-005 1.30925833e-005      1556.69593
      1542.77207      473.488303      486.797388      1.10529383      1.05157211
      1.08857211     0.501733013     0.769998294      2720.52538      2719.60635
      340.884479      429.350997      2679.38893      88.4665185      2291.17438
      387.345646      342.305362      320.901619      295.149546
KEY POINT #7 (t plus 8712.5413 s with a Mixing Number of 89.7922):  18.5629217
      0.040894         0.00925          0.3937     0.780630368     0.787907184
      1.01809908             1               1      30.2751849      57939.9854
      0.0622932817    0.0584449325    0.0243812181 8.62616823e-007    0.0243812181
      82.0655217      122.244278      102.415854      93.6351462      82.4988418
      79.5532496       70.834157      4.19729009      4.21975742      2.08728396
      0.668346764     0.678719215     0.678719215      2.16924751      1.70813839
      0.0379861965     970.509187      956.606401      0.647976864     0.613161521
      0.000345415619  0.000274742415 1.23519186e-005 1.31016968e-005      1556.48895
      1542.78487      473.481802      486.954198      1.10479207      1.05154839
      1.08854839      0.51522182     0.804462895      2721.00956      2720.09297
      343.665321      429.296467      2679.36873      85.6311452      2291.71309
      392.291317      345.482832      333.124769      296.580317
KEY POINT #8 (t plus 9344.9515 s with a Mixing Number of 100.3919):  18.573379
      0.040894         0.00925          0.3937     0.780318136     0.787922475
      1.01813072             1               1      30.3079737       57967.396
      0.0618527943    0.0584458625    0.0243949531 7.35712596e-006    0.0243949531
      84.448507       122.27486      102.411055      96.2452032      85.2300862
      84.4433639      71.5157276      4.19946818      4.21975111      2.08726404
      0.669838341     0.678717376     0.678717376      2.10379267      1.70822495
      0.0379854323     968.984313      956.609898      0.647874622     0.613006352
      0.000335566536  0.000274756005 1.23517545e-005 1.31028787e-005      1555.61177
      1542.78963      473.479387      486.974844      1.10460569      1.05138714
      1.08838714     0.566274928      0.88561273      2721.07544      2720.15687
      353.669963      429.276205      2679.36122       75.606242      2291.79924
      403.28091      356.951136       353.64978      299.435287
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KEY POINT #9 (t plus 9485.4535 s with a Mixing Number of 104.401):  18.5788676
       0.040894         0.00925          0.3937     0.780300808     0.788004844
       1.01781875              1               1      30.2874864       58044.076
       0.0617150586    0.0584470602     0.024402162 1.35312424e-006     0.024402162
       85.1906103       121.92292      102.404876      97.0159744      85.7789556
       85.5858067      72.1604192      4.20017079      4.21974299      2.08723841
       0.670287462     0.678715007     0.678715007      2.08413431      1.70833644
       0.0379844483     968.503674      956.614402     0.647742973     0.613451296
       0.000332598165  0.000274773507 1.23515431e-005 1.30894359e-005       1555.2967
       1542.79575      473.476276      486.746112      1.10436569      1.05107641
       1.08807641      0.58301265     0.910836422      2720.36288      2719.44555
       356.786639      429.250112      2679.35155      72.463473      2291.11277
       406.527738      359.256625      358.448017      302.136051
KEY POINT #10 (t plus 9780.3604 s with a Mixing Number of 109.4082):  18.5535139
       0.040894         0.00925          0.3937     0.779941628     0.787862869
       1.01797714              1               1      30.2505769      57932.4189
       0.0615494428    0.0584435145    0.0243688616 8.15937577e-006    0.0243688616
       86.0810442      122.115872      102.423169      97.9722354      87.2109983
       87.1534187      80.9387371      4.20102893      4.21976703      2.08731431
       0.670816809     0.678722019     0.678722019      2.06098395      1.70800643
       0.0379873617     967.923432      956.601068     0.648132763     0.613532967
       0.000329096205    0.0002747217 1.23521688e-005 1.30967671e-005      1554.89293
       1542.77762      473.485485      486.869363      1.10507628      1.05131834
       1.08831834     0.603640133      0.94295593       2720.7448       2719.8297
       360.527014      429.327357      2679.38017      68.8003426      2291.41744
       410.556976      365.273286      365.034059       338.94142
KEY POINT #11 (t plus 12992.3111 s with a Mixing Number of 648.6732):  19.095888
       0.040894         0.00925          0.3937      0.77951688     0.790158943
       1.01832792              1               1      30.7697635      59499.5336
       0.0588219367    0.0583684855    0.0250812354 7.14251177e-006    0.0250812354
       100.466365      122.869102      102.810077       102.69256      100.657177
       100.547054      98.6217698      4.21722177      4.22027735      2.08892618
       0.677953508      0.67886936      0.67886936      1.74403385      1.70105597
       0.0380491754     958.022003      956.318682     0.656421927     0.620782346
       0.000280367961  0.000273630067 1.23654055e-005 1.31245943e-005      1544.67355
       1542.39182      473.679994      487.303887      1.12019438      1.06608652
       1.10308652       1.0311751      1.11558454      2722.15188       2721.2051
       421.072455      430.961242      2679.98517      9.88878657      2291.19063
       2679.96893      421.875903      421.414094      413.300301
KEY POINT #12 (t plus 0 s with a Mixing Number of 33.6287):  17.2933        0.040894
       0.00925          0.3937     0.784525937     0.786366053      1.01229275
       1               1      28.3878995      55108.5536    0.0695240922    0.0585842657
       0.0227136507 3.16566909e-006    0.0227136507       40.444008      115.132806
       101.696401      40.4559645      40.5916857       40.741424      38.0774187
       4.17853687      4.21881729       2.0843193     0.629197093     0.678440305
       0.678440305      4.29935352      1.72121457    0.0378722462      992.050873
       957.129682     0.632792924     0.609263471  0.000647389461  0.000276793532
       1.23273139e-005 1.28327122e-005      1532.08343      1543.49029      473.118764
       482.37706      1.07713425      1.02022112      1.05722112    0.0756103015
       0.0756583575      2706.73038      2705.92451      169.483515      426.258826
       2678.24146      256.775311      2280.47156      169.533476      170.099088
       170.727871      159.600179
KEY POINT #13 (t plus 12992.3111 s with a Mixing Number of 648.6732):  19.095888
       0.040894         0.00925          0.3937      0.77951688     0.790158943
       1.01832792              1               1      30.7697635      59499.5336
       0.0588219367    0.0583684855    0.0250812354 7.14251177e-006    0.0250812354
       100.466365      122.869102      102.810077       102.69256      100.657177
       100.547054      98.6217698      4.21722177      4.22027735      2.08892618
       0.677953508      0.67886936      0.67886936      1.74403385      1.70105597
       0.0380491754     958.022003      956.318682     0.656421927     0.620782346
       0.000280367961  0.000273630067 1.23654055e-005 1.31245943e-005      1544.67355
       1542.39182      473.679994      487.303887      1.12019438      1.06608652
       1.10308652       1.0311751      1.11558454      2722.15188       2721.2051
       421.072455      430.961242      2679.98517      9.88878657      2291.19063
       2679.96893      421.875903      421.414094      413.300301
KEY POINT #14 (t plus 9195.649 s with a Mixing Number of 97.207):  18.5672789
       0.040894         0.00925          0.3937     0.780290647     0.787829249
```

1.01785897	1	1	30.2737279	57999.6893
0.0619774507	0.0584462455	0.024386941	5.95636522e-006	0.024386941
83.7756365	121.971492	102.409079	96.2986751	84.4819381
83.3669485	71.2169212	4.19884112	4.21974851	2.08725585
0.669424818	0.678716619	0.678716619	2.12190976	1.7082606
0.0379851176	969.41774	956.611339	0.64783252	0.613463062
0.00033829788	0.000274761601	1.23516869e-005	1.30912822e-005	1555.88034
1542.79158	473.478392	486.777203	1.10452894	1.05150639
1.08850639	0.5514482	0.887343686	2720.45891	2719.54241
350.844485	429.267861	2679.35813	78.4233755	2291.19105
403.506145	353.80903	349.129965	298.18361	

End

D.21 TEST #21 - T21_RCIC_020GPM_57KW_RESULTS_RCICLAND.TXT

Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T21_RCIC_020GPM_57kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2225.0753 s, and ending (KEY POINT #11) at t plus 18140.1606 s, for a time period of 15915.0853 s.
Original Data Record Time: 19780.1504 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus 2412.944 s, T_bulk = 51.7363 C and T_out = 49.2512 C
Stratification Beginning SP12 Temperature = 51.6947 C
Stratification Beginning Pressure = 16.284 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus 11365.199 s, T_bulk = 93.9202 C and T_out = 71.0933 C
Stratification Ending SP12 Temperature = 93.8152 C
Stratification Ending Pressure = 28.0762 psia
Plume detected! Setting t_plume (KEY POINT #2) to 1776.5286 s.
At t = 1776.5286 s, the pool pressure is 15.9188 psia while the Smoothed Upper, Mid, SP8, Lower, and Outlet Temperatures are 49.0328, 48.884, 50.8941, 49.1077, and 46.584 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9 temperatures were 10.9113 +/- 3.8881 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 10.372 +/- 3.7803 C.
Minimum Steam Quality: 0.57084 at t plus 2299.3415 s
Maximum Steam Quality: 0.68061 at t plus 13275.3323 s
Time-Averaged Steam Quality: 0.62229 +/- 0.018351
Minimum Turbine Outlet Steam Quality: 0.58905 at t plus 2299.5735 s
Maximum Turbine Outlet Steam Quality: 0.68737 at t plus 13275.3323 s
Time-Averaged Turbine Outlet Steam Quality: 0.6345 +/- 0.014589
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 15825.1091 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.456 degrees/min at t plus 6332.7162 s and 0.17192 degrees/min at t plus 11080.3947 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.35745 degrees/min at t plus 8053.8426 s and 0.19229 degrees/min at t plus 11605.7048 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.15261 degrees/min at t plus 6326.8109 s and -0.11865 degrees/min at t plus 5353.4952 s, respectively
Max and min smoothed lower level changerates: 1.4088 degrees/min at t plus 9535.6684 s and 0.027255 degrees/min at t plus 8778.16 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.29941 degrees/min at t plus 8778.064 s and -1.1796 degrees/min at t plus 9535.6684 s, respectively
Max and min smoothed outlet level changerates: 2.9442 degrees/min at t plus 11681.2091 s and -0.0019412 degrees/min at t plus 9423.464 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.39 degrees/min at t plus 9535.6684 s and -2.5921 degrees/min at t plus 11654.5026 s, respectively
Max and min smoothed hot (SP8) level changerates: 0.81927 degrees/min at t plus 6579.8123 s and -0.14543 degrees/min at t plus 10524.784 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.4953 degrees/min at t plus 6621.5137 s and -0.36276 degrees/min at t plus 10524.784 s, respectively
The mean steam flow rate was 23.811 +/- 0.75462 g/s

The mean feedwater flow rate was 23.2469 +/- 0.85061 g/s
The mean water injection to steam flow rate was 12.4674 +/- 0.36292 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.4856 +/- 3.348 C over the Stratification Period, beginning at 3.5174 C and ending at 14.8787 C
Mean Smoothed SP8-Upper Pool delta T is 10.9199 +/- 3.282 C over the Stratification Period, beginning at 3.2995 C and ending at 14.1912 C
The stratification period begins and ends with Smoothed SP8 readings of 55.4119 and 108.9393 C, respectively
The stratification period begins and ends with condensing flows of 0.22806 and 0.46943 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 3.8644 and 0.83918 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1873.5353 +/- 22.9931 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.21668 and 6.7977 kg/s, respectively
The plume period had a mean steam enthalpy of 1870.4632 +/- 25.6547 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.2792 degrees C at t plus 15536.0736 s with T_upper = 113.3442 C and T_mid = 112.065 C
At t plus 15536.0736 s, Smoothed SP8-SP9 is 12.2296 C and Smoothed SP8-Top is 10.9504 C, where Smoothed SP8 is 124.2946 C and Pool P = 39.3564 psia
Maximum Smoothed Top-Lower delta T is 9.8992 degrees C at t plus 9253.1612 s with T_upper = 86.5543 C and T_low = 76.6552 C
At t plus 9253.1612 s, Smoothed SP8-SP9 is 13.7849 C and Smoothed SP8-Top is 13.2754 C, where Smoothed SP8 is 99.8297 C and Pool P = 24.425 psia
Maximum Smoothed Mid-Lower delta T is 9.3944 degrees C at t plus 9254.7623 s with T_mid = 86.0525 C and T_low = 76.6581 C
At t plus 9254.7623 s, Smoothed SP8-SP9 is 13.8327 C and Smoothed SP8-Top is 13.3337 C, where Smoothed SP8 is 99.8852 C and Pool P = 24.4266 psia
Maximum Smoothed Top-Outlet delta T is 23.7673 degrees C at t plus 11258.9969 s with T_upper = 94.4223 C and T_out = 70.655 C
At t plus 11258.9969 s, Smoothed SP8-SP9 is 14.6701 C and Smoothed SP8-Top is 13.8416 C, where Smoothed SP8 is 108.2639 C and Pool P = 27.8734 psia
Maximum Smoothed Mid-Outlet delta T is 23.0068 degrees C at t plus 11336.3014 s with T_mid = 93.9499 C and T_out = 70.9432 C
At t plus 11336.3014 s, Smoothed SP8-SP9 is 15.2702 C and Smoothed SP8-Top is 14.5995 C, where Smoothed SP8 is 109.2202 C and Pool P = 28.0234 psia
Maximum Smoothed Lower-Outlet delta T is 23.1475 degrees C at t plus 11234.7956 s with T_low = 93.7436 C and T_out = 70.5961 C
At t plus 11234.7956 s, Smoothed SP8-SP9 is 14.9113 C and Smoothed SP8-Top is 14.1792 C, where Smoothed SP8 is 108.4789 C and Pool P = 27.8321 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 16.0051 degrees C at (KEY POINT #14) t plus 11156.0001 s with T_SP8 = 109.282 C and T_SP9 = 93.2768 C and Pool P = 27.6943 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 15.3167 degrees C at t plus 11156.0001 s with T_SP8 = 109.282 C and T_upper = 93.9653 C and Pool P = 27.6943 psia
Maximum Top-Mid delta T is 1.5038 degrees C at (KEY POINT #4) t plus 6632.7164 s ignoring SP 4, with temperatures of 73.1159 and 71.612 C, respectively, at Set # 2, where Pool P = 20.148 psia and T_outlet = 66.1422 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 7235.2268 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99935 C and a raw SP12 Reading of 74.899 C.
Maximum Top-Lower delta T is 11.7104 degrees C at t plus 9445.2662 s, with temperatures of 87.7114 and 76.001 C, respectively, at Set # 1, where Pool P = 24.7752 psia and T_outlet = 69.3374 C
Maximum Mid-Low delta T is 10.6345 degrees C at (KEY POINT #6) t plus 9368.7628 s ignoring SP 4, with temperatures of 86.3071 and 75.6726 C, respectively, at Set # 2, where Pool P = 24.6282 psia and T_outlet = 69.3547 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 9607.7795 s with a Smoothed Mid-Axis Mid-Low Delta T of 3.5446 C and a raw SP12 Reading of 87.4097 C.
Maximum Top-Outlet delta T is 24.0903 degrees C at t plus 11265.2973 s, with temperatures of 94.635 and 70.5447 C, respectively, at Set # 1, where Pool P = 27.8862 psia
Maximum Mid-Outlet delta T is 23.0215 degrees C at t plus 11323.7977 s ignoring SP 4, with temperatures of 93.8984 and 70.8768 C, respectively, at Set # 2, where Pool P = 27.9945 psia

Maximum Lower-Outlet delta T is 23.9096 degrees C at (KEY POINT #8) t plus 11293.5979 s, with temperatures of 94.6902 and 70.7806 C, respectively, at Set # 1, where Pool P = 27.9383 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 11859.1083 s with a Smoothed Mid-Axis Low-Outlet Delta T of 7.9685 C and a raw SP12 Reading of 95.9483 C.
Minimum SP Pressure is 15.1517 psia at t plus 0.39802 s
Maximum SP Pressure is 40.7132 psia at t plus 15915.0853 s
Beginning SP Pressure is 15.1583 psia
Ending SP Pressure is 40.7132 psia
Time-Average SP Pressure is 23.9081 +/- 7.2782 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.49 cm (cold) / 77.6269 cm (hot) at 14.6959 psia
Beginning Smoothed SP Level is 77.8778 cm (cold) / 78.059 cm (hot) at 15.1586 psia
Ending Smoothed SP Level is 79.1329 cm (cold) / 80.5747 cm (hot) at 40.7106 psia
Minimum Smoothed Cold SP Level is 77.7337 cm at t plus 2118.6352 s and 16.1046 psia
Minimum Smoothed Hot SP Level is 78.0136 cm at t plus 2118.6352 s and 16.1046 psia
Maximum Smoothed Cold SP Level is 79.1379 cm at t plus 15742.6794 s and 40.0887 psia
Maximum Smoothed Hot SP Level is 80.5749 cm at t plus 15909.6929 s and 40.6906 psia
SP 12 Temperature at the beginning is 39.8595 C, and at the end is 113.5954 C
At plume detection, the Mixing Number is 40.0775
The Mixing Number ranges from a minimum of 34.7871 at (KEY POINT #12) t plus 0 s to a maximum of 220.3551 at (KEY POINT #13) t plus 15866.6805 s; it had a mean value of 93.0894 +/- 51.2867 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 34.7871): 26.4827517 0.040894
0.00925 0.3937 0.778778348 0.780589535 0.609059596
0.609059596 0.999566626 24.9717928 86896.9888 0.0695312694
0.0584611863 0.0223482762 0.0124351353 0.0347834115 40.3999124
102.331989 102.331989 40.7913522 40.5759864 40.8351669
38.6385874 4.17853099 4.21964725 2.08693622 0.629142616
0.67868703 0.67868703 4.30326097 1.70965257 0.0379728482
992.068913 956.667518 0.64619178 1.06050663 0.000647922649
0.0002749801 1.23490499e-005 1.24628674e-005 1532.01364 1542.86789
473.439573 465.974067 1.10153816 1.04514773 1.08214773
0.0754332975 0.0770171539 1800.12978 1799.50619 169.301467
428.94234 2679.23747 259.640873 1371.18744 170.93711
170.035693 171.121783 161.947289
KEY POINT #2 (t plus 1776.5286 s with a Mixing Number of 40.0775): 26.9434015
0.040894 0.00925 0.3937 0.778670054 0.781309486
0.619600034 0.619600034 0.999566804 24.7562002 88102.3008
0.0681309808 0.0582060829 0.0228819152 0.0125065306 0.0353884458
48.8839859 103.646358 103.646358 50.8940905 49.0328377
49.1076931 46.584048 4.17930397 4.22139158 2.09245199
0.639278148 0.679181593 0.679181593 3.64240454 1.68622227

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       0.0381840531      988.549362      955.706023     0.674633723      1.08834964
       0.000557152493  0.000271297061 1.23940268e-005 1.25061826e-005      1544.07656
       1541.54286      474.098692      466.792707      1.15345585      1.09760116
       1.13460116     0.116832758     0.129098105      1827.22151      1826.60865
       204.759125      434.493519      2681.28992      229.734393       1392.728
       213.16037      205.379754      205.695627      195.152927
KEY POINT #3 (t plus 2412.944 s with a Mixing Number of 42.2955):  26.8372733
       0.040894         0.00925          0.3937     0.777631587     0.780578502
       0.62656261      0.62656261     0.999570963      24.4533188      87624.0133
       0.0676248291     0.058089461    0.0229767688    0.0122722844    0.0352490532
       51.8944337      104.245895      104.245895      55.4118696      52.1123465
       52.0415152      49.2560554      4.17996501      4.22219984      2.09501524
       0.642594095     0.679400198     0.679400198      3.44662761      1.67574478
       0.0382818273      987.182882      955.264874     0.687941363      1.09749002
       0.000529856721  0.000269646482 1.24145546e-005 1.25249166e-005       1547.3728
       1540.92161      474.397404      467.229816      1.17779977      1.12239987
       1.15939987     0.135602507     0.160750778      1844.38051      1843.78255
       217.343777      437.026446      2682.22283      219.682669      1407.35407
       232.048259      218.253193      217.960119      206.321717
KEY POINT #4 (t plus 6632.7164 s with a Mixing Number of 64.9032):  27.4071564
       0.040894         0.00925          0.3937     0.777912327      0.78357501
       0.638681217     0.638681217     0.999505536      21.0631899       87991.576
       0.064121093    0.0569272199    0.0236968303    0.0123007281    0.0359975584
       72.0115794       110.17634       110.17634      84.3882082      72.7905912
       70.2594315      66.1290259      4.18933005      4.23062624      2.12203637
       0.661226027     0.681329186     0.681329186      2.49013068      1.57874103
       0.0392993476       976.63859      950.815142     0.831455047      1.30118735
       0.000393031629  0.000254251329 1.26179706e-005 1.27374495e-005      1557.87978
       1534.22104      477.285292      469.780404      1.44227267      1.38935771
       1.42635771     0.340169241     0.564932779      1886.31809      1885.87443
       301.534885      462.109976      2691.33548      160.575091      1424.20812
       353.443313      304.797251      294.197055      276.907189
KEY POINT #5 (t plus 7235.2268 s with a Mixing Number of 70.2271):  27.5752125
       0.040894         0.00925          0.3937     0.777615173     0.783720388
       0.635955664     0.635955664     0.999481136      20.3666961      88230.3714
       0.0635446115    0.0567031278    0.0237596986    0.0124585907    0.0362182894
       75.2123747      111.310746      111.310746      87.5969215      75.9157907
       72.178864      67.9803421      4.19159994      4.23232873      2.12756373
       0.663652178     0.681650332     0.681650332      2.3793299      1.56147418
       0.0395048029      974.751586       949.94631     0.861490556      1.35393646
       0.000376717122  0.000251487883 1.26569473e-005 1.27808681e-005      1557.89812
       1532.82697      477.823578      470.091948      1.49803665      1.44592208
       1.48292208     0.389395866     0.640159224      1883.05515      1882.64035
       314.95223      466.914233      2693.05388      151.962004      1416.14092
       366.927133      317.899487      302.241767      284.661829
KEY POINT #6 (t plus 9368.7628 s with a Mixing Number of 94.9988):  27.9124289
       0.040894         0.00925          0.3937     0.777456253     0.785345737
       0.632885231     0.632885231     0.999390374      17.7627248      88094.4702
       0.0614693817    0.0557708888    0.0240701947     0.012591007    0.0366612017
       86.510761       115.99986       115.99986      100.585062      87.0197293
       78.0469384      69.3844276      4.20130561      4.23968316      2.15170112
       0.671103429     0.682817116     0.682817116      2.0499088      1.49408804
       0.0403929968      967.671104      946.295404     0.995125465      1.57140468
       0.000327446026  0.000240628568 1.28182438e-005 1.29571228e-005      1554.81214
       1526.6943      479.999072      471.567851      1.74767006      1.69817822
       1.73517822     0.613810958       1.0355381      1887.85848      1887.54296
       362.382909      486.795085      2700.06822      124.412176      1401.06339
       421.620424      364.520042      326.85829      290.561618
KEY POINT #7 (t plus 9607.7795 s with a Mixing Number of 97.6445):  27.7532201
       0.040894         0.00925          0.3937     0.777494646     0.785585314
       0.635277543     0.635277543     0.999387068      17.4590139      87474.1852
       0.061287831    0.0556698888    0.0240199669    0.0124321242    0.0364520911
       87.4834569      116.505036      116.505036      102.474516      87.9529185
       83.5912579      69.4794092      4.20226417      4.24050642      2.15442873
       0.671665942     0.682927492     0.682927492      2.02539011      1.48719245
       0.0404925334      967.032098      945.896384      1.01047005      1.58962128
       0.000323726805  0.000239510217 1.28356366e-005 1.29745728e-005      1554.33062
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     1525.99864      480.228617      471.817012      1.77648309      1.72713635
     1.76413635     0.637363351      1.10707286      1894.39911      1894.09429
     366.472227       488.93913      2700.81515      122.466903      1405.45998
     429.593152      368.443817      350.124978      290.961731
KEY POINT #8 (t plus 11293.5979 s with a Mixing Number of 117.1848):  27.6653481
     0.040894         0.00925          0.3937     0.779783255     0.789110918
     0.635875829     0.635875829     0.999323241       15.780444      86376.1375
     0.0601155694    0.0550071191    0.0240715373    0.0122651395    0.0363366768
     93.7071374      119.806636      119.806636      108.611433      94.4817792
     93.7166695      70.7545309      4.20886611      4.24603848      2.17288375
     0.674975991     0.683576171     0.683576171     1.88053383      1.44375699
     0.0411621693     962.836169      943.261451      1.11553513       1.7531413
     0.000301581269  0.000232432626 1.29493711e-005 1.30979085e-005      1550.49016
     1521.28832      481.705273      472.882388      1.97451877      1.92616152
     1.96316152      0.80661515      1.36815793       1903.8494      1903.60037
     392.661273      502.962651      2705.65327      110.301378      1400.88674
     455.52933       395.92068       392.70277      296.318174
KEY POINT #9 (t plus 11365.199 s with a Mixing Number of 118.434):  27.4182218
     0.040894         0.00925          0.3937     0.780102124     0.789486854
     0.642920035     0.642920035      0.99934058      15.7422282      85597.0077
     0.0600484451    0.0549768866    0.0240875912    0.0119245009    0.0360120921
     94.0606042      119.956693      119.956693      108.939324      94.7481172
     94.1833218      71.1110333      4.20926613      4.24629623      2.17374877
     0.67514899     0.683602671     0.683602671      1.87288862      1.44184804
     0.0411934044     962.592246      943.14058       1.12051202      1.74169892
     0.000300403639  0.000232120209 1.29545427e-005 1.30990649e-005      1550.23313
     1521.06755      481.771409      473.189661      1.98393081      1.93558648
     1.97258648     0.817252017      1.38342153      1919.73236      1919.48454
     394.149759      503.600478      2705.87134      109.450719      1416.13188
     456.916481      397.042658      394.667695      297.812144
KEY POINT #10 (t plus 11859.1083 s with a Mixing Number of 125.579):  28.037825
     0.040894         0.00925          0.3937     0.782297829     0.792197956
     0.633299975     0.633299975     0.999290598      15.3805249      87231.3345
     0.059686006    0.0547683443    0.0241895515    0.0126363499    0.0368259015
     95.9638834      120.990497      120.990497      110.651357      96.7582503
     96.4640592      87.6915344      4.21146255      4.24808706      2.17977113
     0.676054156      0.68377823      0.68377823      1.83271396      1.42884518
     0.041410521      961.269427      942.305216      1.15528952      1.82294331
     0.000294200382  0.000229988984  1.2990177e-005 1.31441164e-005      1548.78294
     1519.53099      482.224714      473.145476      2.04977511       2.0015063
     2.0385063     0.876552136      1.46541167      1901.0956      1900.85904
     402.168272      507.995858      2707.36935      105.827587      1393.09974
     464.163049      405.512803      404.276258      367.372923
KEY POINT #11 (t plus 15915.0853 s with a Mixing Number of 220.2694):  28.616288
     0.040894         0.00925          0.3937     0.791329086     0.805746971
     0.659350564     0.659350564     0.999128604       11.986706      86456.9869
     0.0562174046    0.0525539395    0.0253003969    0.0122852791     0.037585676
     113.759887      131.835814      131.835814       124.97161      115.032522
     114.711983      111.916605      4.23581647      4.26852567      2.24976412
     0.682364599      0.68489137      0.68489137      1.52543991      1.30676383
     0.043899995      948.106165      933.266415      1.57546381      2.38733543
     0.00024573921  0.000209672225 1.33643912e-005  1.3535453e-005      1529.95666
     1501.81286      486.729965       477.23643       2.8543268      2.80689515
     2.84389515      1.62448293      2.32021395      1984.09129      1983.94761
     477.381116      554.230888      2722.60201      76.8497716       1429.8604
     524.976982      482.771826      481.416019      469.580552
KEY POINT #12 (t plus 0 s with a Mixing Number of 34.7871):  26.4827517         0.040894
     0.00925          0.3937     0.778778348     0.780589535     0.609059596
     0.609059596     0.999566626      24.9717928      86896.9888    0.0695312694
     0.0584611863    0.0223482762    0.0124351353    0.0347834115      40.3999124
     102.331989      102.331989      40.7913522      40.5759864      40.8351669
     38.6385874      4.17853099      4.21964725      2.08693622     0.629142616
     0.67868703      0.67868703      4.30326097      1.70965257    0.0379728482
     992.068913      956.667518      0.64619178      1.06050663  0.000647922649
     0.0002749801 1.23490499e-005 1.24628674e-005      1532.01364      1542.86789
     473.439573      465.974067      1.10153816      1.04514773      1.08214773
     0.0754332975    0.0770171539      1800.12978      1799.50619      169.301467
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        428.94234      2679.23747      259.640873      1371.18744       170.93711
        170.035693      171.121783      161.947289
KEY POINT #13 (t plus 15866.6805 s with a Mixing Number of 220.3551):  28.7336427
        0.040894         0.00925          0.3937     0.791351451     0.805683184
        0.657412587     0.657412587     0.999124669      12.0483431      86836.8985
        0.0562319699    0.0525834885     0.025341838    0.0123979759    0.0377398139
        113.686636      131.692619      131.692619      125.446765      114.772686
        114.47919       111.72551      4.23570356      4.2682354       2.2487571
        0.682345934     0.684885234     0.684885234      1.52649108      1.30821947
        0.0438645049      948.162834      933.389021      1.56921226      2.38486258
        0.000245908375  0.000209918178 1.33594472e-005 1.35315011e-005      1530.05074
        1502.06533      486.673507      477.118592      2.84224886      2.79474413
        2.83174413      1.62057809      2.35434451      1979.55256      1979.4074
        477.06997      553.618864      2722.40688      76.5488948      1425.9337
        526.998185      481.669864      480.428774      468.770812
KEY POINT #14 (t plus 11156.0001 s with a Mixing Number of 115.6884):  27.5105095
        0.040894         0.00925          0.3937     0.779311724     0.788527461
        0.639358884     0.639358884     0.999338829      15.9047866      85973.7114
        0.060197204    0.0550614585    0.0240423803    0.0120909258    0.0361333061
        93.2768468      119.536808      119.536808      109.281956      93.9652996
        93.0248698      70.3410475      4.20838397      4.24557641      2.17133409
        0.674762954     0.683527869     0.683527869      1.88992103      1.44720354
        0.0411061805      963.132062      943.478556      1.10663073         1.7297
        0.000303025748  0.000232996385 1.29400722e-005 1.30855671e-005      1550.79651
        1521.68384      481.586135      472.928026      1.95768606      1.90929413
        1.94629413     0.793822043      1.39952075      1910.86087      1910.6079
        390.84905       501.81583      2705.26073      110.96678      1409.04504
        458.363524      393.745291      389.79005      294.585033
End
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D.22 TEST #22 - T22_RCIC_5PSIG_57KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T22_RCIC_5PSIG_57kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1765.272 s, and ending (KEY POINT #11) at t
        plus 18019.0696 s, for a time period of 16253.7976 s.
Original Data Record Time:  20227.2079 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
        3089.9657 s, T_bulk = 55.3946 C and T_out = 53.443 C
Stratification Beginning SP12 Temperature = 55.0453 C
Stratification Beginning Pressure = 21.9324 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
        13171.8404 s, T_bulk = 103.3419 C and T_out = 74.1528 C
Stratification Ending SP12 Temperature = 103.2469 C
Stratification Ending Pressure = 39.1479 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 3062.4552 s.
At t = 3062.4552 s, the pool pressure is 21.9116 psia while the Smoothed Upper, Mid, SP8,
        Lower, and Outlet Temperatures are 55.6055, 55.3391, 57.3462, 55.7947, and
        53.0737 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
        temperatures were 11.7856 +/- 4.2743 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
        temperatures were 11.1821 +/- 4.1572 C.
Minimum Steam Quality:  0.98863 at t plus 16097.0927 s
Maximum Steam Quality:  1.0091 at t plus 3508.3577 s
Time-Averaged Steam Quality:  1.0007 +/- 0.0037667
Minimum Turbine Outlet Steam Quality:  0.9904 at t plus 16097.0927 s
Maximum Turbine Outlet Steam Quality:  1.0154 at t plus 1602.0286 s
Time-Averaged Turbine Outlet Steam Quality:  1.0045 +/- 0.0050629
Smoothed Changerates may not fully include test beginning and end periods, analysis
        ending at t plus 16163.7965 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.4574 degrees/min at t plus 7092.8267 s
        and 0.16889 degrees/min at t plus 10312.8888 s, respectively
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Max and min smoothed mid (SP9) level changerates: 0.40467 degrees/min at t plus 8256.4482 s and 0.2058 degrees/min at t plus 10363.2367 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.19153 degrees/min at t plus 7090.4266 s and -0.11469 degrees/min at t plus 6859.2223 s, respectively
Max and min smoothed lower level changerates: 1.8499 degrees/min at t plus 10345.5887 s and -0.021777 degrees/min at t plus 9934.6002 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.35861 degrees/min at t plus 9676.3754 s and -1.6425 degrees/min at t plus 10345.5887 s, respectively
Max and min smoothed outlet level changerates: 2.0683 degrees/min at t plus 13892.6576 s and -0.040146 degrees/min at t plus 8599.7548 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.8526 degrees/min at t plus 10345.5887 s and -1.7796 degrees/min at t plus 13922.5533 s, respectively
Max and min smoothed hot (SP8) level changerates: 0.70033 degrees/min at t plus 9287.0652 s and -0.29324 degrees/min at t plus 10671.0953 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.47559 degrees/min at t plus 5101.5888 s and -0.50703 degrees/min at t plus 10671.0953 s, respectively
The mean steam flow rate was 23.7392 +/- 0.56134 g/s
The mean feedwater flow rate was 23.4865 +/- 0.8817 g/s
The mean water injection to steam flow rate was 0.017675 +/- 0.029716 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.8119 +/- 4.2502 C over the Stratification Period, beginning at 2.2106 C and ending at 15.0497 C
Mean Smoothed SP8-Upper Pool delta T is 11.2075 +/- 4.1344 C over the Stratification Period, beginning at 2.0026 C and ending at 14.2081 C
The stratification period begins and ends with Smoothed SP8 readings of 57.686 and 118.4363 C, respectively
The stratification period begins and ends with condensing flows of 0.21873 and 0.45742 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 6.2292 and 0.84267 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2720.0668 +/- 1.0376 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.21792 and 6.852 kg/s, respectively
The plume period had a mean steam enthalpy of 2720.1395 +/- 1.0015 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.0545 degrees C at t plus 8131.5431 s with T_upper = 80.9894 C and T_mid = 79.9349 C
At t plus 8131.5431 s, Smoothed SP8-SP9 is 12.8938 C and Smoothed SP8-Top is 11.8393 C, where Smoothed SP8 is 92.8286 C and Pool P = 28.0467 psia
Maximum Smoothed Top-Lower delta T is 12.9009 degrees C at t plus 10102.8818 s with T_upper = 92.0631 C and T_low = 79.1622 C
At t plus 10102.8818 s, Smoothed SP8-SP9 is 16.2686 C and Smoothed SP8-Top is 15.4549 C, where Smoothed SP8 is 107.518 C and Pool P = 32.3078 psia
Maximum Smoothed Mid-Lower delta T is 12.0973 degrees C at t plus 10063.6826 s with T_mid = 91.1066 C and T_low = 79.0092 C
At t plus 10063.6826 s, Smoothed SP8-SP9 is 15.5925 C and Smoothed SP8-Top is 15.0003 C, where Smoothed SP8 is 106.6991 C and Pool P = 32.2268 psia
Maximum Smoothed Top-Outlet delta T is 30.2653 degrees C at t plus 12949.5336 s with T_upper = 103.2358 C and T_out = 72.9705 C
At t plus 12949.5336 s, Smoothed SP8-SP9 is 15.2852 C and Smoothed SP8-Top is 14.4968 C, where Smoothed SP8 is 117.7326 C and Pool P = 38.565 psia
Maximum Smoothed Mid-Outlet delta T is 29.5206 degrees C at t plus 12997.1364 s with T_mid = 102.6842 C and T_out = 73.1637 C
At t plus 12997.1364 s, Smoothed SP8-SP9 is 15.1479 C and Smoothed SP8-Top is 14.4663 C, where Smoothed SP8 is 117.8321 C and Pool P = 38.6917 psia
Maximum Smoothed Lower-Outlet delta T is 29.8239 degrees C at t plus 12898.1377 s with T_low = 102.6611 C and T_out = 72.8372 C
At t plus 12898.1377 s, Smoothed SP8-SP9 is 15.0114 C and Smoothed SP8-Top is 14.3193 C, where Smoothed SP8 is 117.3048 C and Pool P = 38.43 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 18.1021 degrees C at (KEY POINT #14) t plus 10550.2944 s with T_SP8 = 111.0549 C and T_SP9 = 92.9529 C and Pool P = 33.2167 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 17.5044 degrees C at t plus 10550.2944 s with T_SP8 = 111.0549 C and T_upper = 93.5506 C and Pool P = 33.2167 psia
Maximum Top-Mid delta T is 1.6915 degrees C at (KEY POINT #4) t plus 6732.6231 s ignoring SP 4, with temperatures of 74.0878 and 72.3963 C, respectively, at Set # 2, where Pool P = 25.7782 psia and T_outlet = 66.8951 C

Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 8868.2572 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.9994 C and a raw SP12 Reading of 83.9331 C.
Maximum Top-Lower delta T is 14.4675 degrees C at t plus 10301.3862 s, with temperatures of 92.6994 and 78.2319 C, respectively, at Set # 1, where Pool P = 32.7151 psia and T_outlet = 71.6388 C
Maximum Mid-Low delta T is 13.2481 degrees C at (KEY POINT #6) t plus 10258.7397 s ignoring SP 4, with temperatures of 91.7788 and 78.5307 C, respectively, at Set # 2, where Pool P = 32.6305 psia and T_outlet = 71.6201 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 10458.3922 s with a Smoothed Mid-Axis Mid-Low Delta T of 4.4123 C and a raw SP12 Reading of 92.4085 C.
Maximum Top-Outlet delta T is 30.6625 degrees C at t plus 12924.6352 s, with temperatures of 103.3544 and 72.6918 C, respectively, at Set # 1, where Pool P = 38.4974 psia
Maximum Mid-Outlet delta T is 29.5836 degrees C at t plus 12924.7342 s ignoring SP 4, with temperatures of 102.2785 and 72.6949 C, respectively, at Set # 2, where Pool P = 38.4975 psia
Maximum Lower-Outlet delta T is 30.6689 degrees C at (KEY POINT #8) t plus 12910.5334 s, with temperatures of 103.5366 and 72.8677 C, respectively, at Set # 1, where Pool P = 38.4705 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 14089.9559 s with a Smoothed Mid-Axis Low-Outlet Delta T of 10.2204 C and a raw SP12 Reading of 107.0718 C.
Minimum SP Pressure is 20.1853 psia at t plus 0.30001 s
Maximum SP Pressure is 49.2923 psia at t plus 16253.0976 s
Beginning SP Pressure is 20.1914 psia
Ending SP Pressure is 49.2886 psia
Time-Average SP Pressure is 30.2835 +/- 8.4019 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.3645 cm (cold) / 77.5128 cm (hot) at 19.7982 psia
Beginning Smoothed SP Level is 77.3546 cm (cold) / 77.5321 cm (hot) at 20.1957 psia
Ending Smoothed SP Level is 77.8339 cm (cold) / 79.2667 cm (hot) at 49.2959 psia
Minimum Smoothed Cold SP Level is 77.2367 cm at t plus 5942.5379 s and 24.7324 psia
Minimum Smoothed Hot SP Level is 77.5311 cm at t plus 1.1981 s and 20.196 psia
Maximum Smoothed Cold SP Level is 78.6466 cm at t plus 13729.0512 s and 40.6809 psia
Maximum Smoothed Hot SP Level is 79.887 cm at t plus 14137.4596 s and 41.8904 psia
SP 12 Temperature at the beginning is 40.0468 C, and at the end is 116.5126 C
At plume detection, the Mixing Number is 44.594
The Mixing Number ranges from a minimum of 35.5649 at (KEY POINT #12) t plus 0 s to a maximum of 206.2654 at (KEY POINT #13) t plus 16253.7976 s; it had a mean value of 90.5371 +/- 48.283 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 35.5649): 15.5362169 0.040894 0.00925 0.3937 0.773545542 0.775321363 1.00673936 1 1 19.1096756 49296.4793 0.0695306602 0.0569384095 0.0204058336 8.80188471e-006 0.0204058336 40.403655 117.254516 110.11962 40.7724006 40.5654084 40.7402484 38.2946725

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      4.17844559      4.23054189      2.12176312     0.629165348     0.681312728
      0.681312728     4.30272383      1.5796147    0.0392891688      992.082199
      950.858435       0.8299759     0.813353331  0.000647878423  0.000254390958
      1.26160223e-005 1.2888102e-005    1532.07613      1534.28981      477.258257
      482.282767      1.43952996      1.39244581      1.42944581    0.0754483068
      0.0769398152     2706.63913      2706.27395      169.347854      461.869821
      2691.24935      292.521967      2244.76931      170.888637      170.022227
      170.755882      160.541145
KEY POINT #2 (t plus 3062.4552 s with a Mixing Number of 44.594):  17.6611485
      0.040894         0.00925          0.3937     0.773118119     0.776409939
      1.01082763             1               1      20.3620499      54966.5105
      0.0670397749    0.0564491676    0.0231967963 2.30876977e-005    0.0231967963
      55.3391484      124.009982      112.592921      57.3462098      55.6054959
      55.7946696      53.0737003      4.18088158      4.23428868      2.13395531
      0.646232504     0.681995004     0.681995004      3.24282184      1.54242295
      0.0397413709      985.56333      948.957527     0.896491504     0.868219394
      0.000501238037  0.000248430097 1.27010235e-005 1.31395463e-005       1550.6137
      1531.2089      478.426406      486.383132      1.56318451      1.51059265
      1.54759265     0.160193116     0.176205327      2719.46673      2719.05212
      231.77722       472.34678      2694.98619       240.56956      2247.11995
      240.169193      232.889354      233.683263      222.311847
KEY POINT #3 (t plus 3089.9657 s with a Mixing Number of 44.731):  17.6993602
      0.040894         0.00925          0.3937     0.773122234     0.776436812
      1.01051895             1               1      20.3666005      55135.3135
      0.0670165095     0.056444374    0.0232469849 1.65191312e-005    0.0232469849
      55.4753755      123.704287      112.617087      57.6859916      55.6834218
      55.9112573        53.22141      4.18092627      4.23432599      2.13407726
      0.646371899     0.682001314     0.682001314      3.23517605      1.54206851
      0.0397458746       985.49714      948.938822     0.897162103     0.869656045
      0.000500158757  0.000248373119 1.27018544e-005 1.31276597e-005      1550.72694
      1531.17798      478.437711       486.17181       1.5644344      1.51203613
      1.54903613     0.161239127     0.179046874      2718.81644      2718.40164
      232.346895      472.449199      2695.02251      240.102305      2246.36724
      241.590163      233.215284      234.170844      222.929426
KEY POINT #4 (t plus 6732.6231 s with a Mixing Number of 62.667):  18.0632776
      0.040894         0.00925          0.3937     0.772841749      0.77849456
      1.00792273             1               1      17.8264043       56032.101
      0.0640150299    0.0554931262    0.0237249673 1.80473687e-005    0.0237249673
      72.6026116      125.577408      117.387846      84.2000122      73.1515219
      72.951167      66.9041623      4.18965035      4.24195978      2.15925609
      0.661704639     0.683113271     0.683113271      2.46893949      1.47530422
      0.0406683211      976.310811      945.196436      1.03774437      1.01405858
      0.000389939154  0.000237578841 1.28660375e-005 1.31831515e-005      1557.98272
      1524.76688       480.62747      486.424488      1.82776788      1.77793401
      1.81493401     0.348840784     0.560760955      2719.93873      2719.62095
      304.042587      492.686976      2702.11623      188.644388      2227.25175
      352.683596      306.341056      305.504415      280.183868
KEY POINT #5 (t plus 8868.2572 s with a Mixing Number of 83.1324):  18.2265247
      0.040894         0.00925          0.3937     0.779113634     0.786778312
      1.00567192             1               1      15.8171761       56330.683
      0.0618522359    0.0546686425    0.0239393821 1.89491579e-005    0.0239393821
      84.4515185      127.241835      121.483962      98.3758947      85.1441977
      78.0630957      71.2041901       4.1992538      4.24895123      2.18268469
      0.669892993      0.68385772      0.68385772      2.10359929      1.42272896
      0.0415153503      969.026433      941.904855      1.17219432      1.15323694
      0.000335580198  0.000228984549 1.30071892e-005 1.32317853e-005      1555.79739
      1518.78797       482.43965      486.580137      2.08182749      2.03482506
      2.07182506      0.56634203     0.956793281      2720.79868      2720.54849
      353.759913      510.094597      2708.08169      156.334684      2210.70408
      412.332369      356.667542      326.952984      298.210432
KEY POINT #6 (t plus 10258.7397 s with a Mixing Number of 101.5478):  18.4068117
      0.040894         0.00925          0.3937      0.78491513     0.794050909
      1.00333299             1               1      14.4770728      56825.7555
      0.060451645    0.0540311824    0.0241761776 2.00072339e-005    0.0241761776
      91.9327585      127.956862      124.627208      108.807427      92.5452571
      81.2441369      71.6275595      4.20681493      4.25459962      2.20184076
      0.674103782     0.684299018     0.684299018      1.91978327      1.38509416
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       0.0422015034     964.068608      939.33019      1.28462056      1.27249789
       0.000307627785  0.000222775034 1.31155931e-005 1.32462499e-005      1551.79183
       1513.91147      483.786726      486.222718      2.29572811      2.24991264
       2.28691264     0.754942464      1.37726484      2720.08301      2719.87342
       385.219824      523.47377      2712.57717      138.253945      2196.60924
       456.381701      387.795394      340.314499      300.001342
KEY POINT #7 (t plus 10458.3922 s with a Mixing Number of 103.1962):  18.4547648
       0.040894        0.00925          0.3937     0.785215657     0.794520335
       1.00390168              1              1      14.3720279      56820.3784
       0.0603225561    0.0539519417    0.0242391609 1.40079163e-005    0.0242391609
       92.6152321      128.912195      125.016529      108.557704      93.1373029
       87.7114832      71.6298906      4.2075616      4.25531675       2.204286
       0.67445236     0.684345887     0.684345887      1.9044923      1.38058727
       0.0422887386      963.60331      939.008354      1.29913031      1.28481729
       0.00030528117  0.000222027941 1.31290242e-005 1.32820156e-005      1551.33362
       1513.29035      483.950908      486.796373      2.32342317      2.27763689
       2.31463689      0.774480885      1.36567007      2721.87227      2721.66572
       388.09325      525.132225      2713.12886      137.038975      2196.74005
       455.327848      390.288744      367.474757      300.013364
KEY POINT #8 (t plus 12910.5334 s with a Mixing Number of 135.8328):  18.3937277
       0.040894        0.00925          0.3937      0.78587739     0.797201171
       1.00065312              1              1      12.3393039        56454.32
       0.0584675691    0.0529457052    0.0241589926 1.11574052e-005    0.0241589926
       102.299051      130.56458      129.934062      117.343098      103.048675
       102.670969      72.8630667      4.21923713      4.26471654      2.2365733
       0.678764507     0.684791367     0.684791367      1.71014295      1.32641496
       0.0434345384      956.76531      934.887615      1.49405187      1.49135014
       0.000275117113  0.000212984264 1.32987356e-005 1.33239246e-005      1543.22748
       1505.12618      485.973478      486.448438      2.69727054      2.65207695
       2.68907695      1.10026235      1.8251395      2721.56908      2721.41683
       428.921742      546.106264      2719.99702      117.184521      2175.46282
       492.558259      432.083691      430.492383      305.209873
KEY POINT #9 (t plus 13171.8404 s with a Mixing Number of 140.4129):  18.378512
       0.040894        0.00925          0.3937     0.786234044     0.797803544
       0.999808366     0.999808366     0.999999689      12.1099615      56429.6636
       0.0582565672    0.0528269771    0.0241390076 1.66145248e-005    0.0241390076
       103.386567      130.511149      130.511149      118.436298      104.22818
       103.292591      74.0833013      4.22067478      4.26586198      2.24053423
       0.67917628      0.68482595      0.68482595      1.69070022      1.32037827
       0.0435744419      955.970619      934.397286      1.51838988      1.51868044
       0.000272061588   0.00021196872 1.33186578e-005 1.33187196e-005      1542.13808
       1504.12984      486.204559      486.201029      2.74416924      2.69904811
       2.73604811      1.14303696      1.89024234      2720.52096      2720.3743
       433.514501      548.570878      2720.79058      115.056376      2171.95008
       497.199572      437.065892      433.119204      310.326525
KEY POINT #10 (t plus 14089.9559 s with a Mixing Number of 156.9678):  18.3808507
       0.040894        0.00925          0.3937     0.786346974     0.798851486
       0.998193548     0.998193548     0.999996873      11.398155      56123.3808
       0.0575094243    0.0523857964    0.0241420794 2.51625127e-005    0.0241420794
       107.215564      132.649887      132.649887      121.168013      107.815474
       107.358053      96.7357501      4.22594317      4.27018667      2.25553189
       0.68051207      0.68492195      0.68492195      1.62561317      1.29856138
       0.0441031388      953.13066      932.567739      1.61138597      1.61429708
       0.000261775736  0.000208284382 1.33924987e-005 1.33931081e-005      1538.02886
       1500.36836      487.049369      487.015017      2.92378344      2.87878023
       2.91578023      1.30472146      2.06125872      2719.9253      2719.79538
       449.698693      557.711108      2723.70815      108.012414      2162.21419
       508.810584      452.23289      450.30218      405.490639
KEY POINT #11 (t plus 16253.7976 s with a Mixing Number of 206.2654):  18.9328689
       0.040894        0.00925          0.3937     0.778339103      0.79266675
       0.995718401     0.995718401     0.999991291      10.0417966      56975.9509
       0.0556325613    0.0512135006    0.0248671203 1.92110075e-005    0.0248671203
       116.691601      138.290861      138.290861      128.603318      117.591941
       117.095469      112.761731      4.2404128      4.2822131      2.29750815
       0.683066177     0.684934065     0.684934065      1.48458437      1.24497819
       0.0455765122      945.824058      927.649044      1.87880066      1.88686309
       0.000239144021  0.000199132541 1.35872884e-005 1.35889042e-005      1526.09707
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       1489.93466      489.189216      489.100957      3.44358836      3.39883349
       3.43583349      1.78722174      2.59159975      2722.11948      2722.01865
       489.84828      581.866956      2731.22132      92.0186762      2140.25253
       540.483006      493.665548      491.562255      473.201117
KEY POINT #12 (t plus 0 s with a Mixing Number of 35.5649):  15.5362169        0.040894
       0.00925          0.3937     0.773545542     0.775321363      1.00673936
       1               1      19.1096756      49296.4793    0.0695306602    0.0569384095
       0.0204058336 8.80188471e-006    0.0204058336       40.403655      117.254516
       110.11962      40.7724006      40.5654084      40.7402484      38.2946725
       4.17844559      4.23054189      2.12176312      0.629165348     0.681312728
       0.681312728      4.30272383       1.5796147    0.0392891688      992.082199
       950.858435      0.8299759     0.813353331  0.000647878423  0.000254390958
       1.26160223e-005  1.2888102e-005      1532.07613      1534.28981      477.258257
       482.282767      1.43952996      1.39244581      1.42944581    0.0754483068
       0.0769398152      2706.63913      2706.27395      169.347854      461.869821
       2691.24935      292.521967      2244.76931      170.888637      170.022227
       170.755882      160.541145
KEY POINT #13 (t plus 16253.7976 s with a Mixing Number of 206.2654):  18.9328689
       0.040894         0.00925          0.3937     0.778339103      0.79266675
       0.995718401     0.995718401     0.999991291      10.0417966      56975.9509
       0.0556325613    0.0512135006    0.0248671203 1.92110075e-005    0.0248671203
       116.691601      138.290861      138.290861      128.603318      117.591941
       117.095469      112.761731       4.2404128       4.2822131      2.29750815
       0.683066177     0.684934065     0.684934065      1.48458437      1.24497819
       0.0455765122      945.824058      927.649044      1.87880066      1.88686309
       0.000239144021  0.000199132541 1.35872884e-005 1.35889042e-005      1526.09707
       1489.93466      489.189216      489.100957      3.44358836      3.39883349
       3.43583349      1.78722174      2.59159975      2722.11948      2722.01865
       489.84828      581.866956      2731.22132      92.0186762      2140.25253
       540.483006      493.665548      491.562255      473.201117
KEY POINT #14 (t plus 10550.2944 s with a Mixing Number of 104.2972):  18.4105783
       0.040894         0.00925          0.3937     0.785292561     0.794692623
       1.00328923              1               1      14.2435787      56762.1132
       0.0602586153    0.0539165035    0.0241811247  1.8178264e-005    0.0241811247
       92.9528502      128.468738      125.190543      111.054946      93.5505635
       89.4839913      71.6738573      4.20793489      4.25563855      2.20538417
       0.674622537     0.684366282     0.684366282      1.89701226      1.37858354
       0.0423278922      963.372255      938.864295      1.30565825      1.29352453
       0.000304131898  0.000221695542 1.31350277e-005 1.32638153e-005      1551.10106
       1513.01152      484.024101      486.426387      2.33588959      2.29015998
       2.32715998     0.784300971      1.48531018      2720.77315      2720.57027
       389.514823      525.873595      2713.37507      136.358772      2194.89955
       465.891762      392.028861       374.92606      300.198555
End
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D.23 TEST #23 -

T23_RCIC_020GPM_5PSIG_57KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T23_RCIC_020GPM_5PSIG_57kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2193.2825 s, and ending (KEY POINT #11) at t
       plus 18315.3556 s, for a time period of 16122.0731 s.
Original Data Record Time:  20155.7398 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2371.0316 s, T_bulk = 51.6511 C and T_out = 49.4885 C
Stratification Beginning SP12 Temperature = 51.4379 C
Stratification Beginning Pressure = 21.5501 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       13104.5215 s, T_bulk = 102.7497 C and T_out = 70.8931 C
Stratification Ending SP12 Temperature = 102.6447 C
Stratification Ending Pressure = 38.8963 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1871.525 s.
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At t = 1871.525 s, the pool pressure is 21.2267 psia while the Smoothed Upper, Mid, SP8, Lower, and Outlet Temperatures are 49.7758, 49.5888, 51.59, 49.8948, and 47.4724 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9 temperatures were 12.087 +/- 4.246 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 11.4914 +/- 4.1702 C.
Minimum Steam Quality: 0.54962 at t plus 1669.0205 s
Maximum Steam Quality: 0.6619 at t plus 15438.4621 s
Time-Averaged Steam Quality: 0.60989 +/- 0.014907
Minimum Turbine Outlet Steam Quality: 0.56166 at t plus 1669.2245 s
Maximum Turbine Outlet Steam Quality: 0.66577 at t plus 15438.4621 s
Time-Averaged Turbine Outlet Steam Quality: 0.61822 +/- 0.013391
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 16032.073 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.43635 degrees/min at t plus 6218.6017 s and 0.1574 degrees/min at t plus 12511.9107 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.41786 degrees/min at t plus 7380.2201 s and 0.21319 degrees/min at t plus 10301.5732 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.1456 degrees/min at t plus 6106.5993 s and -0.13983 degrees/min at t plus 5732.4919 s, respectively
Max and min smoothed lower level changerates: 1.8459 degrees/min at t plus 10064.7767 s and -0.048452 degrees/min at t plus 6238.9168 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.35597 degrees/min at t plus 6218.6017 s and -1.6097 degrees/min at t plus 10123.071 s, respectively
Max and min smoothed outlet level changerates: 2.5215 degrees/min at t plus 13883.235 s and -0.041776 degrees/min at t plus 7842.2296 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.844 degrees/min at t plus 10122.983 s and -2.3407 degrees/min at t plus 13883.3361 s, respectively
Max and min smoothed hot (SP8) level changerates: 0.83671 degrees/min at t plus 3905.9584 s and -0.16118 degrees/min at t plus 11941.3181 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.56439 degrees/min at t plus 3905.9584 s and -0.39221 degrees/min at t plus 11941.3181 s, respectively
The mean steam flow rate was 23.2608 +/- 0.52474 g/s
The mean feedwater flow rate was 22.9218 +/- 1.2274 g/s
The mean water injection to steam flow rate was 12.4637 +/- 0.42445 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 12.5343 +/- 3.7904 C over the Stratification Period, beginning at 3.2487 C and ending at 14.7817 C
Mean Smoothed SP8-Upper Pool delta T is 11.9227 +/- 3.7434 C over the Stratification Period, beginning at 3.0067 C and ending at 14.1501 C
The stratification period begins and ends with Smoothed SP8 readings of 55.2347 and 117.5495 C, respectively
The stratification period begins and ends with condensing flows of 0.18985 and 0.41195 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 4.1263 and 0.79736 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1868.491 +/- 22.527 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.18285 and 6.7411 kg/s, respectively
The plume period had a mean steam enthalpy of 1866.0177 +/- 25.0028 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.2445 degrees C at t plus 7231.6206 s with T_upper = 76.5145 C and T_mid = 75.27 C
At t plus 7231.6206 s, Smoothed SP8-SP9 is 12.9052 C and Smoothed SP8-Top is 11.6607 C, where Smoothed SP8 is 88.1752 C and Pool P = 26.7746 psia
Maximum Smoothed Top-Lower delta T is 13.901 degrees C at t plus 9722.6611 s with T_upper = 90.0903 C and T_low = 76.1893 C
At t plus 9722.6611 s, Smoothed SP8-SP9 is 16.1154 C and Smoothed SP8-Top is 15.6275 C, where Smoothed SP8 is 105.7178 C and Pool P = 31.6763 psia
Maximum Smoothed Mid-Lower delta T is 13.4151 degrees C at t plus 9723.4621 s with T_mid = 89.6059 C and T_low = 76.1908 C
At t plus 9723.4621 s, Smoothed SP8-SP9 is 16.1626 C and Smoothed SP8-Top is 15.6772 C, where Smoothed SP8 is 105.7685 C and Pool P = 31.6772 psia
Maximum Smoothed Top-Outlet delta T is 32.7578 degrees C at t plus 12986.4187 s with T_upper = 103.0909 C and T_out = 70.3331 C
At t plus 12986.4187 s, Smoothed SP8-SP9 is 14.8252 C and Smoothed SP8-Top is 14.0135 C, where Smoothed SP8 is 117.1044 C and Pool P = 38.5985 psia

Maximum Smoothed Mid-Outlet delta T is 31.9519 degrees C at t plus 12989.422 s with T_mid = 102.2956 C and T_out = 70.3437 C
At t plus 12989.422 s, Smoothed SP8-SP9 is 14.8039 C and Smoothed SP8-Top is 14.0135 C, where Smoothed SP8 is 117.0995 C and Pool P = 38.6139 psia
Maximum Smoothed Lower-Outlet delta T is 32.0958 degrees C at t plus 13080.8431 s with T_low = 102.8859 C and T_out = 70.7902 C
At t plus 13080.8431 s, Smoothed SP8-SP9 is 14.9258 C and Smoothed SP8-Top is 14.2353 C, where Smoothed SP8 is 117.5729 C and Pool P = 38.8444 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 17.1342 degrees C at (KEY POINT #14) t plus 10412.3736 s with T_SP8 = 109.337 C and T_SP9 = 92.2028 C and Pool P = 33.0453 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 16.6294 degrees C at t plus 10412.3736 s with T_SP8 = 109.337 C and T_upper = 92.7076 C and Pool P = 33.0453 psia
Maximum Top-Mid delta T is 1.7768 degrees C at (KEY POINT #4) t plus 6703.2074 s ignoring SP 4, with temperatures of 73.8722 and 72.0954 C, respectively, at Set # 2, where Pool P = 25.9467 psia and T_outlet = 66.2571 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 8262.9376 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99937 C and a raw SP12 Reading of 81.2771 C.
Maximum Top-Lower delta T is 15.7337 degrees C at t plus 9958.4655 s, with temperatures of 91.2724 and 75.5386 C, respectively, at Set # 1, where Pool P = 32.1355 psia and T_outlet = 68.0813 C
Maximum Mid-Low delta T is 14.4379 degrees C at (KEY POINT #6) t plus 9889.5637 s ignoring SP 4, with temperatures of 90.1271 and 75.6893 C, respectively, at Set # 2, where Pool P = 32.0156 psia and T_outlet = 68.0212 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 10134.2677 s with a Smoothed Mid-Axis Mid-Low Delta T of 4.8114 C and a raw SP12 Reading of 91.0473 C.
Maximum Top-Outlet delta T is 33.0979 degrees C at t plus 13052.2216 s, with temperatures of 103.6805 and 70.5826 C, respectively, at Set # 1, where Pool P = 38.7598 psia
Maximum Mid-Outlet delta T is 31.9227 degrees C at t plus 12992.4212 s ignoring SP 4, with temperatures of 102.1219 and 70.1992 C, respectively, at Set # 2, where Pool P = 38.6142 psia
Maximum Lower-Outlet delta T is 32.906 degrees C at (KEY POINT #8) t plus 13093.5229 s, with temperatures of 103.8949 and 70.9889 C, respectively, at Set # 1, where Pool P = 38.8707 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 14154.1406 s with a Smoothed Mid-Axis Low-Outlet Delta T of 10.9677 C and a raw SP12 Reading of 106.7449 C.
Minimum SP Pressure is 20.3078 psia at t plus 3.4932 s
Maximum SP Pressure is 48.1581 psia at t plus 16121.9701 s
Beginning SP Pressure is 20.3167 psia
Ending SP Pressure is 48.1577 psia
Time-Average SP Pressure is 30.1934 +/- 8.0838 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.5669 cm (cold) / 76.7094 cm (hot) at 14.6231 psia
Beginning Smoothed SP Level is 77.01 cm (cold) / 77.184 cm (hot) at 20.3101 psia
Ending Smoothed SP Level is 77.6691 cm (cold) / 79.0604 cm (hot) at 48.1646 psia
Minimum Smoothed Cold SP Level is 76.9818 cm at t plus 4118.7736 s and 22.9369 psia
Minimum Smoothed Hot SP Level is 77.1784 cm at t plus 151.6947 s and 20.3688 psia
Maximum Smoothed Cold SP Level is 78.5494 cm at t plus 13221.9253 s and 39.1895 psia
Maximum Smoothed Hot SP Level is 79.7381 cm at t plus 13896.6348 s and 40.9547 psia
SP 12 Temperature at the beginning is 39.9661 C, and at the end is 115.0955 C
At plume detection, the Mixing Number is 41.8031
The Mixing Number ranges from a minimum of 36.3202 at (KEY POINT #12) t plus 0 s to a maximum of 202.1715 at (KEY POINT #13) t plus 16122.0061 s; it had a mean value of 91.9771 +/- 47.5729 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,

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        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 36.3202):  26.308562        0.040894
        0.00925          0.3937     0.770100391     0.771839768      0.58851607
        0.58851607     0.999385637      18.5347816       84236.325    0.0695141745
        0.0568939649    0.0218860127    0.0126686117    0.0345546245      40.5049298
        110.344865      110.344865      41.0017771      40.5985197      40.6665476
        38.4391222      4.17844323      4.23087729        2.12285     0.629293784
        0.681377859     0.681377859      4.29372813      1.57615103    0.0393296436
        992.043687      950.686426     0.835862537      1.41941581  0.000646656247
        0.000253837287 1.26237597e-005 1.27719524e-005      1532.24675      1534.01618
        477.36555       468.10107      1.45044723      1.40033402      1.43733402
        0.0758554371    0.0778803816      1774.83272      1774.48918      169.771723
        462.82356      2691.59128      293.051837      1312.00916      171.847771
        170.161278      170.448626      161.145428
KEY POINT #2 (t plus 1871.525 s with a Mixing Number of 41.8031):  27.141099
        0.040894         0.00925          0.3937     0.770078465     0.772679246
        0.597373881     0.597373881     0.999382283      18.6278943      86603.5629
        0.0680129069    0.0566339696    0.0226153118    0.0130327971    0.0356481089
        49.5888288      111.660266      111.660266      51.5900366      49.7757825
        49.8948196      47.4724465      4.1793573       4.23285925      2.12929079
        0.640086043     0.681746212     0.681746212      3.59482886      1.55623251
        0.0395688304     988.250247      949.677481     0.870919971      1.4570138
        0.000550563069  0.000250647508 1.26689602e-005 1.28159635e-005      1544.95242
        1532.39033      477.988497      468.861943      1.51557058      1.46383853
        1.50083853     0.121014493      0.13359421      1798.01035      1797.66335
        207.736547      468.394878      2693.58167      260.658331      1329.61547
        216.100744       208.51643      209.016954      198.897327
KEY POINT #3 (t plus 2371.0316 s with a Mixing Number of 43.4983):  26.7220172
        0.040894         0.00925          0.3937     0.770151872     0.773014512
        0.610444997     0.610444997     0.999407085      18.4935624       85211.864
        0.0676093521    0.0565492324    0.0226362192    0.0124614523    0.0350976715
        51.9860382      112.088153      112.088153      55.2347363      52.2280338
        52.1420255       49.610811      4.17990506      4.23351255      2.13142065
        0.642711479     0.681861626     0.681861626      3.44081378      1.54986509
        0.039647683      987.15596      949.347649     0.882577345      1.44493616
        0.000529067164  0.000249625699 1.26836688e-005 1.28241552e-005      1547.52598
        1531.85124      478.189794      469.48049      1.53726501      1.48574045
        1.52274045     0.136211917     0.159395324      1828.19104      1827.84903
        217.757853      470.207774      2694.22674      252.449921      1357.98326
        231.338574      218.767921      218.411412      207.835749
KEY POINT #4 (t plus 6703.2074 s with a Mixing Number of 64.6401):  27.1378071
        0.040894         0.00925          0.3937     0.770505684     0.776107994
        0.627708353     0.627708353     0.999345678      16.3383899      85243.0875
        0.0640351105    0.0554575656    0.0233722763    0.0122715088    0.0356437851
        72.4907882      117.565247      117.565247      85.2877958      73.4560268
        70.2326117      66.2139635      4.18957071      4.2422541       2.16023553
        0.661618894     0.683149515     0.683149515      2.4729103      1.47293984
        0.0407039306     976.376644      945.055376      1.04329629      1.66098417
        0.000390523109  0.000237194217 1.28721475e-005 1.30189264e-005      1557.97953
        1524.5169      480.707268      471.88052      1.83821828      1.78881647
        1.82581647     0.347185968     0.585234945      1880.27527      1880.00833
        303.574975      493.440269      2702.37703      189.865294        1386.835
        357.252692      307.617857      294.117374      277.29571
KEY POINT #5 (t plus 8262.9376 s with a Mixing Number of 80.1941):  27.2012958
        0.040894         0.00925          0.3937     0.775465444     0.782526682
        0.630125646     0.630125646     0.999290566      15.044343      84723.8867
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      0.0623645951    0.0548587126    0.0235810452    0.0121461284    0.0357271736
      81.6783177      120.542789      120.542789      95.5214502      82.3982641
      74.5341802      67.5277581      4.19674462      4.24730826      2.17714953
      0.668146483     0.683703703     0.683703703      2.18011548      1.43444459
      0.0413160808     970.795364      942.667549      1.14012307      1.80807469
      0.000347087236  0.000230907441 1.29747438e-005 1.31293527e-005      1556.78481
      1520.19977      482.028902      472.888835      2.02104446      1.97333119
      2.01033119     0.507302689     0.862458255      1892.99149      1892.76516
      342.113199      506.092119      2706.72155      163.978919      1386.89938
      400.302951      345.133517      312.153739      282.810456
KEY POINT #6 (t plus 9889.5637 s with a Mixing Number of 100.4121):  27.2093551
      0.040894         0.00925         0.3937     0.783588296     0.792348312
      0.626777498     0.626777498     0.999200842      13.5208762      83893.5631
      0.0607716186    0.0541541911    0.0235987737    0.0121389852    0.0357377589
      90.2360814      124.022239      124.022239      106.504567      90.6450922
      78.2107943       67.978147      4.20499559      4.25349299       2.198073
      0.673212741     0.684222791     0.684222791      1.95880867      1.39216377
      0.0420669403     965.216971      939.829009      1.26233323      2.01239584
      0.000313601983  0.000223945399  1.3094724e-005 1.32632269e-005      1552.86903
      1514.86919      483.530431      473.771435      2.25322636      2.20691149
      2.24391149     0.708139875      1.27335335      1894.23699      1894.05417
      378.080452      520.897263      2711.71763      142.816811      1373.33972
      446.644984      379.799117      327.586157      284.715205
KEY POINT #7 (t plus 10134.2677 s with a Mixing Number of 102.99):  27.289104
      0.040894         0.00925         0.3937     0.784186906     0.793161704
      0.623505332     0.623505332     0.999178087      13.3061976      84010.3377
      0.0605955329    0.0540578086     0.023569421     0.012273083     0.035842504
      91.1706759      124.496321      124.496321      107.98639       91.7109154
      84.8440833       68.160269      4.20598806      4.2543594       2.2010223
      0.67370866     0.684282877     0.684282877      1.93713008      1.38661683
      0.042172288      964.586563      939.438244      1.27977193      2.05085666
      0.000310286498  0.000223027269 1.31110778e-005 1.32836107e-005      1552.28944
      1514.11945      483.731396      473.769478      2.2864778       2.24024666
      2.27724666     0.733611649      1.33944558      1888.24277      1888.06571
      382.013455      522.916272      2712.39144      140.902818      1365.32649
      452.909822      384.284545      355.426008      285.48042
KEY POINT #8 (t plus 13093.5229 s with a Mixing Number of 142.4475):  27.3611726
      0.040894         0.00925         0.3937     0.785443237     0.796820066
      0.613151408     0.613151408     0.998982543      11.1310965      82800.4767
      0.0583881361    0.0528740159    0.0234650109    0.0124721507    0.0359371616
      102.708777      130.282591      130.282591      117.7352        103.377356
      102.878931      70.8944166      4.21977327      4.26540724      2.23896113
      0.678921934     0.684812695     0.684812695      1.70276555      1.32276138
      0.0435188936     956.467041      934.591652      1.50871285      2.45808422
      0.000273959004  0.000212369824 1.33107674e-005 1.35133013e-005      1542.82335
      1504.52539      486.113197      474.819662      2.72551634      2.68021009
      2.71721009      1.11621977      1.84827575      1880.02419      1879.90029
      430.65268      547.594674      2720.4766      116.941994      1332.42952
      494.223547      433.472963      431.372049      296.965585
KEY POINT #9 (t plus 13104.5215 s with a Mixing Number of 142.6853):  27.3421464
      0.040894         0.00925         0.3937     0.785439459     0.796825277
      0.614035668     0.614035668     0.998985703      11.1327212      82742.4841
      0.0583766752    0.0528696315    0.0234768931    0.0124352787    0.0359121718
      102.767861      130.303899      130.303899      117.549536      103.39944
      102.806357      70.9907438      4.21985142      4.26544957      2.23910754
      0.678944335     0.684813956     0.684813956      1.70170703      1.32253878
      0.0435240645     956.423855      934.573542      1.5096129       2.45601645
      0.00027379266  0.000212332369  1.3311503e-005 1.35133692e-005      1542.76418
      1504.48857      486.121723      474.865838      2.72725092      2.68195375
      2.71895375      1.11853658      1.83729082      1881.99873      1881.87479
      430.902133      547.685677      2720.50589      116.783543      1334.31305
      493.436056      433.566304      431.065921      297.369177
KEY POINT #10 (t plus 14154.1406 s with a Mixing Number of 160.884):  27.4499979
      0.040894         0.00925         0.3937      0.78488748     0.797235013
      0.616147102     0.616147102      0.99892701      10.5293299      82544.9048
      0.0575678844    0.0524014205    0.0234012083    0.0126526197     0.036053828
      106.917171      132.574296      132.574296      120.85804       107.676545
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        107.174391      95.6703989      4.22551902      4.27003166      2.25499325
        0.680414777     0.684919418     0.684919418      1.63050374      1.29931783
        0.0440841766     953.354715      932.632734      1.60802293      2.60700331
        0.000262552087  0.000208412509 1.33898887e-005  1.3599146e-005      1538.36591
        1500.50315      487.019823      475.504102      2.91727693      2.87207067
        2.90907067      1.29148018      2.04124047      1892.20756      1892.0967
        448.437275       557.38789      2723.60567      108.950616      1334.81967
        507.493378      451.645187      449.525533      401.003367
KEY POINT #11 (t plus 16122.0731 s with a Mixing Number of 202.1714):  28.0703691
        0.040894         0.00925         0.3937     0.776690973     0.790604041
        0.645069705     0.645069705     0.998911171      9.85643487      83403.9352
        0.0559186614    0.0513793987    0.0245396181     0.012329028    0.0368686461
        115.25975      137.496193      137.496193      128.050623      116.103226
        115.674719      112.926921      4.23809011      4.28046307      2.29138166
        0.682748419     0.684953376     0.684953376      1.50423324      1.25219582
        0.0453618952     946.953678      928.350143      1.83911143      2.84792315
        0.000242329171  0.000200374526 1.35598464e-005 1.37632555e-005      1528.05743
        1491.44892      488.895569      477.989244      3.36615251      3.32083419
        3.35783419      1.70614942       2.548712      1966.56593      1966.46878
        483.772767      578.459653      2730.17926      94.6868854      1388.10628
        538.122469      487.346849      485.532864      473.894945
KEY POINT #12 (t plus 0 s with a Mixing Number of 36.3202):  26.308562        0.040894
        0.00925          0.3937     0.770100391     0.771839768      0.58851607
        0.58851607     0.999385637      18.5347816       84236.325    0.0695141745
        0.0568939649    0.0218860127    0.0126686117    0.0345546245      40.5049298
        110.344865      110.344865      41.0017771      40.5985197      40.6665476
        38.4391222      4.17844323      4.23087729         2.12285     0.629293784
        0.681377859     0.681377859      4.29372813      1.57615103    0.0393296436
        992.043687      950.686426     0.835862537      1.41941581  0.000646656247
        0.000253837287 1.26237597e-005 1.27719524e-005      1532.24675      1534.01618
        477.36555       468.10107      1.45044723      1.40033402      1.43733402
        0.0758554371    0.0778803816      1774.83272      1774.48918      169.771723
        462.82356      2691.59128      293.051837      1312.00916      171.847771
        170.161278      170.448626      161.145428
KEY POINT #13 (t plus 16122.0061 s with a Mixing Number of 202.1715):  28.0701445
        0.040894         0.00925         0.3937     0.776691788      0.79060484
        0.645050733     0.645050733     0.998911086      9.85610597      83403.2001
        0.0559187195    0.0513794294    0.0245387461     0.012329605    0.0368683511
        115.259459      137.496047      137.496047      128.052906      116.102927
        115.673957      112.927195      4.23808965      4.28046274      2.29138053
        0.682748352     0.684953379     0.684953379      1.50423729      1.25219717
        0.0453618557     946.953907      928.350272      1.83910415      2.8479954
        0.000242329828  0.000200374757 1.35598413e-005 1.37632667e-005      1528.05783
        1491.44919      488.895515      477.988328      3.36613832      3.32081751
        3.35781751      1.70613324      2.54888797      1966.52475      1966.42761
        483.771531      578.459023      2730.17906      94.6874913      1388.06573
        538.132196      487.345582      485.529631      473.896105
KEY POINT #14 (t plus 10412.3736 s with a Mixing Number of 105.859):  27.2675288
        0.040894         0.00925         0.3937     0.784663069     0.793880175
        0.623803718     0.623803718     0.999166092      13.1001514      83818.0369
        0.060400598    0.0539498751    0.0235749046    0.0122392618    0.0358141664
        92.2027747      125.026679      125.026679      109.337009      92.7075816
        90.0583152      68.1777648      4.20710531      4.2553355      2.20434997
        0.674243343     0.684347086     0.684347086      1.91370471      1.38047022
        0.0422910195     963.885587      938.999955      1.29951033      2.08146669
        0.000306696069  0.000222008528 1.31293744e-005 1.33035605e-005      1551.61576
        1513.27411      483.955181      473.928617      2.3241488      2.27803068
        2.31503068     0.762623062      1.40212185      1890.2095      1890.03789
        386.357935      525.175464      2713.14322      138.81753      1365.03404
        458.623242      388.480546      377.339857      285.556774
End
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D.24 TEST #24 - T24_RCIC_15PSIG_VENT86C_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T24_RCIC_15PSIG_VENT86C_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 3038.2918 s, and ending (KEY POINT #11) at t
       plus 11246.9323 s, for a time period of 8208.6405 s.
Original Data Record Time:  12983.6576 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       540.1059 s, T_bulk = 45.2374 C and T_out = 41.1117 C
Stratification Beginning SP12 Temperature = 44.8367 C
Stratification Beginning Pressure = 31.0244 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       6115.5028 s, T_bulk = 96.2799 C and T_out = 61.2771 C
Stratification Ending SP12 Temperature = 95.9282 C
Stratification Ending Pressure = 20.8446 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 530.2053 s.
At t = 530.2053 s, the pool pressure is 31.0141 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 45.9483, 46.0653, 48.0662, 45.8911, and
       40.9845 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 11.4238 +/- 4.6645 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.8795 +/- 3.7847 C.
Minimum Steam Quality:  0.99474 at t plus 120.5009 s
Maximum Steam Quality:  1.0027 at t plus 4592.0817 s
Time-Averaged Steam Quality:  0.99919 +/- 0.0012281
Minimum Turbine Outlet Steam Quality:  1.0021 at t plus 4413.6845 s
Maximum Turbine Outlet Steam Quality:  1.0252 at t plus 4845.4821 s
Time-Averaged Turbine Outlet Steam Quality:  1.0111 +/- 0.0054923
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 8118.6343 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.86495 degrees/min at t plus 2631.9425 s
       and 0.2698 degrees/min at t plus 5749.4029 s, respectively
Max and min smoothed mid (SP9) level changerates:  1.0301 degrees/min at t plus 4668.48 s
       and 0.31509 degrees/min at t plus 5424.6943 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.38676 degrees/min at t
       plus 2735.3424 s and -0.63035 degrees/min at t plus 4697.9357 s, respectively
Max and min smoothed lower level changerates:  2.643 degrees/min at t plus 5064.7837 s
       and -0.11384 degrees/min at t plus 1988.6327 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.74034 degrees/min at t
       plus 4702.377 s and -2.1252 degrees/min at t plus 5064.7837 s, respectively
Max and min smoothed outlet level changerates:  5.9618 degrees/min at t plus 6372.4075 s
       and -0.027165 degrees/min at t plus 2850.047 s, respectively
Max and min smoothed lower-outlet level changerate differences:  2.5547 degrees/min at t
       plus 5076.3834 s and -5.3039 degrees/min at t plus 6378.8049 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.4102 degrees/min at t plus 1680.3261
       s and -1.7822 degrees/min at t plus 4564.1741 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.91742 degrees/min
       at t plus 1680.3261 s and -2.5409 degrees/min at t plus 4564.2731 s, respectively
The mean steam flow rate was 44.7852 +/- 1.2886 g/s
The mean feedwater flow rate was 44.0008 +/- 1.8175 g/s
The mean water injection to steam flow rate was 0.0098182 +/- 0.026025 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.4402 +/- 4.6524 C over the
       Stratification Period, beginning at 2.3276 C and ending at 11.2607 C
Mean Smoothed SP8-Upper Pool delta T is 9.8928 +/- 3.7748 C over the Stratification
       Period, beginning at 2.5375 C and ending at 10.8079 C
The stratification period begins and ends with Smoothed SP8 readings of 48.5645 and
       108.3207 C, respectively
The stratification period begins and ends with condensing flows of 0.29505 and 1.7593
       kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 11.1616 and
       2.1617 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2730.6608 +/- 1.4045 kJ/kg.
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At plume detection, the condensing and condensing+cooling flows are 0.29447 and 12.9958 kg/s, respectively
The plume period had a mean steam enthalpy of 2731.4411 +/- 1.6834 kJ/kg.
Maximum Smoothed Top-Mid delta T is 3.6719 degrees C at t plus 3174.9596 s with T_upper = 72.2899 C and T_mid = 68.618 C
At t plus 3174.9596 s, Smoothed SP8-SP9 is 16.2705 C and Smoothed SP8-Top is 12.5986 C, where Smoothed SP8 is 84.8885 C and Pool P = 36.1724 psia
Maximum Smoothed Top-Lower delta T is 14.0896 degrees C at t plus 4619.2752 s with T_upper = 87.6787 C and T_low = 73.5891 C
At t plus 4619.2752 s, Smoothed SP8-SP9 is 9.1824 C and Smoothed SP8-Top is 6.4506 C, where Smoothed SP8 is 94.1294 C and Pool P = 20.6372 psia
Maximum Smoothed Mid-Lower delta T is 13.4675 degrees C at t plus 4836.9777 s with T_mid = 88.2075 C and T_low = 74.74 C
At t plus 4836.9777 s, Smoothed SP8-SP9 is 7.2291 C and Smoothed SP8-Top is 6.7113 C, where Smoothed SP8 is 95.4366 C and Pool P = 15.3434 psia
Maximum Smoothed Top-Outlet delta T is 36.3436 degrees C at t plus 6088.1052 s with T_upper = 97.3828 C and T_out = 61.0392 C
At t plus 6088.1052 s, Smoothed SP8-SP9 is 11.5878 C and Smoothed SP8-Top is 11.0456 C, where Smoothed SP8 is 108.4284 C and Pool P = 20.7639 psia
Maximum Smoothed Mid-Outlet delta T is 35.8449 degrees C at t plus 6109.7005 s with T_mid = 97.0338 C and T_out = 61.1889 C
At t plus 6109.7005 s, Smoothed SP8-SP9 is 11.1972 C and Smoothed SP8-Top is 10.7631 C, where Smoothed SP8 is 108.231 C and Pool P = 20.821 psia
Maximum Smoothed Lower-Outlet delta T is 35.6495 degrees C at t plus 6080.8028 s with T_low = 96.6377 C and T_out = 60.9881 C
At t plus 6080.8028 s, Smoothed SP8-SP9 is 11.4958 C and Smoothed SP8-Top is 10.961 C, where Smoothed SP8 is 108.281 C and Pool P = 20.7348 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 19.0892 degrees C at (KEY POINT #14) t plus 3737.2608 s with T_SP8 = 94.2638 C and T_SP9 = 75.1746 C and Pool P = 37.9781 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 16.1741 degrees C at t plus 3737.2608 s with T_SP8 = 94.2638 C and T_upper = 78.0896 C and Pool P = 37.9781 psia
Maximum Top-Mid delta T is 5.0724 degrees C at (KEY POINT #4) t plus 3187.2523 s ignoring SP 4, with temperatures of 73.6726 and 68.6002 C, respectively, at Set # 2, where Pool P = 36.1998 psia and T_outlet = 56.1338 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 4654.2762 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.6885 C and a raw SP12 Reading of 86.1157 C.
Maximum Top-Lower delta T is 18.8355 degrees C at t plus 4613.1759 s, with temperatures of 87.7763 and 68.9407 C, respectively, at Set # 1, where Pool P = 21.0516 psia and T_outlet = 58.5542 C
Maximum Mid-Low delta T is 14.5565 degrees C at (KEY POINT #6) t plus 4990.9805 s ignoring SP 4, with temperatures of 89.3747 and 74.8182 C, respectively, at Set # 2, where Pool P = 16.4433 psia and T_outlet = 59.0766 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 5241.1868 s with a Smoothed Mid-Axis Mid-Low Delta T of 4.8447 C and a raw SP12 Reading of 91.5377 C.
Maximum Top-Outlet delta T is 36.7412 degrees C at t plus 6096.0037 s, with temperatures of 97.7389 and 60.9977 C, respectively, at Set # 1, where Pool P = 20.7742 psia
Maximum Mid-Outlet delta T is 35.4601 degrees C at t plus 6105.5022 s ignoring SP 4, with temperatures of 96.6135 and 61.1534 C, respectively, at Set # 2, where Pool P = 20.8038 psia
Maximum Lower-Outlet delta T is 36.5721 degrees C at (KEY POINT #8) t plus 6103.0011 s, with temperatures of 97.6688 and 61.0967 C, respectively, at Set # 1, where Pool P = 20.8016 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 6459.1074 s with a Smoothed Mid-Axis Low-Outlet Delta T of 12.188 C and a raw SP12 Reading of 98.6875 C.
Minimum SP Pressure is 15.343 psia at t plus 4836.1856 s
Maximum SP Pressure is 40.8567 psia at t plus 4470.4747 s
Beginning SP Pressure is 30.5239 psia
Ending SP Pressure is 32.3111 psia
Time-Average SP Pressure is 29.1865 +/- 6.9157 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.363 cm (cold) / 76.4948 cm (hot) at 14.6281 psia
Beginning Smoothed SP Level is 78.3622 cm (cold) / 78.5503 cm (hot) at 30.5234 psia
Ending Smoothed SP Level is 77.938 cm (cold) / 79.3065 cm (hot) at 32.3224 psia
Minimum Smoothed Cold SP Level is 76.3791 cm at t plus 6840.6193 s and 23.9818 psia
Minimum Smoothed Hot SP Level is 77.1817 cm at t plus 4814.1794 s and 15.4067 psia

Maximum Smoothed Cold SP Level is 78.7871 cm at t plus 3281.6527 s and 36.482 psia
Maximum Smoothed Hot SP Level is 79.5186 cm at t plus 4420.0748 s and 40.6367 psia
SP 12 Temperature at the beginning is 39.9438 C, and at the end is 113.4903 C
At plume detection, the Mixing Number is 42.0753
The Mixing Number ranges from a minimum of 39.6359 at (KEY POINT #12) t plus 0 s to a maximum of 254.8528 at (KEY POINT #13) t plus 8208.6405 s; it had a mean value of 97.4678 +/- 58.8632 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11

KEY POINT #1 (t plus 0 s with a Mixing Number of 39.6359): 33.08521587 0.040894
0.00925 0.3937 0.7836220492 0.7855031549 1.006313715
1 1 27.75982624 101743.5513 0.06948876859
0.05442750174 0.0434553287 1.006187186e-005 0.0434553287 40.66093633
129.0613714 122.6753877 41.66791232 40.71885552 40.23158929
36.87472868 4.17827036 4.251062793 2.189823602 0.6295271393
0.6840381966 0.6840381966 4.279562952 1.40819784 0.04177166183
992.0145929 940.9339203 1.213833482 1.192113967 0.0006447885825
0.0002265930092 1.30482712e-005 1.329801054e-005 1532.620416
1516.968672 482.9547405 487.5467971 2.160903368 2.1045156
2.1415156 0.07648630269 0.08066835385 2724.421126 2723.650518
170.4858849 515.163675 2709.794247 344.6777901 2209.257451
174.6933078 170.7263833 168.6935511 154.6715116

KEY POINT #2 (t plus 530.2053 s with a Mixing Number of 42.0753): 32.76904188
0.040894 0.00925 0.3937 0.784424842 0.7867699226
1.00710534 1 1 27.14747972 100399.857
0.06860051293 0.05432300786 0.04304005426 1.491588007e-005 0.04304005426
46.0652565 130.3710527 123.1907633 48.06618006 45.94829043
45.89105069 40.98448666 4.178614866 4.251987273 2.192957696
0.6360967796 0.6841112625 0.6841112625 3.842214204 1.402013778
0.04188395326 989.8205754 940.5120399 1.232211157 1.20749324
0.0005848876148 0.0002255729743 1.306604509e-005 1.334720227e-005
1540.709288 1516.170651 483.1758588 488.3290108 2.195859544
2.138609516 2.175609516 0.1013250578 0.1121368043 2726.85206
2726.115074 193.0702119 517.3572369 2710.531822 324.287025
2209.494823 201.4315817 192.5799745 192.3438448 171.8463477

KEY POINT #3 (t plus 540.1059 s with a Mixing Number of 42.16): 32.76622413
0.040894 0.00925 0.3937 0.7844483409 0.7868052427
1.007095247 1 1 27.1353368 100391.7342
0.0685720452 0.05432099934 0.04303635331 1.302954618e-005 0.04303635331
46.23688756 130.3703826 123.2006642 48.56446787 46.02692685
46.31460925 41.06472298 4.178636836 4.252005099 2.193018179
0.6362974863 0.6841126367 0.6841126367 3.82951838 1.40189557
0.04188611893 989.7475114 940.5039241 1.232566395 1.20787682
0.0005831358442 0.000225553463 1.306638656e-005 1.334713441e-005
1540.937848 1516.155256 483.1800966 488.3259703 2.196535571

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       2.139328415      2.176328415     0.1022158838     0.1149783375      2726.843217
       2726.10689      193.7874563      517.3993823      2710.545973      323.611926
       2209.443834      203.5139666      192.9086279      194.1137952      172.1816586
KEY POINT #4 (t plus 3187.2523 s with a Mixing Number of 57.8576):  33.83776389
       0.040894         0.00925          0.3937      0.787796125     0.7937242272
       1.006595513            1               1      24.34436369       102565.825
       0.06471000507    0.05333542332    0.0444437527 9.437640397e-006    0.0444437527
       68.71191805      134.5691723      128.0351923      85.59562172      72.37365253
       65.33644069      56.29154615      4.186957893      4.261010985      2.223796172
       0.6586355417     0.6846514171     0.6846514171      2.613834399      1.346743194
       0.0429823386      978.577462      936.4910128      1.416175869      1.390258122
       0.0004111730472  0.0002163922223 1.323319079e-005 1.349144821e-005
       1557.624262      1508.348213      485.2037818      489.9576215      2.547522951
       2.495793287      2.532793287     0.2950289164     0.5923206736      2732.333904
       2731.741256      287.8058811      538.0014902      2717.367222      250.1956091
       2194.332414      358.6010315      303.1402947      273.6777407      235.848131
KEY POINT #5 (t plus 4654.2762 s with a Mixing Number of 82.0582):  35.04082734
       0.040894         0.00925          0.3937     0.7655041431     0.7731254214
       1.019482522            1               1      47.41772052       107287.276
       0.06159698407    0.05729966426    0.0460239001 7.921878714e-006    0.0460239001
       85.8256479      129.2738055      108.2845642      93.68446909      87.84261223
       74.42372091      58.50612623      4.200728703      4.227852395      2.113080015
       0.6706787897     0.6807596282     0.6807596282         2.067558      1.608425454
       0.03896460042     968.1016437      952.2514683     0.7832600012     0.7391088895
       0.0003301016073  0.0002589851802 1.255301584e-005 1.335628647e-005
       1555.056855      1536.466528      476.3774335      490.6359105      1.353080157
       1.287819746      1.324819746     0.5976622715     0.8059369408      2734.231049
       2731.982608      359.4726364      454.1027132      2688.451851      94.63007678
       2280.128335      392.5170029      367.946032       311.635418       245.0062643
KEY POINT #6 (t plus 4990.9805 s with a Mixing Number of 102.5165):  34.77070922
       0.040894         0.00925          0.3937     0.7650457809     0.7729939096
       1.021298947            1               1       52.9192652      106768.8167
       0.06092460601    0.05797959147    0.04566911711 5.655252398e-006    0.04566911711
       89.42229738      128.0303828       104.80996      97.78135382       89.8340324
       76.83265374      59.16034487      4.204379328      4.222967512      2.097454261
       0.6727150874     0.6796018868     0.6796018868      1.978167456      1.666004793
       0.03837464772     965.7160045      954.8483604     0.7006559393     0.6571333667
       0.0003165135658  0.0002681100429 1.243387447e-005 1.331768419e-005
       1553.146725      1540.327546      474.6773256      490.3603293      1.201089095
       1.134076085      1.171076085     0.6865652219     0.9364705679      2733.687284
       2730.886835      374.575695      439.4099829      2683.098629      64.83428788
       2294.277301      409.758862      376.3055583      321.7211974      247.7293941
KEY POINT #7 (t plus 5241.1868 s with a Mixing Number of 109.1277):  34.57936056
       0.040894         0.00925          0.3937     0.7653078691     0.7736505596
       1.01997673             1               1      49.11594585       106095.456
       0.06052835661    0.05758663741    0.0454177928 9.113729752e-006    0.0454177928
       91.52664635      128.4483202      106.821409      100.8075141      92.34479714
       85.82742646      59.49387495      4.206602115      4.22576248       2.106372121
       0.6738383643     0.6802897987     0.6802897987      1.929093819      1.632175826
       0.03871230899     964.2991395      953.3515431     0.7475619559     0.7041765929
       0.0003090136381  0.0002627579211 1.250281877e-005 1.332845368e-005
       1551.858524      1538.134366      475.6666271      490.3292666      1.287254269
       1.222421777      1.259421777     0.7435119656      1.043756028      2733.332604
       2730.920228      383.4323262      447.9134164      2686.206454      64.48109024
       2285.419188      422.5229446      386.873021       359.4763964      249.1317901
KEY POINT #8 (t plus 6103.0011 s with a Mixing Number of 130.4794):  34.33773188
       0.040894         0.00925          0.3937     0.7646154523     0.7738265626
       1.017219329            1               1      41.99244426      105098.8921
       0.05949665081    0.05671017522    0.04510042889 9.251259416e-006    0.04510042889
       96.95475008      129.6181101      111.2751135      108.2586808      97.41882553
       96.67845021      61.13211779      4.21277406       4.232274806      2.127388299
       0.676474041     0.6816404762     0.6816404762      1.812496353       1.5620106
       0.03949829487     960.5468563      949.9736863      0.860533935     0.8178798839
       0.0002910449777  0.0002515738457 1.265572276e-005 1.336081837e-005
       1547.860852      1532.871294      477.8067404      490.3609109      1.496258537
       1.434330227      1.471330227     0.9088112939      1.351892081      2733.097692
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     2731.334326     406.2988582     466.7632988     2693.000025     60.46444059
     2266.334393     454.0019345     408.2527459     405.136281      256.0020276
KEY POINT #9 (t plus 6115.5028 s with a Mixing Number of 131.0746):  34.34906302
     0.040894        0.00925         0.3937     0.7646102611     0.7738309495
     1.017172925           1               1      41.92851755     105134.8677
     0.0594765048    0.05669964055   0.04511531162 7.077462995e-006    0.04511531162
     97.06003132     129.6180808     111.3283765     108.3207045     97.5128098
     96.80048694     61.24096777     4.212900338     4.232355425     2.127650573
     0.6765214033    0.6816552029    0.6816552029     1.810367608     1.561208896
     0.03950802445     960.472648     949.9327624     0.8619642141     0.819357648
     0.0002907147894  0.0002514453678 1.265755325e-005 1.336065393e-005
     1547.773699     1532.805022     477.8319075     490.3515712     1.498917105
     1.437020204     1.474020204     0.9122960158    1.354740478     2733.067023
     2731.309022     406.7425947     466.9889171     2693.080518     60.2463224
     2266.078106     454.2643569     408.6489423     405.650566      256.4575907
KEY POINT #10 (t plus 6459.1074 s with a Mixing Number of 145.302):  34.38755972
     0.040894        0.00925         0.3937     0.7643698195     0.7741047966
     1.016127401           1               1      39.64067204     105137.3033
     0.05896793912   0.05635372949   0.04516587459 1.829882892e-005    0.04516587459
     99.70897084     130.1368523     113.0738284     110.4497117     100.4649535
     100.4437162     86.40375151     4.216151427     4.235033637     2.136392584
     0.6776687292    0.6821192887    0.6821192887     1.758347409     1.535401612
     0.03983130715    958.5896413     948.5848129     0.9099128031     0.8678332121
     0.0002826219776  0.0002473007643 1.271756095e-005 1.337531801e-005
     1545.471657     1530.590502     478.6509734     490.3800875     1.588211466
     1.527441608     1.564441608     1.003692059     1.45555215      2733.103752
     2731.532369     417.9134062     474.385065      2695.7082       56.47165879
     2258.718687     463.2754417     421.0998296     421.012895      361.9249126
KEY POINT #11 (t plus 8208.6405 s with a Mixing Number of 254.8528):  36.53177854
     0.040894        0.00925         0.3937     0.7793797652     0.7930647225
     1.010234481           1               1      29.40895034     110527.8788
     0.0560604913    0.05406252905   0.04798216976 8.245342853e-006    0.04798216976
     114.5482901     134.8067154     124.473113      123.0968613     114.6922455
     114.8406192     111.4767501     4.237215211     4.25431685      2.200877364
     0.6825201329    0.6842799945    0.6842799945     1.514262784     1.386887216
     0.04216711365    947.4604905     939.4573956     1.278913746     1.242412796
     0.0002439136993  0.0002230720489 1.311027719e-005 1.351632338e-005
     1528.777987     1514.15628      483.7215788     491.0746608     2.28484078
     2.228547864     2.265547864     1.667001461     2.189456391     2735.632193
     2734.767306     480.6796993     522.817425      2712.358491     42.13772569
     2212.814768     516.9628161     481.2884671     481.9197139     467.676962
KEY POINT #12 (t plus 0 s with a Mixing Number of 39.6359):  33.08521587        0.040894
     0.00925         0.3937     0.7836220492     0.7855031549     1.006313715
     1               1      27.75982624      101743.5513    0.06948876859
     0.05442750174    0.0434553287 1.006187186e-005    0.0434553287     40.66093633
     129.0613714     122.6753877     41.66791232     40.71885552     40.23158929
     36.87472868     4.17827036      4.251062793     2.189823602     0.6295271393
     0.6840381966    0.6840381966    4.279562952     1.40819784      0.04177166183
     992.0145929     940.9339203     1.213833482     1.192113967  0.0006447885825
     0.0002265930092  1.30482712e-005 1.329801054e-005     1532.620416
     1516.968672     482.9547405     487.5467971     2.160903368     2.1045156
     2.1415156    0.07648630269    0.08066835385     2724.421126     2723.650518
     170.4858849     515.163675      2709.794247     344.6777901     2209.257451
     174.6933078     170.7263833     168.6935511     154.6715116
KEY POINT #13 (t plus 8208.6405 s with a Mixing Number of 254.8528):  36.53177854
     0.040894        0.00925         0.3937     0.7793797652     0.7930647225
     1.010234481           1               1      29.40895034     110527.8788
     0.0560604913    0.05406252905   0.04798216976 8.245342853e-006    0.04798216976
     114.5482901     134.8067154     124.473113      123.0968613     114.6922455
     114.8406192     111.4767501     4.237215211     4.25431685      2.200877364
     0.6825201329    0.6842799945    0.6842799945     1.514262784     1.386887216
     0.04216711365    947.4604905     939.4573956     1.278913746     1.242412796
     0.0002439136993  0.0002230720489 1.311027719e-005 1.351632338e-005
     1528.777987     1514.15628      483.7215788     491.0746608     2.28484078
     2.228547864     2.265547864     1.667001461     2.189456391     2735.632193
     2734.767306     480.6796993     522.817425      2712.358491     42.13772569
     2212.814768     516.9628161     481.2884671     481.9197139     467.676962
```

```
KEY POINT #14 (t plus 3737.2608 s with a Mixing Number of 64.4178):  33.83158113
       0.040894         0.00925          0.3937     0.7877283078     0.7945388724
       1.005722397              1                1        23.234677       102407.731
       0.06355144889    0.05301664135    0.04443563204 5.065536873e-006    0.04443563204
       75.17457701      135.2141941      129.5889592      94.26377105      78.0896482
       68.42178886      57.00288861      4.191315097      4.264035882        2.234222
       0.6636862837     0.6847689184     0.6847689184      2.380413198      1.33005606
       0.043351429      974.8262096      935.1801587      1.479648245      1.456247394
       0.000376933624  0.0002135960097  1.32868225e-005 1.350980698e-005
       1558.114163      1505.718191      485.8346561      489.9603839      2.669536997
       2.618538282      2.655538282     0.3887813445     0.8234185076      2732.506623
       2731.966773      314.8883591      544.6327402      2719.521197      229.7443811
       2187.873883      395.0571551      327.1082361      286.6027061      238.8327099
End
```

D.25 TEST #25 - T25_SRV_STD_57KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T25_SRV_STD_57kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1691.7668 s, and ending (KEY POINT #11) at t
       plus 18621.6661 s, for a time period of 16929.8993 s.
Original Data Record Time:  20030.7427 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       6603.4197 s, T_bulk = 70.0701 C and T_out = 67.761 C
Stratification Beginning SP12 Temperature = 69.956 C
Stratification Beginning Pressure = 19.2421 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       16900.1006 s, T_bulk = 116.2053 C and T_out = 114.0093 C
Stratification Ending SP12 Temperature = 116.1249 C
Stratification Ending Pressure = 42.1972 psia
No Plume detected, setting t_plume (KEY POINT #2) to the end at 16929.8993 s.
At t = 16929.8993 s, the pool pressure is 42.3063 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 117.3251, 116.9493, 116.9278, 117.224, and
       114.4262 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 0 +/- 0 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 0 +/- 0 C.
Minimum Steam Quality:  0.9936 at t plus 16855.603 s
Maximum Steam Quality:  1.0174 at t plus 2627.9463 s
Time-Averaged Steam Quality:  1.0076 +/- 0.0049616
SRV Alignment, no RCIC Turbine 0 0 0 0 0 0
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 16839.8972 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.33739 degrees/min at t plus 10745.4896 s
       and 0.22283 degrees/min at t plus 8309.9443 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.3961 degrees/min at t plus 7018.6475
       s and 0.14012 degrees/min at t plus 339.4064 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.13307 degrees/min at t
       plus 10333.789 s and -0.14591 degrees/min at t plus 8349.6475 s, respectively
Max and min smoothed lower level changerates:  0.41737 degrees/min at t plus 10729.8977 s
       and 0.15482 degrees/min at t plus 10143.6781 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.20819 degrees/min at t
       plus 10145.8783 s and -0.19929 degrees/min at t plus 10731.4878 s, respectively
Max and min smoothed outlet level changerates:  0.49568 degrees/min at t plus 7996.9414 s
       and 0.061126 degrees/min at t plus 12571.92 s, respectively
Max and min smoothed lower-outlet level changerate differences:  0.21599 degrees/min at t
       plus 10730.6387 s and -0.18239 degrees/min at t plus 8076.743 s, respectively
Max and min smoothed hot (SP8) level changerates:  0.37154 degrees/min at t plus 5909.405
       s and 0.17485 degrees/min at t plus 10163.4803 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.16484 degrees/min
       at t plus 10333.883 s and -0.18319 degrees/min at t plus 7069.7224 s,
       respectively
The mean steam flow rate was 23.9164 +/- 0.92242 g/s
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The mean feedwater flow rate was 23.7145 +/- 1.0977 g/s
The mean water injection to steam flow rate was 0.0096928 +/- 0.026798 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is -0.14091 +/- 0.205 C over the Stratification Period, beginning at 0.3469 C and ending at -0.11539 C
Mean Smoothed SP8-Upper Pool delta T is -0.22317 +/- 0.19547 C over the Stratification Period, beginning at 0.10825 C and ending at -0.35347 C
The stratification period begins and ends with Smoothed SP8 readings of 70.9899 and 116.798 C, respectively
The stratification period begins and ends with condensing flows of 0.33727 and 0.80483 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 39.5461 and -115.5447 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2718.4167 +/- 1.0752 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.80306 and -620.5149 kg/s, respectively
The plume period had a mean steam enthalpy of 0 +/- 0 kJ/kg.
Maximum Smoothed Top-Mid delta T is 0.64757 degrees C at t plus 6368.9103 s with T_upper = 69.8538 C and T_mid = 69.2063 C
At t plus 6368.9103 s, Smoothed SP8-SP9 is 0.55351 C and Smoothed SP8-Top is -0.094059 C, where Smoothed SP8 is 69.7598 C and Pool P = 18.9846 psia
Maximum Smoothed Top-Lower delta T is 1.2709 degrees C at t plus 6509.7133 s with T_upper = 70.4505 C and T_low = 69.1796 C
At t plus 6509.7133 s, Smoothed SP8-SP9 is 0.076161 C and Smoothed SP8-Top is -0.097364 C, where Smoothed SP8 is 70.3531 C and Pool P = 19.133 psia
Maximum Smoothed Mid-Lower delta T is 1.4952 degrees C at t plus 7482.133 s with T_mid = 75.3094 C and T_low = 73.8142 C
At t plus 7482.133 s, Smoothed SP8-SP9 is -0.30494 C and Smoothed SP8-Top is 0.11512 C, where Smoothed SP8 is 75.0045 C and Pool P = 20.2598 psia
Maximum Smoothed Top-Outlet delta T is 4.1028 degrees C at t plus 7659.7361 s with T_upper = 75.7184 C and T_out = 71.6156 C
At t plus 7659.7361 s, Smoothed SP8-SP9 is -0.21127 C and Smoothed SP8-Top is 0.092383 C, where Smoothed SP8 is 75.8108 C and Pool P = 20.4894 psia
Maximum Smoothed Mid-Outlet delta T is 4.4689 degrees C at t plus 7482.332 s with T_mid = 75.3099 C and T_out = 70.8411 C
At t plus 7482.332 s, Smoothed SP8-SP9 is -0.30353 C and Smoothed SP8-Top is 0.11678 C, where Smoothed SP8 is 75.0064 C and Pool P = 20.2601 psia
Maximum Smoothed Lower-Outlet delta T is 3.9891 degrees C at t plus 13684.4407 s with T_low = 102.9397 C and T_out = 98.9506 C
At t plus 13684.4407 s, Smoothed SP8-SP9 is -0.18986 C and Smoothed SP8-Top is -0.31091 C, where Smoothed SP8 is 102.6498 C and Pool P = 31.8778 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 0.56935 degrees C at (KEY POINT #14) t plus 6386.6133 s with T_SP8 = 69.8783 C and T_SP9 = 69.309 C and Pool P = 19.0114 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 0.41262 degrees C at t plus 8325.5472 s with T_SP8 = 78.855 C and T_upper = 78.4424 C and Pool P = 21.3724 psia
Maximum Top-Mid delta T is 1.8778 degrees C at (KEY POINT #4) t plus 5238.1636 s ignoring SP 4, with temperatures of 65.3151 and 63.4373 C, respectively, at Set # 2, where Pool P = 17.884 psia and T_outlet = 61.3759 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5238.1636 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.50499 C and a raw SP12 Reading of 63.4373 C.
Maximum Top-Lower delta T is 1.994 degrees C at t plus 5428.5975 s, with temperatures of 66.1962 and 64.2022 C, respectively, at Set # 2, where Pool P = 18.0618 psia and T_outlet = 62.3223 C
Maximum Mid-Low delta T is 2.2984 degrees C at (KEY POINT #6) t plus 4913.6861 s ignoring SP 4, with temperatures of 64.107 and 61.8087 C, respectively, at Set # 2, where Pool P = 17.5857 psia and T_outlet = 59.9851 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 4913.6861 s with a Smoothed Mid-Axis Mid-Low Delta T of 0.77012 C and a raw SP12 Reading of 64.107 C.
Maximum Top-Outlet delta T is 4.8176 degrees C at t plus 7684.8366 s, with temperatures of 76.3598 and 71.5422 C, respectively, at Set # 1, where Pool P = 20.5177 psia
Maximum Mid-Outlet delta T is 4.1598 degrees C at t plus 5667.8462 s ignoring SP 4, with temperatures of 67.141 and 62.9812 C, respectively, at Set # 2, where Pool P = 18.2755 psia
Maximum Lower-Outlet delta T is 4.4134 degrees C at (KEY POINT #8) t plus 312.9049 s, with temperatures of 42.7376 and 38.3242 C, respectively, at Set # 1, where Pool P = 14.9519 psia

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Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 9730.9715 s with a Smoothed
        Mid-Axis Low-Outlet Delta T of 1.4708 C and a raw SP12 Reading of 84.2147 C.
Minimum SP Pressure is 14.8651 psia at t plus 53.035 s
Maximum SP Pressure is 42.3064 psia at t plus 16929.1423 s
Beginning SP Pressure is 14.8724 psia
Ending SP Pressure is 42.3063 psia
Time-Average SP Pressure is 23.8366 +/- 7.793 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.5315 cm (cold) / 77.6764 cm (hot) at 14.5453 psia
Beginning Smoothed SP Level is 77.8835 cm (cold) / 78.0552 cm (hot) at 14.8659 psia
Ending Smoothed SP Level is 78.8656 cm (cold) / 80.3502 cm (hot) at 42.312 psia
Minimum Smoothed Cold SP Level is 77.6424 cm at t plus 10599.3842 s and 25.0142 psia
Minimum Smoothed Hot SP Level is 78.0535 cm at t plus 32.1008 s and 14.8741 psia
Maximum Smoothed Cold SP Level is 78.8909 cm at t plus 16654.6976 s and 41.2695 psia
Maximum Smoothed Hot SP Level is 80.3533 cm at t plus 16823.9192 s and 41.9066 psia
SP 12 Temperature at the beginning is 39.7858 C, and at the end is 116.2199 C
At plume detection, the Mixing Number is 257.6212
The Mixing Number ranges from a minimum of 32.9355 at (KEY POINT #12) t plus 0 s to a
        maximum of 258.5348 at (KEY POINT #13) t plus 16885.1507 s; it had a mean value
        of 97.5297 +/- 61.7823 over the test period.
Key Points have Data Dumps of the following for each Key Point:  Sparger Massflux (kg/m2-
        s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet
        Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1,
        Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1,
        Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat
        Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,
        Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
        Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
        Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
        (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
        Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
        Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 32.9355):  15.7813689        0.040894
        0.00925          0.3937     0.778835164     0.780551912      1.00830913
        1               1      26.9054711      51154.2295    0.0697067273    0.0588738685
        0.0207278253 5.08205061e-006    0.0207278253      39.3198886      109.289089
        100.197122      39.1941363      39.4943748      40.0334569      37.1190151
        4.17855667      4.21689432      2.07827362     0.627765276     0.677838671
        0.677838671      4.40103552      1.74910493    0.0376388204      992.476182
        958.212648     0.602081769     0.586692503  0.000661189375   0.00028115738
        1.22760775e-005 1.26160301e-005      1530.16435      1544.91056      472.356696
        478.692918      1.02133481      1.02496454      1.06196454    0.0712082334
        0.0707298422      2695.35193      2694.62802      164.786753       419.93091
        2675.88303      255.144157      2275.42102      164.261289      165.514344
        167.770027      155.595783
KEY POINT #2 (t plus 16929.8993 s with a Mixing Number of 257.6212):  19.3316694
        0.040894         0.00925          0.3937     0.788656314     0.803502014
        0.99864144      0.99864144     0.999997695      12.2208543      59132.5479
        0.0555809724    0.0525284558    0.0253909194 1.85852259e-005    0.0253909194
        116.949322      131.959277      131.959277      116.927815      117.325128
        117.224021      114.426164      4.24096055      4.26877639      2.25063417
        0.683091683     0.684896479     0.684896479      1.48109233      1.30551188
        0.0439306527      945.589105      933.160635      1.58086996      1.58301694
        0.0002385596  0.000209460606 1.33686539e-005 1.33691058e-005      1525.62735
        1501.59479      486.778577      486.753004      2.86477374      2.91730979
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       2.95430979      1.8021435      1.80089439      2719.97409      2719.82474
       490.906964      554.758609     2722.77011      63.8516447      2165.21548
       490.815755      492.499647      492.07329      480.216118
KEY POINT #3 (t plus 6603.4197 s with a Mixing Number of 60.1263):  18.0812751
       0.040894         0.00925         0.3937     0.778250598     0.783628121
       1.01368497             1              1      25.2296215      56603.6886
       0.0643660181    0.0575897134    0.0237486058 9.98159096e-006    0.0237486058
       70.6429975      121.548735      106.8057      70.9899009      70.8816522
       69.7482559      67.8179327      4.1884331      4.2257403      2.10630112
       0.660142955     0.680284615     0.680284615      2.54020261      1.63243468
       0.038709631      977.421869      953.363303     0.747185981     0.716969719
       0.000400363767  0.00026279897  1.250228e-005 1.30630296e-005      1557.73678
       1538.15194      475.658955      485.803537      1.28656211      1.32644324
       1.36344324      0.32078578     0.325608445      2717.45035      2716.81382
       295.796936      447.846981      2686.18227      152.050045      2269.60337
       297.249957      296.795157      292.051102      283.972044
KEY POINT #4 (t plus 5238.1636 s with a Mixing Number of 51.4485):  17.9032882
       0.040894         0.00925         0.3937     0.778592206     0.783063068
       1.01453689             1              1      26.6200308      56165.8949
       0.0655320051    0.0579583981    0.0235148314 7.93220637e-006    0.0235148314
       64.0536452      120.682541      104.918682      64.0574091      64.4201702
       63.6102757      61.3060709      4.18461626      4.22311629      2.09792745
       0.654565944     0.679640319     0.679640319      2.80786308      1.66414041
       0.0383926318     981.083783      954.767916     0.703128465     0.672776362
       0.000439211492  0.000267815717  1.2437599e-005 1.30352605e-005       1555.9611
       1540.21198      474.731155      485.543444      1.20562142      1.23286355
       1.26986355     0.239999544     0.240040213      2716.58788      2715.87925
       268.203247      439.869454      2683.26722      171.666207      2276.71842
       268.218997      269.735637      266.349464      256.712845
KEY POINT #5 (t plus 5238.1636 s with a Mixing Number of 51.4485):  17.9032882
       0.040894         0.00925         0.3937     0.778592206     0.783063068
       1.01453689             1              1      26.6200308      56165.8949
       0.0655320051    0.0579583981    0.0235148314 7.93220637e-006    0.0235148314
       64.0536452      120.682541      104.918682      64.0574091      64.4201702
       63.6102757      61.3060709      4.18461626      4.22311629      2.09792745
       0.654565944     0.679640319     0.679640319      2.80786308      1.66414041
       0.0383926318     981.083783      954.767916     0.703128465     0.672776362
       0.000439211492  0.000267815717  1.2437599e-005 1.30352605e-005       1555.9611
       1540.21198      474.731155      485.543444      1.20562142      1.23286355
       1.26986355     0.239999544     0.240040213      2716.58788      2715.87925
       268.203247      439.869454      2683.26722      171.666207      2276.71842
       268.218997      269.735637      266.349464      256.712845
KEY POINT #6 (t plus 4913.6861 s with a Mixing Number of 50.0134):  17.8426597
       0.040894         0.00925         0.3937     0.778365421     0.782600182
       1.01463723             1              1      26.9070903      56017.5468
       0.0657516725    0.0580393034    0.0234351997 1.45265227e-005    0.0234351997
       62.7980351      120.397607      104.503493      62.377167      62.8564792
       62.3033172      59.9430052      4.18399269      4.22254955      2.09612578
       0.653431848     0.679492784     0.679492784      2.86433109      1.67128267
       0.0383241162     981.753735      955.074836     0.693724372     0.663532157
       0.000447334711   0.00026894285 1.24233768e-005 1.30255209e-005      1555.40294
       1540.65146      474.525374      485.422134      1.18838889      1.21280922
       1.24980922     0.226754935     0.222456844      2716.20038      2715.47639
       262.947729      438.114906      2682.62302      175.167178      2278.08548
       261.186863      263.190842      260.879395      251.009504
KEY POINT #7 (t plus 4913.6861 s with a Mixing Number of 50.0134):  17.8426597
       0.040894         0.00925         0.3937     0.778365421     0.782600182
       1.01463723             1              1      26.9070903      56017.5468
       0.0657516725    0.0580393034    0.0234351997 1.45265227e-005    0.0234351997
       62.7980351      120.397607      104.503493      62.377167      62.8564792
       62.3033172      59.9430052      4.18399269      4.22254955      2.09612578
       0.653431848     0.679492784     0.679492784      2.86433109      1.67128267
       0.0383241162     981.753735      955.074836     0.693724372     0.663532157
       0.000447334711   0.00026894285 1.24233768e-005 1.30255209e-005      1555.40294
       1540.65146      474.525374      485.422134      1.18838889      1.21280922
       1.24980922     0.226754935     0.222456844      2716.20038      2715.47639
```

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       262.947729      438.114906      2682.62302      175.167178      2278.08548
       261.186863      263.190842      260.879395      251.009504
KEY POINT #8 (t plus 312.9049 s with a Mixing Number of 33.4559):  16.1225646
       0.040894         0.00925         0.3937     0.779006603     0.780860017
       1.01154193              1              1       27.641193      51687.3966
       0.0694673549      0.05884461    0.0211759641 2.07576937e-005    0.0211759641
       40.7923652      113.007466      100.348835      40.6359698      40.8312894
       41.3021971      38.3490232      4.17853395      4.21708669      2.07887735
       0.629637057     0.677900808     0.677900808      4.26845857       1.7462426
       0.0376621953     991.913558      958.103525     0.605133029     0.583852102
       0.000643187234  0.000280710205 1.22812597e-005 1.27558399e-005      1532.66405
       1544.76992      472.434148      481.171726      1.02687001      1.03091571
       1.06791571    0.0770212894    0.0763850388      2702.91969      2702.15566
       170.940084      420.571097      2676.12225      249.631012      2282.3486
       170.286581      171.101227      173.072025      160.736057
KEY POINT #9 (t plus 16900.1006 s with a Mixing Number of 258.1257):  19.3104902
       0.040894         0.00925         0.3937     0.788707239     0.803514088
       0.99853481      0.99853481     0.999997521      12.2345044      59081.3989
       0.0555881629    0.0525471085    0.0253631019 1.37946999e-005    0.0253631019
       116.913409      131.868911      131.868911      116.798022      117.151494
       117.099644      114.244856      4.24090286      4.26859284      2.24999719
       0.683083783     0.684892756     0.684892756       1.4815763      1.30642794
       0.0439082082      945.617309      933.238065       1.5769116      1.57922155
       0.000238638039  0.000209615455 1.33655339e-005 1.33660205e-005      1525.67618
       1501.75444      486.743002      486.715455      2.85712432      2.90965992
       2.94665992      1.80005809      1.79337112      2719.61983      2719.47015
       490.754117      554.372353      2722.64708      63.6182361      2165.24748
       490.264786      491.762648      491.545224      479.447425
KEY POINT #10 (t plus 9730.9715 s with a Mixing Number of 88.3552):  18.4067834
       0.040894         0.00925         0.3937     0.776704849     0.784245298
       1.01002367              1              1      20.9736149      57390.3415
       0.0617740682    0.0563938154    0.0241761404 5.92674364e-006    0.0241761404
       84.8728485      123.422585      112.871899      84.5621553      84.8870366
       84.5566344       82.645315      4.19974253      4.23472018      2.13536652
       0.670126681     0.682067434     0.682067434      2.09238684      1.53834166
       0.039793463      968.730034      948.741435     0.904257622     0.877831307
       0.000333869098  0.000247773809 1.27106166e-005 1.31159178e-005      1555.54254
       1530.85092      478.556782      485.929674      1.57766311      1.62118796
       1.65818796     0.575795749     0.568811807      2718.11646      2717.67657
       355.496793       473.52916      2695.40522      118.032367       2244.5873
       354.192007      355.555045      354.170236      346.149013
KEY POINT #11 (t plus 16929.8993 s with a Mixing Number of 257.6212):  19.3316694
       0.040894         0.00925         0.3937     0.788656314     0.803502014
       0.99864144      0.99864144     0.999997695      12.2208543      59132.5479
       0.0555809724    0.0525284558    0.0253909194 1.85852259e-005    0.0253909194
       116.949322      131.959277      131.959277      116.927815      117.325128
       117.224021      114.426164      4.24096055      4.26877639      2.25063417
       0.683091683     0.684896479     0.684896479      1.48109233      1.30551188
       0.0439306527      945.589105      933.160635      1.58086996      1.58301694
       0.0002385596  0.000209460606 1.33686539e-005 1.33691058e-005      1525.62735
       1501.59479      486.778577      486.753004      2.86477374      2.91730979
       2.95430979       1.8021435      1.80089439      2719.97409      2719.82474
       490.906964      554.758609      2722.77011      63.8516447      2165.21548
       490.815755      492.499647       492.07329      480.216118
KEY POINT #12 (t plus 0 s with a Mixing Number of 32.9355):  15.7813689        0.040894
       0.00925          0.3937     0.778835164     0.780551912      1.00830913
       1               1      26.9054711      51154.2295    0.0697067273    0.0588738685
       0.0207278253 5.08205061e-006    0.0207278253      39.3198886      109.289089
       100.197122      39.1941363      39.4943748      40.0334569      37.1190151
       4.17855667      4.21689432      2.07827362     0.627765276     0.677838671
       0.677838671      4.40103552      1.74910493    0.0376388204      992.476182
       958.212648     0.602081769     0.586692503  0.000661189375   0.00028115738
       1.22760775e-005 1.26160301e-005      1530.16435      1544.91056      472.356696
       478.692918      1.02133481      1.02496454      1.06196454    0.0712082334
       0.0707298422      2695.35193      2694.62802      164.786753       419.93091
       2675.88303      255.144157      2275.42102      164.261289      165.514344
       167.770027      155.595783
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KEY POINT #13 (t plus 16885.1507 s with a Mixing Number of 258.5348):  19.338571
       0.040894         0.00925          0.3937      0.788707509     0.803498179
       0.998435983     0.998435983     0.999997357      12.2645023        59174.25
       0.0555885827    0.0525566683    0.0253999841 8.96296035e-006    0.0253999841
       116.911312      131.822592      131.822592      116.727251      117.072935
       117.038411      114.131704      4.24090037      4.26849884      2.24967104
       0.683083118     0.684890813     0.684890813      1.48160473      1.30689808
       0.0438967149      945.618784      933.27774      1.57488573      1.57734856
       0.000238642527  0.000209694912 1.33639347e-005 1.33644536e-005      1525.67825
       1501.83619      486.724755      486.695367      2.85320982      2.90574654
       2.94274654       1.7999364       1.7892798      2719.34298      2719.19257
       490.744947      554.174374      2722.58399      63.4294267      2165.16861
       489.964392      491.429186      491.285252      478.967782
KEY POINT #14 (t plus 6386.6133 s with a Mixing Number of 58.1547):  18.0654861
       0.040894         0.00925          0.3937      0.77835866     0.783585897
       1.01390526               1               1      25.4922163      56560.4796
       0.0646038538    0.0576516648    0.0237278681 1.89340726e-005    0.0237278681
       69.3089606      121.487187      106.489185      69.8783126      69.9241998
       68.7114288       66.700166      4.18758647      4.22529463      2.10487518
       0.659064162     0.680179541     0.680179541      2.59077834      1.63766774
       0.038655813      978.182746      953.600006     0.739643527     0.709232245
       0.000407750185  0.000263628502 1.24914263e-005 1.30615934e-005      1557.52982
       1538.5046      475.504192      485.816388      1.27268167      1.31033905
       1.34733905     0.302798327     0.310367925      2717.48112      2716.83127
       290.208664      446.508524      2685.69481      156.299861      2270.9726
       292.592976      292.783759      287.708036       279.29137
End
```

D.26 TEST #26 -

T26_RCIC_1ATM_VENT82C_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T26_RCIC_1ATM_VENT82C_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1509.1673 s, and ending (KEY POINT #11) at t
       plus 10111.6164 s, for a time period of 8602.4491 s.
Original Data Record Time:  11495.6395 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2640.345 s, T_bulk = 63.6021 C and T_out = 61.4211 C
Stratification Beginning SP12 Temperature = 63.4172 C
Stratification Beginning Pressure = 15.2914 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       6323.8097 s, T_bulk = 97.0206 C and T_out = 70.8237 C
Stratification Ending SP12 Temperature = 96.9722 C
Stratification Ending Pressure = 22.0599 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 2082.5331 s.
At t = 2082.5331 s, the pool pressure is 15.2922 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 59.1194, 59.1647, 61.1649, 58.9958, and
       56.2378 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 8.5801 +/- 2.1794 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 7.9115 +/- 1.9317 C.
Minimum Steam Quality:  0.99202 at t plus 25.8015 s
Maximum Steam Quality:  1.0028 at t plus 2775.4548 s
Time-Averaged Steam Quality:  0.99993 +/- 0.0012993
Minimum Turbine Outlet Steam Quality:  1.0072 at t plus 8593.6485 s
Maximum Turbine Outlet Steam Quality:  1.0254 at t plus 4198.5711 s
Time-Averaged Turbine Outlet Steam Quality:  1.0191 +/- 0.0043041
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 8512.4489 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.84043 degrees/min at t plus 3772.8678 s
       and 0.41471 degrees/min at t plus 3417.2585 s, respectively
```

Max and min smoothed mid (SP9) level changerates: 0.7516 degrees/min at t plus 3835.6664 s and 0.36488 degrees/min at t plus 6562.7144 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.20378 degrees/min at t plus 6562.7144 s and -0.27064 degrees/min at t plus 7050.6223 s, respectively
Max and min smoothed lower level changerates: 1.2781 degrees/min at t plus 4573.3776 s and 0.044961 degrees/min at t plus 3701.0637 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.59245 degrees/min at t plus 3701.0637 s and -0.70995 degrees/min at t plus 4573.3776 s, respectively
Max and min smoothed outlet level changerates: 5.7403 degrees/min at t plus 6529.0134 s and -0.048199 degrees/min at t plus 5084.6958 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.2426 degrees/min at t plus 4573.3776 s and -5.0585 degrees/min at t plus 6532.9357 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.2131 degrees/min at t plus 2512.6417 s and 0.24144 degrees/min at t plus 3461.656 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.6746 degrees/min at t plus 2516.873 s and -0.32688 degrees/min at t plus 3843.8649 s, respectively
The mean steam flow rate was 45.565 +/- 1.3016 g/s
The mean feedwater flow rate was 44.6838 +/- 1.5754 g/s
The mean water injection to steam flow rate was 0.0097884 +/- 0.028318 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 9.2768 +/- 1.2571 C over the Stratification Period, beginning at 6.465 C and ending at 11.7715 C
Mean Smoothed SP8-Upper Pool delta T is 8.5209 +/- 1.1511 C over the Stratification Period, beginning at 5.8939 C and ending at 10.8756 C
The stratification period begins and ends with Smoothed SP8 readings of 70.6423 and 109.2254 C, respectively
The stratification period begins and ends with condensing flows of 0.64802 and 1.6396 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 4.0282 and 2.1077 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2730.8514 +/- 1.1326 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.56834 and 13.146 kg/s, respectively
The plume period had a mean steam enthalpy of 2732.9937 +/- 0.91994 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.7985 degrees C at t plus 6653.4135 s with T_upper = 101.3939 C and T_mid = 99.5954 C
At t plus 6653.4135 s, Smoothed SP8-SP9 is 11.94 C and Smoothed SP8-Top is 10.1415 C, where Smoothed SP8 is 111.5354 C and Pool P = 23.4219 psia
Maximum Smoothed Top-Lower delta T is 6.5168 degrees C at t plus 4451.0766 s with T_upper = 82.1349 C and T_low = 75.6181 C
At t plus 4451.0766 s, Smoothed SP8-SP9 is 8.1524 C and Smoothed SP8-Top is 7.2914 C, where Smoothed SP8 is 89.4263 C and Pool P = 15.2931 psia
Maximum Smoothed Mid-Lower delta T is 5.6576 degrees C at t plus 4451.8766 s with T_mid = 81.2811 C and T_low = 75.6236 C
At t plus 4451.8766 s, Smoothed SP8-SP9 is 8.2045 C and Smoothed SP8-Top is 7.3481 C, where Smoothed SP8 is 89.4856 C and Pool P = 15.2923 psia
Maximum Smoothed Top-Outlet delta T is 27.4555 degrees C at t plus 6341.9107 s with T_upper = 98.5772 C and T_out = 71.1217 C
At t plus 6341.9107 s, Smoothed SP8-SP9 is 11.6858 C and Smoothed SP8-Top is 10.6089 C, where Smoothed SP8 is 109.1861 C and Pool P = 22.1177 psia
Maximum Smoothed Mid-Outlet delta T is 26.5262 degrees C at t plus 6324.6097 s with T_mid = 97.4617 C and T_out = 70.9355 C
At t plus 6324.6097 s, Smoothed SP8-SP9 is 11.7431 C and Smoothed SP8-Top is 10.8452 C, where Smoothed SP8 is 109.2048 C and Pool P = 22.062 psia
Maximum Smoothed Lower-Outlet delta T is 26.8493 degrees C at t plus 6326.0088 s with T_low = 97.797 C and T_out = 70.9477 C
At t plus 6326.0088 s, Smoothed SP8-SP9 is 11.7032 C and Smoothed SP8-Top is 10.7966 C, where Smoothed SP8 is 109.1745 C and Pool P = 22.0628 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 12.5882 degrees C at (KEY POINT #14) t plus 6199.7076 s with T_SP8 = 108.848 C and T_SP9 = 96.2597 C and Pool P = 21.5888 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 11.351 degrees C at t plus 6199.6096 s with T_SP8 = 108.8474 C and T_upper = 97.4964 C and Pool P = 21.5897 psia
Maximum Top-Mid delta T is 2.2039 degrees C at (KEY POINT #4) t plus 3775.2629 s ignoring SP 4, with temperatures of 75.7427 and 73.5389 C, respectively, at Set # 2, where Pool P = 15.2903 psia and T_outlet = 67.2342 C

Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 3996.1786 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.99997 C and a raw SP12 Reading of 76.7294 C.
Maximum Top-Lower delta T is 8.9909 degrees C at t plus 4725.7823 s, with temperatures of 85.4287 and 76.4379 C, respectively, at Set # 1, where Pool P = 16.0928 psia and T_outlet = 69.7055 C
Maximum Mid-Low delta T is 5.8443 degrees C at (KEY POINT #6) t plus 4453.9778 s ignoring SP 4, with temperatures of 81.2265 and 75.3822 C, respectively, at Set # 2, where Pool P = 15.2906 psia and T_outlet = 69.5136 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 4729.3845 s with a Smoothed Mid-Axis Mid-Low Delta T of 1.9481 C and a raw SP12 Reading of 83.9083 C.
Maximum Top-Outlet delta T is 27.769 degrees C at t plus 6317.5123 s, with temperatures of 98.5289 and 70.7599 C, respectively, at Set # 1, where Pool P = 22.0199 psia
Maximum Mid-Outlet delta T is 26.4062 degrees C at t plus 6338.6125 s ignoring SP 4, with temperatures of 97.4816 and 71.0754 C, respectively, at Set # 2, where Pool P = 22.1052 psia
Maximum Lower-Outlet delta T is 27.6752 degrees C at (KEY POINT #8) t plus 6300.4094 s, with temperatures of 98.4029 and 70.7277 C, respectively, at Set # 1, where Pool P = 21.9649 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 6569.4147 s with a Smoothed Mid-Axis Low-Outlet Delta T of 9.222 C and a raw SP12 Reading of 98.8064 C.
Minimum SP Pressure is 15.0019 psia at t plus 5.8023 s
Maximum SP Pressure is 35.42 psia at t plus 8602.4491 s
Beginning SP Pressure is 15.0056 psia
Ending SP Pressure is 35.42 psia
Time-Average SP Pressure is 19.3841 +/- 5.807 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.0053 cm (cold) / 77.1471 cm (hot) at 14.6275 psia
Beginning Smoothed SP Level is 77.5295 cm (cold) / 77.7042 cm (hot) at 15.0073 psia
Ending Smoothed SP Level is 78.3837 cm (cold) / 79.8394 cm (hot) at 35.4126 psia
Minimum Smoothed Cold SP Level is 77.0556 cm at t plus 6859.8234 s and 24.4406 psia
Minimum Smoothed Hot SP Level is 77.667 cm at t plus 1136.419 s and 15.2928 psia
Maximum Smoothed Cold SP Level is 78.3881 cm at t plus 8563.2508 s and 35.1228 psia
Maximum Smoothed Hot SP Level is 79.8402 cm at t plus 8601.45 s and 35.4055 psia
SP 12 Temperature at the beginning is 40.0993 C, and at the end is 116.1783 C
At plume detection, the Mixing Number is 43.1113
The Mixing Number ranges from a minimum of 33.092 at (KEY POINT #12) t plus 0 s to a maximum of 265.6553 at (KEY POINT #13) t plus 8594.2756 s; it had a mean value of 95.099 +/- 63.2521 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 33.092): 32.12299817 0.040894
0.00925 0.3937 0.7752947668 0.7770417406 1.01508366
1 1 51.98562368 101259.0949 0.0695913551
0.05845146077 0.04219151689 7.518137368e-006 0.04219151689 40.03049824
118.8719371 102.3821718 40.38905902 39.99034888 40.14875671

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       37.10384371      4.178537448      4.219713153       2.08714423     0.6286735691
       0.6787062992     0.6787062992      4.336370381      1.708746198    0.03798083344
       992.2107477      956.6309505     0.6472594501     0.6180309077  0.0006524200102
       0.0002748378306 1.235076643e-005 1.297303603e-005      1531.388781
       1542.818238      473.4648448      484.7481391      1.103484274      1.034718392
       1.071718392    0.07396443077    0.07538978576      2715.959198      2713.256693
       167.7569336        429.15424      2679.316018      261.3973065      2286.804958
       169.2551925      167.5876612      168.2526757      155.5332582
KEY POINT #2 (t plus 2082.5331 s with a Mixing Number of 43.1113):  33.86741642
       0.040894          0.00925          0.3937     0.7732251275      0.776964192
       1.021292233              1                1      54.11118369      104383.2621
       0.06638273419     0.0582673855    0.04448269941 9.781019026e-006    0.04448269941
       59.16472889      126.645787      103.3308756      61.16492946      59.11940016
       58.99575949      56.23781761      4.182398101      4.220969441      2.091115143
       0.6500137008     0.6790648055     0.6790648055      3.039100596       1.69178802
       0.03813296622      983.641766      955.9375131     0.6677157224     0.6260233283
       0.0004723263968  0.0002721729496 1.238322786e-005 1.326816291e-005
       1553.355625      1541.865541      473.9410179      489.6786587      1.140813636
       1.05426262       1.09126262     0.1918730746     0.2104618939      2731.583419
       2728.655399      247.7357094      433.1608712      2680.798181      185.4251618
       2298.422548      256.1021893      247.5446961      247.0305339      235.5012192
KEY POINT #3 (t plus 2640.345 s with a Mixing Number of 47.136):  34.10870152
       0.040894          0.00925          0.3937     0.7725502866     0.7769150951
       1.021774835              1                1      54.95701958      105019.9145
       0.06551032867    0.05830878328    0.04479961206 8.118896114e-006    0.04479961206
       64.17729651      126.9835477      103.1176986      70.64231007      64.74842759
       64.01254673      61.45689986      4.184719343      4.220685431      2.090216455
       0.6546669858     0.6789852041     0.6789852041      2.802544188       1.69556954
       0.03809858674      981.0151614      956.0936828     0.6630738951      0.620755696
       0.0004384363695  0.0002727676936 1.237593199e-005 1.328168326e-005
       1555.9807      1542.081928      473.8342841      489.926578      1.132336044
       1.054293348      1.091293348     0.2413386716     0.3207762832      2732.440151
       2729.419877      268.705853      432.2604575      2680.465582      163.5546045
       2300.179693      295.7718399      271.0945505      268.0179243      257.3288695
KEY POINT #4 (t plus 3775.2629 s with a Mixing Number of 58.9357):  34.62123231
       0.040894          0.00925          0.3937     0.7719950154      0.777907966
       1.022266776              1                1      56.24754711      106484.2289
       0.06375767287    0.05834876664    0.04547278869 1.037108454e-005    0.04547278869
       74.03269581      127.3392114      102.9117047      83.19025321      75.25512996
       72.54072764      67.10429218      4.190819732      4.220411938       2.08935159
       0.6627550209     0.6789077587     0.6789077587      2.419219798      1.699239559
       0.03806547323      975.4379115      956.2443966     0.6586134746     0.6156557972
       0.0003825862649  0.0002733446255 1.236888288e-005 1.329587196e-005
       1557.872338      1542.289752      473.7310012      490.1843528      1.124193621
       1.054267396      1.091267396     0.3705977286     0.5388149937      2733.380219
       2730.216432      309.9763199      431.3904446      2680.143942      121.4141247
       2301.989774      348.3869287      315.0984965      303.7260039      280.9619924
KEY POINT #5 (t plus 3996.1786 s with a Mixing Number of 63.5247):  34.72902357
       0.040894          0.00925          0.3937     0.7718946322     0.7781193432
       1.022348221              1                1      56.44152672      106787.3312
       0.06327717839    0.05834845266    0.04561436565 1.716074362e-005    0.04561436565
       76.68771792      127.4313434      102.9133227      85.38951066      77.38768641
       73.29709537      68.44577368      4.192809473      4.220414082      2.089358369
       0.6647006467     0.6789083691     0.6789083691      2.331194218      1.699210671
       0.03806573291      973.8460813      956.2432135     0.6586484141     0.6155412711
       0.0003695723152  0.0002733400853 1.236893825e-005 1.329941177e-005
       1557.691797      1542.288125      473.731813      490.243419      1.124257388
       1.054253106      1.091253106     0.4140300275     0.5875683949      2733.58766
       2730.402014      321.1056478      431.397278      2680.146469      110.2916302
       2302.190382      357.6223225      324.0393117      306.8952027      286.5783691
KEY POINT #6 (t plus 4453.9778 s with a Mixing Number of 74.0127):  34.94783353
       0.040894          0.00925          0.3937     0.7717118507     0.7786073981
       1.022516618              1                1      56.80404153      107400.9865
       0.06243399257    0.05834777565    0.04590175864 5.415621659e-006    0.04590175864
       81.30113521      127.6219873      102.9168115      89.49232223      82.14475012
       75.66373279      69.55944445      4.196615969      4.220418707      2.089372989
       0.66785242     0.6789096849     0.6789096849      2.191036383      1.699148386
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      0.03806629286      970.9933774      956.2406626      0.658723756      0.6153075702
      0.0003486830726  0.0002733302963 1.236905762e-005 1.330673722e-005
      1556.726789      1542.284615      473.7335634      490.3655761      1.124394892
      1.054239956      1.091239956      0.4996869135      0.6883998627      2734.012635
      2730.785936      340.4574403      431.4120123      2680.151919      90.95457198
      2302.600623      374.8639225      343.9967368      316.814125      291.2417968
KEY POINT #7 (t plus 4729.3845 s with a Mixing Number of 80.6335):  35.04036703
      0.040894         0.00925          0.3937     0.7732379057     0.7806248165
      1.021812666              1                1      54.3521079      107562.7182
      0.06195026974    0.05808315764    0.04602329551 9.986768363e-006    0.04602329551
      83.92245459      128.1045956      104.2782761      92.33644629      84.79209298
      81.32700224      69.72257908      4.198964131      4.222243717      2.095154531
      0.6695187189     0.6794118808     0.6794118808      2.117936138      1.675182567
      0.03828713394     969.3269137      955.2410021      0.6886661495     0.6448318553
      0.0003377018344    0.00026955785 1.241566352e-005 1.332190923e-005
      1555.834295      1540.887754      474.4135029      490.4850004      1.179126576
      1.11038952       1.14738952     0.5546553001     0.7664493458      2734.199136
      2731.244984      351.4655965      437.1632654      2682.273153      85.69766895
      2297.03587       386.8305818      355.116196      340.5718741      291.929573
KEY POINT #8 (t plus 6300.4094 s with a Mixing Number of 125.5324):  35.06509258
      0.040894         0.00925          0.3937     0.7710103267      0.780610561
      1.016530622              1                1      40.72944722      107131.1167
      0.05946538753    0.05639600116    0.04605577094 9.885778489e-006    0.04605577094
      97.11811774      130.3690049      112.860886      109.2643423      98.10580254
      97.36978089      70.73272397      4.21295266      4.234703113      2.135310669
      0.6765517048     0.6820645917     0.6820645917      1.809189405      1.538502351
      0.03979140233     960.4352594      948.7499724     0.9039500134     0.8611120853
      0.0002905349941  0.0002477996567 1.271023789e-005 1.338501772e-005
      1547.740903      1530.865096      478.5516403      490.5722022      1.577089466
      1.514926185      1.551926185     0.9142233685      1.398689391      2733.777065
      2732.118177      406.9932116      473.482481      2695.388685      66.48926936
      2260.294584      458.2602733      411.1535882      408.0548574      296.193276
KEY POINT #9 (t plus 6323.8097 s with a Mixing Number of 127.4873):  35.06380873
      0.040894         0.00925          0.3937     0.7710007765     0.7806442933
      1.016425685              1                1      40.57949676      107133.0952
      0.05940108778    0.05637437911     0.0460540847 1.149065311e-005     0.0460540847
      97.45391681      130.3589539      112.9698189      109.2254455      98.34987487
      97.74376425      70.92869353      4.213358078      4.234872064      2.135863596
      0.6767014426     0.6820926391     0.6820926391      1.802440309      1.536914501
      0.0398117998      960.1980068      948.6655081     0.9069963721     0.8642925633
      0.000289487372   0.000247544212   1.2713984e-005 1.338428047e-005
      1547.459435      1530.724778      478.6024758      490.5457205      1.582771027
      1.520672755      1.557672755     0.9254317688      1.396854929      2733.690301
      2732.043605       408.40842       473.9441979      2695.552173      65.53577788
      2259.746103      458.0961896      412.1826181      409.6310631      297.0145634
KEY POINT #10 (t plus 6569.4147 s with a Mixing Number of 132.9717):  35.1046525
      0.040894         0.00925          0.3937     0.7708691994     0.7809034876
      1.016008564              1                1      39.01661424      107058.3972
      0.05912469307    0.05612282508    0.04610773039 7.584911267e-006    0.04610773039
      98.89428294      131.1053721      114.2352586      110.6320402      100.5417726
      100.2028889      89.47545659      4.215114846      4.236855034      2.142369836
      0.6773301342     0.6824082541     0.6824082541      1.774029383      1.518717534
      0.04005125968     959.1764024      947.6805268     0.9429985564     0.8998840121
      0.000285070183   0.000244611952 1.275751261e-005 1.340922055e-005
      1546.22097      1529.071329      479.1898418      490.804152      1.65001182
      1.588671251      1.625671251     0.9748099623      1.464464783      2734.477122
      2732.954826      414.4835919      479.3092566      2697.445648      64.8256647
      2255.167865      464.0513447      421.4283795      420.0019402      374.8393064
KEY POINT #11 (t plus 8602.4491 s with a Mixing Number of 265.116):  36.55809967
      0.040894         0.00925          0.3937     0.7838366873      0.79839433
      1.008815198              1                1      26.95952323      110271.3178
      0.0555672    0.05346942301    0.04801674089 5.364221568e-006    0.04801674089
      117.0181003      136.1645972      127.3806378      125.8031651      117.2859049
      117.3566581      114.2175139      4.241194308      4.259755956      2.219482431
      0.6830779249     0.6845938473     0.6845938473      1.480233455      1.353919546
      0.04282932882     945.5175837      937.0401595      1.390102184      1.35618807
      0.0002384033184  0.0002175911015 1.321060018e-005 1.355753208e-005
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       1525.423773      1509.438711      484.9351553      491.2592809      2.497497851
       2.441609699      2.478609699       1.80614289      2.380212137      2736.409074
       2735.682258      491.1648663      535.2094238      2716.454155      44.04455751
       2201.19965      528.4908585      492.2995269      492.6021231      479.2980209
KEY POINT #12 (t plus 0 s with a Mixing Number of 33.092):  32.12299817         0.040894
       0.00925          0.3937     0.7752947668     0.7770417406       1.01508366
       1                1      51.98562368      101259.0949     0.0695913551
       0.05845146077    0.04219151689 7.518137368e-006    0.04219151689      40.03049824
       118.8719371      102.3821718      40.38905902      39.99034888      40.14875671
       37.10384371      4.178537448      4.219713153       2.08714423     0.6286735691
       0.6787062992     0.6787062992      4.336370381      1.708746198    0.03798083344
       992.2107477      956.6309505     0.6472594501     0.6180309077  0.0006524200102
       0.0002748378306 1.235076643e-005 1.297303603e-005      1531.388781
       1542.818238      473.4648448      484.7481391      1.103484274      1.034718392
       1.071718392    0.07396443077    0.07538978576      2715.959198      2713.256693
       167.7569336        429.15424      2679.316018      261.3973065      2286.804958
       169.2551925      167.5876612      168.2526757      155.5332582
KEY POINT #13 (t plus 8594.2756 s with a Mixing Number of 265.6553):  36.56168624
       0.040894         0.00925          0.3937     0.7838495292     0.7983978601
       1.008852294              1                1      27.00435989      110283.7667
       0.05556944362    0.05347960215    0.04802145163 7.308479108e-006    0.04802145163
       117.0068965      136.1539958      127.3308804      125.7751127       117.205089
       117.2787581      114.1686252      4.241176698      4.259661015      2.219156405
       0.6830753747     0.6845892748     0.6845892748      1.480384402      1.354468684
       0.04281775706      945.5263224      937.0818295      1.388136061      1.354123956
       0.0002384277293  0.0002176827524 1.320888298e-005 1.355733162e-005
       1525.438665      1509.521183       484.914666      491.2653217      2.493727981
       2.437565029      2.474565029      1.805490906      2.378167741      2736.424128
       2735.694893      491.1170617      534.9972142       2716.38461      43.88015252
       2201.426914      528.3711692      491.9564543      492.2714095      479.0906102
KEY POINT #14 (t plus 6199.7076 s with a Mixing Number of 121.4863):  35.03039498
       0.040894         0.00925          0.3937     0.7710885616     0.7805528358
       1.017010832              1                1      41.38673382      106998.3653
       0.05962951791    0.05649521993    0.04601019786 1.196679185e-005    0.04601019786
       96.25972611      130.4144973      112.3606834       108.847975      97.49772143
       96.25589236      70.34167064      4.211929986      4.233930859      2.132786158
       0.6761618699     0.6819340113     0.6819340113      1.826665123      1.545837715
       0.03969817622      961.0388256      949.1371554      0.890067863     0.8466361756
       0.0002932435509  0.0002489788684 1.269303837e-005 1.338836317e-005
       1548.44195      1531.505295      478.3176582      490.6924114      1.551215081
       1.488786928      1.525786928     0.8860825787      1.379155142      2734.169591
       2732.456729       403.375306      471.3625991      2694.636983      67.98729315
       2262.806992      456.4975745      408.5892861      403.3605259      294.5532883
End
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D.27 TEST #27 - T27_RCIC_080GPM_107KW_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T27_RCIC_080GPM_107kW\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1819.4701 s, and ending (KEY POINT #11) at t
       plus 10524.1239 s, for a time period of 8704.6538 s.
Original Data Record Time:  11618.0575 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2592.5453 s, T_bulk = 63.7245 C and T_out = 61.6323 C
Stratification Beginning SP12 Temperature = 63.8034 C
Stratification Beginning Pressure = 17.5567 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       7301.1276 s, T_bulk = 105.037 C and T_out = 90.9014 C
Stratification Ending SP12 Temperature = 104.899 C
Stratification Ending Pressure = 33.7117 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 1694.1349 s.
At t = 1694.1349 s, the pool pressure is 16.3486 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 55.6644, 55.6855, 57.6886, 55.4453, and
       53.8309 C, respectively.
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Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9 temperatures were 9.9742 +/- 3.4134 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 9.5579 +/- 3.2697 C.
Minimum Steam Quality: 0.319 at t plus 2.0721 s
Maximum Steam Quality: 0.47964 at t plus 8520.6813 s
Time-Averaged Steam Quality: 0.3986 +/- 0.029085
Minimum Turbine Outlet Steam Quality: 0.37276 at t plus 2.1151 s
Maximum Turbine Outlet Steam Quality: 0.50272 at t plus 8520.6813 s
Time-Averaged Turbine Outlet Steam Quality: 0.44072 +/- 0.020375
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 8614.6517 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.7136 degrees/min at t plus 3219.3091 s and 0.37045 degrees/min at t plus 3891.0695 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.62455 degrees/min at t plus 3016.7535 s and 0.45099 degrees/min at t plus 3865.8691 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.20347 degrees/min at t plus 3217.355 s and -0.13313 degrees/min at t plus 3587.9652 s, respectively
Max and min smoothed lower level changerates: 1.0469 degrees/min at t plus 6386.6133 s and 0.28042 degrees/min at t plus 5700.421 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.2666 degrees/min at t plus 5700.421 s and -0.52418 degrees/min at t plus 6408.5185 s, respectively
Max and min smoothed outlet level changerates: 3.7081 degrees/min at t plus 7448.234 s and 0.061381 degrees/min at t plus 6443.3145 s, respectively
Max and min smoothed lower-outlet level changerate differences: 0.92768 degrees/min at t plus 6386.6133 s and -3.2257 degrees/min at t plus 7447.733 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.0327 degrees/min at t plus 5829.7994 s and 0.23054 degrees/min at t plus 4652.9801 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.5005 degrees/min at t plus 5829.7994 s and -0.32327 degrees/min at t plus 4671.8802 s, respectively
The mean steam flow rate was 44.8416 +/- 1.4812 g/s
The mean feedwater flow rate was 44.3968 +/- 1.5511 g/s
The mean water injection to steam flow rate was 49.8607 +/- 1.5562 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.081 +/- 2.43 C over the Stratification Period, beginning at 6.5808 C and ending at 14.712 C
Mean Smoothed SP8-Upper Pool delta T is 10.6101 +/- 2.3551 C over the Stratification Period, beginning at 6.2803 C and ending at 13.6607 C
The stratification period begins and ends with Smoothed SP8 readings of 70.0916 and 119.7275 C, respectively
The stratification period begins and ends with condensing flows of 0.51407 and 1.0994 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 3.8337 and 1.5724 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1469.3177 +/- 34.6479 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.44817 and 13.0125 kg/s, respectively
The plume period had a mean steam enthalpy of 1460.0121 +/- 39.3415 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.5147 degrees C at t plus 8555.1483 s with T_upper = 116.7845 C and T_mid = 115.2699 C
At t plus 8555.1483 s, Smoothed SP8-SP9 is 13.0526 C and Smoothed SP8-Top is 11.5379 C, where Smoothed SP8 is 128.3224 C and Pool P = 41.5899 psia
Maximum Smoothed Top-Lower delta T is 3.8845 degrees C at t plus 5991.2167 s with T_upper = 94.7735 C and T_low = 90.889 C
At t plus 5991.2167 s, Smoothed SP8-SP9 is 13.5854 C and Smoothed SP8-Top is 13.0411 C, where Smoothed SP8 is 107.8146 C and Pool P = 27.4142 psia
Maximum Smoothed Mid-Lower delta T is 3.3669 degrees C at t plus 5975.4048 s with T_mid = 94.0911 C and T_low = 90.7241 C
At t plus 5975.4048 s, Smoothed SP8-SP9 is 13.83 C and Smoothed SP8-Top is 13.3543 C, where Smoothed SP8 is 107.9211 C and Pool P = 27.3317 psia
Maximum Smoothed Top-Outlet delta T is 15.1842 degrees C at t plus 7156.2453 s with T_upper = 104.8889 C and T_out = 89.7047 C
At t plus 7156.2453 s, Smoothed SP8-SP9 is 14.1991 C and Smoothed SP8-Top is 13.2767 C, where Smoothed SP8 is 118.1656 C and Pool P = 32.9107 psia
Maximum Smoothed Mid-Outlet delta T is 14.3678 degrees C at t plus 7138.5253 s with T_mid = 103.8074 C and T_out = 89.4397 C

At t plus 7138.5253 s, Smoothed SP8-SP9 is 14.2212 C and Smoothed SP8-Top is 13.4111 C, where Smoothed SP8 is 118.0287 C and Pool P = 32.8437 psia
Maximum Smoothed Lower-Outlet delta T is 14.5683 degrees C at t plus 7140.7544 s with T_low = 104.0319 C and T_out = 89.4637 C
At t plus 7140.7544 s, Smoothed SP8-SP9 is 14.1817 C and Smoothed SP8-Top is 13.3771 C, where Smoothed SP8 is 118.0102 C and Pool P = 32.8588 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 15.0499 degrees C at (KEY POINT #14) t plus 7229.9255 s with T_SP8 = 119.5729 C and T_SP9 = 104.5229 C and Pool P = 33.3209 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 14.5503 degrees C at t plus 6525.0152 s with T_SP8 = 113.8269 C and T_upper = 99.2767 C and Pool P = 29.7621 psia
Maximum Top-Mid delta T is 1.6971 degrees C at (KEY POINT #4) t plus 1010.5198 s ignoring SP 4, with temperatures of 50.2184 and 48.5213 C, respectively, at Set # 2, where Pool P = 15.6983 psia and T_outlet = 47.4385 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 1010.5198 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.72402 C and a raw SP12 Reading of 48.5213 C.
Maximum Top-Lower delta T is 6.0919 degrees C at t plus 6212.7203 s, with temperatures of 96.5204 and 90.4285 C, respectively, at Set # 1, where Pool P = 28.3515 psia and T_outlet = 87.2296 C
Maximum Mid-Low delta T is 3.6553 degrees C at (KEY POINT #6) t plus 5973.1176 s ignoring SP 4, with temperatures of 94.0895 and 90.4342 C, respectively, at Set # 2, where Pool P = 27.3214 psia and T_outlet = 86.3097 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6452.215 s with a Smoothed Mid-Axis Mid-Low Delta T of 1.2177 C and a raw SP12 Reading of 98.202 C.
Maximum Top-Outlet delta T is 15.7868 degrees C at t plus 7307.925 s, with temperatures of 106.7238 and 90.937 C, respectively, at Set # 1, where Pool P = 33.7402 psia
Maximum Mid-Outlet delta T is 14.5652 degrees C at t plus 7128.0227 s ignoring SP 4, with temperatures of 103.7279 and 89.1627 C, respectively, at Set # 2, where Pool P = 32.7853 psia
Maximum Lower-Outlet delta T is 15.6986 degrees C at (KEY POINT #8) t plus 7170.0251 s, with temperatures of 105.5135 and 89.8148 C, respectively, at Set # 1, where Pool P = 32.9939 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 7477.3327 s with a Smoothed Mid-Axis Low-Outlet Delta T of 5.2281 C and a raw SP12 Reading of 106.5597 C.
Minimum SP Pressure is 15.0115 psia at t plus 11.1976 s
Maximum SP Pressure is 42.7139 psia at t plus 8704.6538 s
Beginning SP Pressure is 15.0199 psia
Ending SP Pressure is 42.7139 psia
Time-Average SP Pressure is 23.9627 +/- 7.9515 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.7617 cm (cold) / 76.9032 cm (hot) at 14.6411 psia
Beginning Smoothed SP Level is 77.1506 cm (cold) / 77.3257 cm (hot) at 15.0134 psia
Ending Smoothed SP Level is 78.1684 cm (cold) / 79.6268 cm (hot) at 42.7224 psia
Minimum Smoothed Cold SP Level is 76.8548 cm at t plus 5354.4412 s and 24.852 psia
Minimum Smoothed Hot SP Level is 77.324 cm at t plus 12.4987 s and 15.02 psia
Maximum Smoothed Cold SP Level is 78.2187 cm at t plus 8375.149 s and 40.3156 psia
Maximum Smoothed Hot SP Level is 79.6415 cm at t plus 8596.4497 s and 41.8829 psia
SP 12 Temperature at the beginning is 39.8782 C, and at the end is 116.5265 C
At plume detection, the Mixing Number is 44.2139
The Mixing Number ranges from a minimum of 34.9051 at (KEY POINT #12) t plus 0 s to a maximum of 207.4643 at (KEY POINT #13) t plus 8704.6538 s; it had a mean value of 88.3259 +/- 48.1948 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam

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        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 34.9051):  72.38472375         0.040894
        0.00925         0.3937     0.7715058191     0.7732573834     0.3789396626
        0.3789396626     0.9988639358      41.38887283      233587.7032    0.06954819604
        0.05830516357    0.04175272278    0.05332001229    0.09507273507      40.29589145
        103.1363424      103.1363424       40.3976587       40.25619674      40.47728475
        38.25276641      4.178534214       4.22071023       2.090294903      0.6290104092
        0.6789921879     0.6789921879      4.312614423      1.695238152    0.03810158895
        992.1106211      956.0800328     0.6634788041      1.748893333  0.0006491940053
        0.0002727155856 1.237657003e-005 1.267233186e-005      1531.837411
        1542.063057      473.8436248      455.0073867      1.133075386      1.035136769
        1.072136769    0.07501716378    0.07542426039      1285.967519      1284.254481
        168.8659257      432.3392025       2680.49468      263.4732768      853.6283169
        169.2911636      168.6985543       169.625477      160.3342155
KEY POINT #2 (t plus 1694.1349 s with a Mixing Number of 44.2139):  71.5942382
        0.040894         0.00925          0.3937     0.7716700471     0.7749681899
        0.4265937528     0.4265937528     0.9989876732      42.49725249      230199.3467
        0.0669805974    0.05782027244    0.04406775194    0.04996673059    0.09403448253
        55.68554134      105.6265975      105.6265975      57.68863303      55.66440626
        55.44527848      53.83091602      4.181083372      4.224091406      2.101033055
        0.646566396     0.6798870617     0.6798870617      3.223617539      1.652102188
        0.03851047249      985.3809365      954.2428296      0.7194019006      1.68467922
        0.0004985030407  0.0002659134934 1.246185629e-005 1.271843217e-005
        1550.834439      1539.451151      475.0806583      458.8677045      1.235478968
        1.127587454      1.164587454     0.1628643149     0.1790691158      1400.878241
        1399.072225      233.1929313      442.8616153      2684.363286       209.668684
        958.0166258      241.5687231      233.1031196      232.1899124      225.4445258
KEY POINT #3 (t plus 2592.5453 s with a Mixing Number of 50.9955):  70.96032712
        0.040894         0.00925          0.3937     0.7702322694     0.7744926058
        0.4358556812     0.4358556812     0.9989671539      40.67338695      227077.0639
        0.06562707942    0.05747585568    0.04397430294    0.04922757767    0.09320188061
        63.51077206      107.3868132      107.3868132      70.09155791      63.81125299
        63.47939345      61.56438452      4.184345574       4.22656438      2.108941886
        0.6540777413     0.6804743961     0.6804743961      2.832172626       1.62291426
        0.0388091269      981.3809107      952.9275656      0.7611964825      1.74463777
        0.0004427122573  0.0002612882477 1.252221191e-005 1.277914893e-005
        1555.726299      1537.497049      475.9421898      459.8580185      1.312371085
        1.210671457      1.247671457     0.2341946949      0.313243933      1426.868393
        1425.214069      265.9297608      450.3047513      2687.075681      184.3749905
        976.5636418      293.4779016      267.1856858      265.7999599      257.7915996
KEY POINT #4 (t plus 1010.5198 s with a Mixing Number of 39.9014):  69.80558008
        0.040894         0.00925          0.3937     0.7718682175     0.7744954294
        0.4177346517     0.4177346517     0.9989913034       42.1877068      225136.0388
        0.06804508629    0.05805509738    0.04265658399    0.04902860976    0.09168519375
        49.39689047      104.4223952      104.4223952      49.95159124      49.38424214
        49.15637218      47.46783232      4.179407167      4.222439293      2.095775555
        0.639852255     0.6794637227     0.6794637227        3.6078582      1.672684886
        0.03831078455      988.3223913      955.1346967      0.6918994986      1.654642676
        0.000552350157  0.0002691640117 1.242059925e-005 1.267957545e-005
        1544.669849      1540.736715      474.4851104      458.0210714      1.185046753
        1.081916249      1.118916249     0.1198632253     0.1232163025      1377.251379
        1375.471576      206.9013789      437.7722241      2682.497071      230.8708452
        939.4791546      209.2197295      206.8470477      205.8977172      198.8448792
KEY POINT #5 (t plus 1010.5198 s with a Mixing Number of 39.9014):  69.80558008
        0.040894         0.00925          0.3937     0.7718682175     0.7744954294
        0.4177346517     0.4177346517     0.9989913034       42.1877068      225136.0388
        0.06804508629    0.05805509738    0.04265658399    0.04902860976    0.09168519375
        49.39689047      104.4223952      104.4223952      49.95159124      49.38424214
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      49.15637218      47.46783232      4.179407167      4.222439293      2.095775555
      0.639852255     0.6794637227     0.6794637227        3.6078582      1.672684886
      0.03831078455     988.3223913      955.1346967     0.6918994986      1.654642676
      0.000552350157  0.0002691640117 1.242059925e-005 1.267957545e-005
      1544.669849      1540.736715      474.4851104      458.0210714      1.185046753
      1.081916249      1.118916249     0.1198632253     0.1232163025      1377.251379
      1375.471576      206.9013789      437.7722241      2682.497071      230.8708452
      939.4791546      209.2197295      206.8470477      205.8977172      198.8448792
KEY POINT #6 (t plus 5973.1176 s with a Mixing Number of 105.5813):  73.72536939
      0.040894          0.00925          0.3937     0.7698469542     0.7789155884
      0.4477116739     0.4477116739     0.9985495911      29.75824235      227314.7072
      0.06004652938    0.05503593498    0.04597649723     0.0508570907    0.09683358793
      94.07068739      119.6635668      119.6635668        107.91297      94.55546099
      90.77406136      86.33890701      4.209289256      4.245793256      2.172061155
      0.6751510653     0.6835506638     0.6835506638      1.872693729      1.445582203
      0.04113245438     962.5848346      943.3766046      1.110806625      2.477477282
      0.0003003716516  0.0002327312271 1.294444055e-005 1.326322125e-005
      1550.215464      1521.498264      481.6421377      463.0894759      1.965579002
      1.884203827      1.921203827     0.8175571537      1.336105712      1489.589513
      1488.70396      394.1882734      502.3545624      2705.445202      108.166289
      987.2349509      452.5733829      396.2276623      380.3192859      361.6803826
KEY POINT #7 (t plus 6452.215 s with a Mixing Number of 119.6125):  73.8167486
      0.040894          0.00925          0.3937     0.7744297915     0.7844841279
      0.4470140955     0.4470140955     0.9984441407      27.86390108      226019.5536
      0.0592538884    0.05458759277    0.04607451586    0.05087909286    0.09695360872
      98.2216309      121.8847389      121.8847389      112.6878802      98.5711825
      97.10985614      87.82559232      4.214180534      4.24965755      2.185069588
      0.6770659849     0.6839202343     0.6839202343      1.787162136      1.417803929
      0.04160106093     959.6777734      941.5789263      1.186070317        2.6491893
      0.0002871321439   0.000228174808 1.302100743e-005 1.335575648e-005
      1546.903326      1518.179978      482.6135274      463.3963093      2.108159343
      2.029390781      2.066390781     0.9514854172      1.56810049      1494.603002
      1493.826605      411.6818491      511.7994588      2708.658922      100.1176098
      982.8035429      472.7851524      413.1537151      406.9987504      367.9384676
KEY POINT #8 (t plus 7170.0251 s with a Mixing Number of 143.3749):  73.1003084
      0.040894          0.00925          0.3937     0.7810004279     0.7925446119
      0.451705466      0.451705466     0.9983056439      25.19972088      221530.9732
      0.0581163177    0.05387924063    0.04630769415    0.04970491588    0.09601261003
      104.1079022        125.37345        125.37345      118.4393628      105.0399639
      104.1668174      89.89440916      4.221749743      4.255977633      2.206541932
      0.6794157073     0.6843873521     0.6843873521      1.678087095       1.37648451
      0.04236915531     955.4206761      938.7127339      1.312548313      2.900838019
      0.0002700583407  0.0002213471664  1.31413383e-005 1.349411312e-005
      1541.300812      1512.717636      484.1009077      464.2614903      2.349051777
      2.274671655      2.311671655      1.172159407      1.890427505      1515.159085
      1514.524059      436.5279041      526.6529194      2713.633626      90.12501536
      988.5061652      497.1825892      440.4621683      436.7779657      376.6539036
KEY POINT #9 (t plus 7301.1276 s with a Mixing Number of 146.7069):  70.99360254
      0.040894          0.00925          0.3937     0.7815013969     0.7933019822
      0.4682405445     0.4682405445     0.9983831791      24.88829082      215071.6004
      0.0579395155    0.05374381516    0.04639272971    0.04685285605    0.09324558576
      105.0155258      126.0376268      126.0376268      119.7274862      106.0667649
      105.1617552        90.974623      4.222982344      4.25721623      2.210776092
      0.6797407924     0.6844606932     0.6844606932      1.662425605      1.368923122
      0.04251992864     954.7507266      938.1611817      1.337814512      2.852490075
      0.0002675877866  0.0002200907867 1.316425483e-005 1.349881796e-005
      1540.347182      1511.643556      484.3787087      465.5889764      2.397355188
      2.32391979       2.36091979      1.209670473      1.96956895      1553.249118
      1552.629691      440.3638642      529.4833741      2714.570353      89.11950989
      1023.765744      502.6537616      444.802738      440.982733      381.2001959
KEY POINT #10 (t plus 7477.3327 s with a Mixing Number of 152.8768):  70.9261623
      0.040894          0.00925          0.3937     0.7819201686     0.7940763129
      0.4706506009     0.4706506009     0.9983566177      24.3710017      214340.5018
      0.05766904282    0.05356367987     0.0463375885    0.04681941878    0.09315700729
      106.4003588      126.919705      126.919705      120.9964548      107.6135128
      106.7186523      100.9416601      4.224900692      4.258878965      2.216472473
      0.6802170017     0.6845504285     0.6845504285      1.63908597      1.359026244
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      0.04272245385      953.7209695      937.4257701      1.371974369      2.910268654
      0.0002638959411  0.0002184429295 1.319469312e-005 1.353199445e-005
      1538.844026      1510.20039      484.7449771      465.8958699      2.462751961
      2.390255593      2.427255593      1.268808525      2.050159706      1561.063449
      1560.469503      446.2182002      533.2437883      2715.809184      87.02558815
      1027.819661      508.0475975      451.3434476      447.564352      423.1809089
KEY POINT #11 (t plus 8704.6538 s with a Mixing Number of 207.4643):  73.0539754
      0.040894          0.00925           0.3937     0.7816843232      0.796268037
      0.4755433619     0.4755433619     0.9980418077      21.00047377      216388.3025
      0.05566649909    0.05217389107    0.0471746867    0.0487770679    0.09595175459
      116.5219815      133.6740265      133.6740265      129.1851853      117.6855719
      117.1014808       115.33043       4.24024623      4.272302544      2.262891593
      0.6830037205     0.6849500464     0.6849500464      1.486914672      1.288416039
      0.04436205792      945.9378004      931.6847753      1.657509977      3.478682252
      0.0002395069055  0.0002065632329 1.342786094e-005 1.380605715e-005
      1526.232874      1498.528999      487.447415      467.1520328      3.013101056
      2.945602819      2.982602819      1.77745626      2.637382709      1591.133014
      1590.691994      489.0968006      562.0914171      2725.092017      72.99461641
      1029.041597      542.9324366      494.0306125      491.555568      484.0500103
KEY POINT #12 (t plus 0 s with a Mixing Number of 34.9051):  72.38472375        0.040894
      0.00925           0.3937     0.7715058191     0.7732573834     0.3789396626
      0.3789396626     0.9988639358      41.38887283      233587.7032    0.06954819604
      0.05830516357    0.04175272278    0.05332001229    0.09507273507      40.29589145
      103.1363424      103.1363424      40.3976587      40.25619674      40.47728475
      38.25276641      4.178534214      4.22071023      2.090294903     0.6290104092
      0.6789921879     0.6789921879      4.312614423      1.695238152    0.03810158895
      992.1106211      956.0800328     0.6634788041      1.748893333  0.0006491940053
      0.0002727155856 1.237657003e-005 1.267233186e-005      1531.837411
      1542.063057      473.8436248      455.0073867      1.133075386      1.035136769
      1.072136769    0.07501716378    0.07542426039      1285.967519      1284.254481
      168.8659257      432.3392025      2680.49468      263.4732768      853.6283169
      169.2911636      168.6985543      169.625477      160.3342155
KEY POINT #13 (t plus 8704.6538 s with a Mixing Number of 207.4643):  73.0539754
      0.040894          0.00925           0.3937     0.7816843232      0.796268037
      0.4755433619     0.4755433619     0.9980418077      21.00047377      216388.3025
      0.05566649909    0.05217389107    0.0471746867    0.0487770679    0.09595175459
      116.5219815      133.6740265      133.6740265      129.1851853      117.6855719
      117.1014808       115.33043       4.24024623      4.272302544      2.262891593
      0.6830037205     0.6849500464     0.6849500464      1.486914672      1.288416039
      0.04436205792      945.9378004      931.6847753      1.657509977      3.478682252
      0.0002395069055  0.0002065632329 1.342786094e-005 1.380605715e-005
      1526.232874      1498.528999      487.447415      467.1520328      3.013101056
      2.945602819      2.982602819      1.77745626      2.637382709      1591.133014
      1590.691994      489.0968006      562.0914171      2725.092017      72.99461641
      1029.041597      542.9324366      494.0306125      491.555568      484.0500103
KEY POINT #14 (t plus 7229.9255 s with a Mixing Number of 145.0114):  72.63314203
      0.040894          0.00925           0.3937      0.781292134     0.7929693141
      0.455251165      0.455251165      0.998314732      25.01756564      219992.6711
      0.05803552189    0.05381786368    0.04632705556    0.04907196115     0.0953990167
      104.5229076      125.6745755      125.6745755      119.5728558      105.4731304
      104.8336481      90.52956651      4.222311133      4.256537771      2.208455778
      0.6795655785      0.684421219      0.684421219      1.670889656      1.373044568
      0.04243733066      955.1147952      938.4629034      1.323955443      2.903285758
      0.0002689235966  0.0002207758717 1.315172795e-005 1.350163028e-005
      1540.867701      1512.232011      484.2270714      464.5737906      2.370852541
      2.296880224      2.333880224      1.189190144      1.95992802      1523.796849
      1523.170971      438.2817134      527.9360878      2714.058737      89.65437445
      995.8607615      501.9953494      442.2932117      439.5951529      379.3264192
End
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D.28 TEST #28 -

T28_RCIC_2ATM_107KW_COOLSTART_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T28_RCIC_2ATM_107kW_coolstart\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 3597.7018 s, and ending (KEY POINT #11) at t
       plus 13818.2734 s, for a time period of 10220.5716 s.
Original Data Record Time:  14771.3649 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       988.9186 s, T_bulk = 39.3671 C and T_out = 36.6186 C
Stratification Beginning SP12 Temperature = 39.2288 C
Stratification Beginning Pressure = 30.2005 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       8556.5464 s, T_bulk = 107.5201 C and T_out = 69.4124 C
Stratification Ending SP12 Temperature = 107.4768 C
Stratification Ending Pressure = 30.1989 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 2149.3419 s.
At t = 2149.3419 s, the pool pressure is 30.292 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 50.3658, 50.2292, 52.237, 50.1444, and 45.916
       C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 11.2061 +/- 3.3388 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.949 +/- 2.8621 C.
Minimum Steam Quality:  0.99388 at t plus 9.7956 s
Maximum Steam Quality:  1.0039 at t plus 8015.8345 s
Time-Averaged Steam Quality:  1.0008 +/- 0.0011507
Minimum Turbine Outlet Steam Quality:  1.0031 at t plus 9.7956 s
Maximum Turbine Outlet Steam Quality:  1.0144 at t plus 8015.8345 s
Time-Averaged Turbine Outlet Steam Quality:  1.011 +/- 0.0014241
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 10130.5724 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.84304 degrees/min at t plus 4342.7714 s
       and 0.25094 degrees/min at t plus 8229.4657 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.83866 degrees/min at t plus
       6041.0035 s and 0.28984 degrees/min at t plus 7939.6361 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.30693 degrees/min at t
       plus 4342.7714 s and -0.21965 degrees/min at t plus 6041.1985 s, respectively
Max and min smoothed lower level changerates:  3.5154 degrees/min at t plus 7620.0298 s
       and -0.1275 degrees/min at t plus 3923.8674 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.7054 degrees/min at t
       plus 6677.1169 s and -3.1628 degrees/min at t plus 7620.0298 s, respectively
Max and min smoothed outlet level changerates:  6.6312 degrees/min at t plus 8815.8502 s
       and -0.035251 degrees/min at t plus 4640.2784 s, respectively
Max and min smoothed lower-outlet level changerate differences:  3.4684 degrees/min at t
       plus 7620.1308 s and -6.0936 degrees/min at t plus 8822.5106 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.4076 degrees/min at t plus 3198.852
       s and 0.038434 degrees/min at t plus 9621.9683 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.90167 degrees/min
       at t plus 3198.852 s and -0.42404 degrees/min at t plus 9049.9566 s, respectively
The mean steam flow rate was 44.5795 +/- 1.549 g/s
The mean feedwater flow rate was 43.8989 +/- 1.5794 g/s
The mean water injection to steam flow rate was 0.0074086 +/- 0.030317 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 9.6494 +/- 4.7812 C over the
       Stratification Period, beginning at 0.41912 C and ending at 11.3544 C
Mean Smoothed SP8-Upper Pool delta T is 8.5702 +/- 4.1794 C over the Stratification
       Period, beginning at 0.27803 C and ending at 11.0314 C
The stratification period begins and ends with Smoothed SP8 readings of 40.0335 and
       119.7256 C, respectively
The stratification period begins and ends with condensing flows of 0.27037 and 1.7594
       kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 61.7957 and
       2.1312 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2733.7677 +/- 1.3241 kJ/kg.
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At plume detection, the condensing and condensing+cooling flows are 0.31515 and 12.8641 kg/s, respectively
The plume period had a mean steam enthalpy of 2734.7211 +/- 0.88685 kJ/kg.
Maximum Smoothed Top-Mid delta T is 3.3234 degrees C at t plus 4804.1788 s with T_upper = 76.155 C and T_mid = 72.8316 C
At t plus 4804.1788 s, Smoothed SP8-SP9 is 15.2149 C and Smoothed SP8-Top is 11.8915 C, where Smoothed SP8 is 88.0465 C and Pool P = 30.1878 psia
Maximum Smoothed Top-Lower delta T is 20.5266 degrees C at t plus 7369.7245 s with T_upper = 102.1131 C and T_low = 81.5864 C
At t plus 7369.7245 s, Smoothed SP8-SP9 is 12.1172 C and Smoothed SP8-Top is 11.1705 C, where Smoothed SP8 is 113.2836 C and Pool P = 30.0455 psia
Maximum Smoothed Mid-Lower delta T is 19.58 degrees C at t plus 7369.6245 s with T_mid = 101.1654 C and T_low = 81.5855 C
At t plus 7369.6245 s, Smoothed SP8-SP9 is 12.1169 C and Smoothed SP8-Top is 11.1703 C, where Smoothed SP8 is 113.2823 C and Pool P = 30.0437 psia
Maximum Smoothed Top-Outlet delta T is 39.4123 degrees C at t plus 8521.0434 s with T_upper = 108.5898 C and T_out = 69.1775 C
At t plus 8521.0434 s, Smoothed SP8-SP9 is 11.4161 C and Smoothed SP8-Top is 11.0152 C, where Smoothed SP8 is 119.605 C and Pool P = 30.1743 psia
Maximum Smoothed Mid-Outlet delta T is 39.0214 degrees C at t plus 8530.3459 s with T_mid = 108.2429 C and T_out = 69.2215 C
At t plus 8530.3459 s, Smoothed SP8-SP9 is 11.2503 C and Smoothed SP8-Top is 10.8761 C, where Smoothed SP8 is 119.4932 C and Pool P = 30.1718 psia
Maximum Smoothed Lower-Outlet delta T is 39.1379 degrees C at t plus 8582.3509 s with T_low = 108.7916 C and T_out = 69.6537 C
At t plus 8582.3509 s, Smoothed SP8-SP9 is 11.4031 C and Smoothed SP8-Top is 11.0166 C, where Smoothed SP8 is 119.8361 C and Pool P = 30.2269 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 15.5863 degrees C at (KEY POINT #14) t plus 4761.7814 s with T_SP8 = 88.0391 C and T_SP9 = 72.4528 C and Pool P = 30.1852 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 13.3846 degrees C at t plus 4176.5719 s with T_SP8 = 81.9147 C and T_upper = 68.5301 C and Pool P = 30.2939 psia
Maximum Top-Mid delta T is 4.5201 degrees C at (KEY POINT #4) t plus 4741.3802 s ignoring SP 4, with temperatures of 76.1137 and 71.5936 C, respectively, at Set # 2, where Pool P = 30.1821 psia and T_outlet = 61.8557 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 6331.4071 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.5067 C and a raw SP12 Reading of 89.78 C.
Maximum Top-Lower delta T is 23.2917 degrees C at t plus 7481.1269 s, with temperatures of 103.5597 and 80.2679 C, respectively, at Set # 1, where Pool P = 30.089 psia and T_outlet = 67.3451 C
Maximum Mid-Low delta T is 20.963 degrees C at (KEY POINT #6) t plus 7512.7287 s ignoring SP 4, with temperatures of 101.9496 and 80.9867 C, respectively, at Set # 2, where Pool P = 30.0895 psia and T_outlet = 67.4549 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 7622.491 s with a Smoothed Mid-Axis Mid-Low Delta T of 6.9675 C and a raw SP12 Reading of 102.8631 C.
Maximum Top-Outlet delta T is 39.8142 degrees C at t plus 8521.9444 s, with temperatures of 108.9019 and 69.0877 C, respectively, at Set # 1, where Pool P = 30.1697 psia
Maximum Mid-Outlet delta T is 38.3183 degrees C at t plus 8550.145 s ignoring SP 4, with temperatures of 107.5931 and 69.2748 C, respectively, at Set # 2, where Pool P = 30.2107 psia
Maximum Lower-Outlet delta T is 39.5557 degrees C at (KEY POINT #8) t plus 8459.9459 s, with temperatures of 108.4633 and 68.9076 C, respectively, at Set # 1, where Pool P = 30.1467 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 8906.7504 s with a Smoothed Mid-Axis Low-Outlet Delta T of 13.1801 C and a raw SP12 Reading of 109.8526 C.
Minimum SP Pressure is 30.0287 psia at t plus 7405.8236 s
Maximum SP Pressure is 30.7579 psia at t plus 3677.8614 s
Beginning SP Pressure is 30.1169 psia
Ending SP Pressure is 30.6733 psia
Time-Average SP Pressure is 30.2926 +/- 0.14944 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 76.9272 cm (cold) / 76.9919 cm (hot) at 14.5072 psia
Beginning Smoothed SP Level is 78.7456 cm (cold) / 78.8526 cm (hot) at 30.1167 psia
Ending Smoothed SP Level is 78.0288 cm (cold) / 79.5634 cm (hot) at 30.655 psia
Minimum Smoothed Cold SP Level is 77.9996 cm at t plus 9856.5667 s and 30.3833 psia
Minimum Smoothed Hot SP Level is 78.85 cm at t plus 72.3011 s and 30.117 psia

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Maximum Smoothed Cold SP Level is 78.7458 cm at t plus 6.4984 s and 30.1169 psia
Maximum Smoothed Hot SP Level is 79.5638 cm at t plus 10220.0725 s and 30.6541 psia
SP 12 Temperature at the beginning is 29.8523 C, and at the end is 120.1484 C
At plume detection, the Mixing Number is 43.7322
The Mixing Number ranges from a minimum of 35.9845 at (KEY POINT #12) t plus 0 s to a
        maximum of 1007.9707 at (KEY POINT #13) t plus 10220.5716 s; it had a mean value
        of 121.5386 +/- 143.845 over the test period.
Key Points have Data Dumps of the following for each Key Point:  Sparger Massflux (kg/m2-
        s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet
        Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1,
        Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1,
        Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat
        Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,
        Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
        Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
        Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
        (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
        Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
        Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 35.9845):  31.6446924        0.040894
        0.00925         0.3937     0.787455978     0.788526287      1.00542564
        1               1       26.769384      97664.8441    0.0710780916    0.0545009661
        0.0415632926 1.33689853e-005    0.0415632926      30.7382055      127.801173
        122.312726      30.8779137      30.7843063      31.2783873       27.991711
        4.17951364      4.25041627      2.18763488     0.616157246     0.683984972
        0.683984972      5.32235029      1.41258604    0.0416931593      995.470697
        941.23011       1.20103447      1.18250278  0.000784637875  0.000227315999
        1.30357651e-005 1.32501932e-005      1512.94113      1517.52624      482.798529
        486.75611       2.1365783       2.07647465      2.11347465     0.0442998975
        0.0446544322      2721.90347      2721.18687      129.019485      513.620401
        2709.27405      384.600916      2208.28307      129.603396      129.210617
        131.278784      117.545138
KEY POINT #2 (t plus 2149.3419 s with a Mixing Number of 43.7322):  32.697841
        0.040894        0.00925         0.3937     0.786829762     0.789722033
        1.0105031              1              1      27.9118811      99339.4162
        0.0679054099     0.054464681    0.0429465364 9.99824197e-006    0.0429465364
        50.2291624      133.18003       122.491884      52.2370218       50.365793
        50.1444409      45.9159789      4.17934812      4.25073524      2.18871441
        0.640828231     0.684011452     0.684011452      3.55238967      1.41041444
        0.0417318871      987.989004      941.08386       1.2073436       1.17173949
        0.000544695374  0.000226958296 1.30419431e-005 1.34603721e-005      1545.77325
        1517.25121      482.875762      490.443865      2.14856701      2.08904351
        2.12604351     0.124924155     0.137893645      2733.36608      2732.58701
        210.466661      514.38276       2709.53115      303.916099      2218.98332
        218.858671      211.036224      210.114133      192.447611
KEY POINT #3 (t plus 988.9186 s with a Mixing Number of 38.9776):  32.1591952
        0.040894        0.00925         0.3937     0.787150606     0.788961015
        1.00932002             1              1      27.4402661      98076.4858
        0.0696589419    0.0544853078    0.0422390593 6.51506704e-006    0.0422390593
        39.6144184      131.864271      122.390047      40.0335347      39.7555084
        39.6102922      36.5769755      4.17828673      4.25055384      2.18810037
        0.628197406     0.683996445     0.683996445      4.37351909      1.41164791
        0.0417098608      992.414501      941.167008      1.2037541       1.17215173
        0.000657550216  0.000227161492 1.30384314e-005 1.34091073e-005      1530.84591
        1517.40764      482.831876      489.565843      2.14174569      2.08231864
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2.11931864 0.0723396474 0.0739764028 2730.59951 2729.84654
166.111277 513.949413 2709.38504 347.838136 2216.6501
167.862463 166.699284 166.095634 153.425382
KEY POINT #4 (t plus 4741.3802 s with a Mixing Number of 59.7026): 34.0677977
0.040894 0.00925 0.3937 0.7844888949 0.7907880513
1.011197812 1 1 29.28787036 103331.4765
0.06403625486 0.05450082459 0.04474588749 5.042827596e-006 0.04474588749
72.48441432 133.725464 122.3134248 87.21517734 75.45274308
70.20394924 61.75105165 4.189502271 4.250417515 2.187639084
0.6616293469 0.6839850759 0.6839850759 2.473094419 1.412577556
0.0416933101 976.3936286 941.2295394 1.201059021 1.163336108
0.0003905647352 0.0002273146022 1.303578916e-005 1.348251826e-005
1558.031936 1517.525164 482.7988302 490.8585728 2.136624945
2.081380299 2.118380299 0.3470918445 0.6307932334 2734.719332
2733.861553 303.5720358 513.6233745 2709.275058 210.0513387
2221.095958 365.3725099 316.0096155 294.0212456 258.6452929
KEY POINT #5 (t plus 6331.4071 s with a Mixing Number of 87.404): 34.52540051
0.040894 0.00925 0.3937 0.7844225027 0.793362633
1.011488945 1 1 29.40302914 104537.845
0.06073591251 0.05443097573 0.04534691971 -1.481818066e-007
0.04534691971 90.42577265 134.3559044 122.6582442 102.4743314
91.5162474 80.21679446 65.62081656 4.20521993 4.251032157
2.189719828 0.6733083686 0.6840357143 0.6840357143 1.954387456
1.408404592 0.04176794135 965.0848794 940.9479342 1.213225989
1.174208532 0.0003129219046 0.0002266270886 1.304767999e-005 1.350593873e-005
1552.732443 1516.995103 482.9473676 491.2065657 2.159748429
2.104593662 2.141593662 0.7132492597 1.107065677 2735.848762
2734.984224 378.870215 515.0907169 2709.769678 136.2205019
2220.758046 429.6205055 383.4552295 335.9923596 274.8392354
KEY POINT #6 (t plus 7512.7287 s with a Mixing Number of 130.6208): 34.71641681
0.040894 0.00925 0.3937 0.782159809 0.793207967
1.01153386 1 1 29.95024108 105215.0321
0.0584952498 0.05451831595 0.04559780748 5.989831328e-006 0.04559780748
102.1561782 133.9899081 122.2270377 115.0341724 103.1690178
85.7987784 67.38697037 4.219183083 4.250263998 2.187119746
0.6786772919 0.6839721776 0.6839721776 1.712774124 1.413627312
0.04167467288 956.8429876 941.3000098 1.198026326 1.15928874
0.0002755085241 0.0002274874576 1.30328103e-005 1.349325397e-005
1543.249686 1517.657492 482.7615456 491.0588545 2.130863595
2.074962834 2.111962834 1.094742489 1.693656357 2735.375169
2734.478152 428.2758845 513.2557984 2709.151005 84.97991388
2222.119371 482.7276868 432.5486522 359.4228136 282.2294441
KEY POINT #7 (t plus 7622.491 s with a Mixing Number of 134.3487): 34.75361592
0.040894 0.00925 0.3937 0.7821283567 0.7933971144
1.011872606 1 1 29.99053981 105213.5812
0.05836577579 0.0545130284 0.04564666615 1.002202388e-005 0.04564666615
102.8240438 134.3650243 122.2531537 115.3671382 104.0084493
93.23483558 67.53569708 4.22006749 4.250310388 2.187276667
0.6789314683 0.6839760859 0.6839760859 1.700747476 1.413309774
0.04168030464 956.3546938 941.278709 1.1989425 1.159073712
0.0002736190793 0.000227435175 1.303371085e-005 1.350789844e-005
1542.581619 1517.617507 482.7728202 491.3076518 2.132603993
2.076603265 2.113603265 1.120743308 1.712123342 2736.158071
2735.258639 431.0941466 513.3669203 2709.188513 82.27277372
2222.791151 484.1390103 436.092093 390.6864547 282.8521919
KEY POINT #8 (t plus 8459.9459 s with a Mixing Number of 173.1395): 34.94934702
0.040894 0.00925 0.3937 0.7811717748 0.7933878768
1.01181609 1 1 30.11763294 105814.2055
0.05741096395 0.05450539346 0.04590374652 4.569947347e-006 0.04590374652
107.7176691 134.342612 122.2908613 119.3003745 108.262016
107.5028049 68.97373807 4.22685524 4.2503774 2.187503363
0.6806270464 0.6839817152 0.6839817152 1.617504459 1.412851575
0.04168843992 952.7144802 941.2479487 1.200266314 1.160543608
0.0002604577682 0.0002273597266 1.303501111e-005 1.350686885e-005
1537.282823 1517.559745 482.7890946 491.2836549 2.135118914
2.078380619 2.115380619 1.327254893 1.943033128 2736.094502

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2735.18743      451.7620714      513.5273659      2709.242662      61.76529452
2222.567136     500.8231895      454.061914       450.8552264      288.8730701
KEY POINT #9 (t plus 8556.5464 s with a Mixing Number of 179.8752):  34.95865339
0.040894        0.00925          0.3937     0.7813213283     0.7936178006
1.011862028           1                1      30.07500685      105810.8909
0.05728264852    0.05449242955    0.04591596984 7.763053386e-006    0.04591596984
108.3711685     134.4512468      122.3548811      119.7256084      108.6941654
108.3229453     69.40459768      4.227801883      4.250491252      2.187888587
0.6808317192    0.6839912355     0.6839912355      1.607004433      1.412074402
0.04170226245     952.2203593      941.19571      1.202516581      1.16257875
0.000258786864  0.0002272317381 1.303721871e-005 1.351088872e-005
1536.523527     1517.461595      482.8167125      491.3425124      2.139394269
2.082592361     2.119592361      1.357061646      1.969451644      2736.282572
2735.378066     454.5249315      513.7997757      2709.33457       59.2748442
2222.482797     502.6288145      455.8893302      454.3223724      290.6775661
KEY POINT #10 (t plus 8906.7504 s with a Mixing Number of 211.9435):  34.86332991
0.040894        0.00925          0.3937     0.7815464539     0.7944454065
1.011737016           1                1      29.76698776      105498.6852
0.0567922359    0.05444355647    0.04579076851 1.844107905e-006    0.04579076851
110.8600019     134.5525896      122.5961555      120.7099794      111.1966996
111.2520209     96.50463179      4.231497357      4.250921262      2.189344248
0.6815642509    0.6840266961     0.6840266961      1.56825889      1.409153956
0.04175447481     950.320957      940.998678      1.211027879      1.171255024
0.000252598337  0.0002267505949 1.304553885e-005  1.35139221e-005
1533.521071     1517.090767      482.9206555      491.3549496      2.15556979
2.099010519     2.136010519      1.475671127      2.031734819      2736.327794
2735.44172      465.0529716      514.8264887      2709.680681      49.77351704
2221.501305     506.8103095      466.4765584      466.7132163      404.4579698
KEY POINT #11 (t plus 10220.5716 s with a Mixing Number of 1007.9707):  36.75326781
0.040894        0.00925          0.3937     0.7802883115     0.7956340204
1.012138596           1                1      31.20530889      111019.5717
0.05482057778    0.05439647514    0.04827308184 5.863811308e-006    0.04827308184
120.7317695     135.1889862      122.8284713      122.8370324      120.917936
120.8604594     116.7488664      4.247624677      4.251336693      2.190751621
0.6837441611    0.6840602146     0.6840602146      1.432080027      1.406354623
0.04180492623     942.5133635      940.8087265      1.219269016      1.177932012
0.0002305232762  0.0002262891214 1.305355045e-005 1.353804659e-005
1519.929093     1516.732328      483.020527       491.7327475      2.171238803
2.113586827     2.150586827      2.033131503      2.171817992      2737.621795
2736.648023     506.9038867      515.8151831      2710.013536      8.911296413
2221.806612     2710.26356       507.6934884      507.4517858      490.0042161
KEY POINT #12 (t plus 0 s with a Mixing Number of 35.9845):  31.6446924       0.040894
0.00925         0.3937      0.787455978     0.788526287      1.00542564
1              1       26.769384      97664.8441     0.0710780916     0.0545009661
0.0415632926 1.33689853e-005    0.0415632926     30.7382055      127.801173
122.312726      30.8779137       30.7843063      31.2783873       27.991711
4.17951364      4.25041627       2.18763488      0.616157246      0.683984972
0.683984972     5.32235029       1.41258604      0.0416931593      995.470697
941.23011       1.20103447       1.18250278   0.000784637875  0.000227315999
1.30357651e-005 1.32501932e-005       1512.94113      1517.52624       482.798529
486.75611       2.1365783        2.07647465       2.11347465     0.0442998975
0.0446544322     2721.90347       2721.18687       129.019485       513.620401
2709.27405      384.600916       2208.28307       129.603396       129.210617
131.278784      117.545138
KEY POINT #13 (t plus 10220.5716 s with a Mixing Number of 1007.9707):  36.75326781
0.040894        0.00925          0.3937     0.7802883115     0.7956340204
1.012138596           1                1      31.20530889      111019.5717
0.05482057778    0.05439647514    0.04827308184 5.863811308e-006    0.04827308184
120.7317695     135.1889862      122.8284713      122.8370324      120.917936
120.8604594     116.7488664      4.247624677      4.251336693      2.190751621
0.6837441611    0.6840602146     0.6840602146      1.432080027      1.406354623
0.04180492623     942.5133635      940.8087265      1.219269016      1.177932012
0.0002305232762  0.0002262891214 1.305355045e-005 1.353804659e-005
1519.929093     1516.732328      483.020527       491.7327475      2.171238803
2.113586827     2.150586827      2.033131503      2.171817992      2737.621795
2736.648023     506.9038867      515.8151831      2710.013536      8.911296413
2221.806612     2710.26356       507.6934884      507.4517858      490.0042161
```

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KEY POINT #14 (t plus 4761.7814 s with a Mixing Number of 59.6698):  34.07064259
       0.040894          0.00925           0.3937     0.7844765921     0.7908128175
       1.011203794             1                1      29.29222799      103338.5904
       0.0640419317    0.05450109571    0.04474962407 5.449893174e-006    0.04474962407
       72.45279463      133.7303582      122.3120859      88.03908103      75.72519598
       70.34500822      61.88135511      4.189480506      4.250415134      2.187631029
       0.6616048973     0.6839848766     0.6839848766      2.474220019      1.412593812
       0.04169302106      976.4120973      941.2306319      1.201011972      1.163270747
       0.0003907300868  0.0002273172794 1.303574299e-005 1.348271592e-005
       1558.030346      1517.527217      482.7982525      490.8622226      2.136535556
       2.081245916      2.118245916     0.3466252317     0.6511523615      2734.730842
       2733.872807      303.4395545      513.6176775      2709.273136      210.178123
       2221.113165      368.8348157      317.1516585      294.6119932      259.1903823
End
```

D.29 TEST #29 - T29_RCIC_040GPM_2ATM_107KW_COOLSTART_RESULTS_RCICLAND.TXT

```
Output Saved to C:\Local
       Files\RCICLAND_NOTITLES\Export\T29_RCIC_040GPM_2ATM_107kW_coolstart\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2421.3895 s, and ending (KEY POINT #11) at t
       plus 11903.9429 s, for a time period of 9482.5534 s.
Original Data Record Time:  12783.2642 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       686.2982 s, T_bulk = 41.237 C and T_out = 38.2616 C
Stratification Beginning SP12 Temperature = 41.1185 C
Stratification Beginning Pressure = 30.4162 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       7919.0259 s, T_bulk = 106.5178 C and T_out = 67.3287 C
Stratification Ending SP12 Temperature = 106.3929 C
Stratification Ending Pressure = 30.1945 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 542.398 s.
At t = 542.398 s, the pool pressure is 30.47 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 40.594, 40.7242, 42.7248, 40.7346, and 37.0169
       C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 11.1358 +/- 3.1852 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 9.7558 +/- 2.9322 C.
Minimum Steam Quality:  0.5427 at t plus 1266.8364 s
Maximum Steam Quality:  0.69186 at t plus 9342.5534 s
Time-Averaged Steam Quality:  0.58277 +/- 0.024407
Minimum Turbine Outlet Steam Quality:  0.56487 at t plus 1266.8364 s
Maximum Turbine Outlet Steam Quality:  0.71497 at t plus 9342.5534 s
Time-Averaged Turbine Outlet Steam Quality:  0.60572 +/- 0.025005
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 9392.5532 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.71102 degrees/min at t plus 3165.8401 s
       and 0.23849 degrees/min at t plus 7474.5195 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.8017 degrees/min at t plus 4929.674
       s and 0.30623 degrees/min at t plus 7376.5179 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.30098 degrees/min at t
       plus 3331.3465 s and -0.24691 degrees/min at t plus 4698.7737 s, respectively
Max and min smoothed lower level changerates:  3.6305 degrees/min at t plus 6834.4069 s
       and -0.22265 degrees/min at t plus 2371.5286 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.73399 degrees/min at t
       plus 2371.5286 s and -3.2396 degrees/min at t plus 6834.5029 s, respectively
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Max and min smoothed outlet level changerates: 7.3879 degrees/min at t plus 8150.8062 s and 0.062581 degrees/min at t plus 3286.646 s, respectively
Max and min smoothed lower-outlet level changerate differences: 3.4692 degrees/min at t plus 6834.5029 s and -6.7515 degrees/min at t plus 8148.7341 s, respectively
Max and min smoothed hot (SP8) level changerates: 1.2922 degrees/min at t plus 1628.7421 s and 0.031968 degrees/min at t plus 8797.9542 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.74072 degrees/min at t plus 1628.7421 s and -0.49716 degrees/min at t plus 4584.9672 s, respectively
The mean steam flow rate was 44.4372 +/- 1.3231 g/s
The mean feedwater flow rate was 43.8014 +/- 1.3563 g/s
The mean water injection to steam flow rate was 24.967 +/- 0.98627 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.3136 +/- 2.9542 C over the Stratification Period, beginning at 2.0677 C and ending at 12.0317 C
Mean Smoothed SP8-Upper Pool delta T is 9.9079 +/- 2.7536 C over the Stratification Period, beginning at 2.043 C and ending at 11.5869 C
The stratification period begins and ends with Smoothed SP8 readings of 44.0852 and 119.1462 C, respectively
The stratification period begins and ends with condensing flows of 0.25209 and 1.4972 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 12.3975 and 1.8759 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1832.8194 +/- 29.4297 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.24798 and 12.8708 kg/s, respectively
The plume period had a mean steam enthalpy of 1832.1684 +/- 30.1413 kJ/kg.
Maximum Smoothed Top-Mid delta T is 3.475 degrees C at t plus 3790.0518 s with T_upper = 72.0414 C and T_mid = 68.5664 C
At t plus 3790.0518 s, Smoothed SP8-SP9 is 13.1252 C and Smoothed SP8-Top is 9.6502 C, where Smoothed SP8 is 81.6916 C and Pool P = 30.0906 psia
Maximum Smoothed Top-Lower delta T is 20.9753 degrees C at t plus 6689.3046 s with T_upper = 100.4795 C and T_low = 79.5042 C
At t plus 6689.3046 s, Smoothed SP8-SP9 is 13.5815 C and Smoothed SP8-Top is 12.8731 C, where Smoothed SP8 is 113.3527 C and Pool P = 30.3847 psia
Maximum Smoothed Mid-Lower delta T is 20.2768 degrees C at t plus 6649.2033 s with T_mid = 99.471 C and T_low = 79.1943 C
At t plus 6649.2033 s, Smoothed SP8-SP9 is 13.7733 C and Smoothed SP8-Top is 13.1036 C, where Smoothed SP8 is 113.2444 C and Pool P = 30.3735 psia
Maximum Smoothed Top-Outlet delta T is 40.2664 degrees C at t plus 7868.225 s with T_upper = 107.3852 C and T_out = 67.1188 C
At t plus 7868.225 s, Smoothed SP8-SP9 is 12.1177 C and Smoothed SP8-Top is 11.624 C, where Smoothed SP8 is 119.0091 C and Pool P = 30.158 psia
Maximum Smoothed Mid-Outlet delta T is 39.8618 degrees C at t plus 7890.5253 s with T_mid = 107.0386 C and T_out = 67.1769 C
At t plus 7890.5253 s, Smoothed SP8-SP9 is 12.023 C and Smoothed SP8-Top is 11.646 C, where Smoothed SP8 is 119.0616 C and Pool P = 30.1835 psia
Maximum Smoothed Lower-Outlet delta T is 39.7363 degrees C at t plus 7876.3265 s with T_low = 106.8678 C and T_out = 67.1315 C
At t plus 7876.3265 s, Smoothed SP8-SP9 is 12.1113 C and Smoothed SP8-Top is 11.6469 C, where Smoothed SP8 is 119.0276 C and Pool P = 30.1566 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 15.2782 degrees C at (KEY POINT #14) t plus 3452.1455 s with T_SP8 = 80.6975 C and T_SP9 = 65.4193 C and Pool P = 30.144 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 13.6966 degrees C at t plus 6438.9993 s with T_SP8 = 112.007 C and T_upper = 98.3103 C and Pool P = 30.3471 psia
Maximum Top-Mid delta T is 4.5032 degrees C at (KEY POINT #4) t plus 3779.2502 s ignoring SP 4, with temperatures of 72.887 and 68.3839 C, respectively, at Set # 2, where Pool P = 30.0883 psia and T_outlet = 55.1907 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5512.7823 s with a Smoothed Mid-Axis Top-Mid Delta T of 1.5009 C and a raw SP12 Reading of 88.1274 C.
Maximum Top-Lower delta T is 24.6725 degrees C at t plus 6864.2076 s, with temperatures of 101.6049 and 76.9323 C, respectively, at Set # 1, where Pool P = 30.2516 psia and T_outlet = 64.4505 C

Maximum Mid-Low delta T is 22.9288 degrees C at (KEY POINT #6) t plus 6779.0087 s ignoring SP 4, with temperatures of 100.3888 and 77.46 C, respectively, at Set # 2, where Pool P = 30.2924 psia and T_outlet = 64.306 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6907.4091 s with a Smoothed Mid-Axis Mid-Low Delta T of 7.6348 C and a raw SP12 Reading of 101.2453 C.
Maximum Top-Outlet delta T is 40.589 degrees C at t plus 7885.227 s, with temperatures of 107.6631 and 67.0741 C, respectively, at Set # 1, where Pool P = 30.1835 psia
Maximum Mid-Outlet delta T is 39.2762 degrees C at t plus 7879.6287 s ignoring SP 4, with temperatures of 106.3925 and 67.1163 C, respectively, at Set # 2, where Pool P = 30.171 psia
Maximum Lower-Outlet delta T is 40.5239 degrees C at (KEY POINT #8) t plus 7897.6257 s, with temperatures of 107.66 and 67.1361 C, respectively, at Set # 1, where Pool P = 30.1844 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 8227.6366 s with a Smoothed Mid-Axis Low-Outlet Delta T of 13.5078 C and a raw SP12 Reading of 108.2521 C.
Minimum SP Pressure is 30.0661 psia at t plus 3906.3534 s
Maximum SP Pressure is 30.7716 psia at t plus 0.095 s
Beginning SP Pressure is 30.7714 psia
Ending SP Pressure is 30.6327 psia
Time-Average SP Pressure is 30.3084 +/- 0.1357 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.6254 cm (cold) / 77.7354 cm (hot) at 14.9529 psia
Beginning Smoothed SP Level is 79.3256 cm (cold) / 79.4734 cm (hot) at 30.7753 psia
Ending Smoothed SP Level is 78.4509 cm (cold) / 79.9593 cm (hot) at 30.6398 psia
Minimum Smoothed Cold SP Level is 78.4361 cm at t plus 8964.7437 s and 30.2278 psia
Minimum Smoothed Hot SP Level is 79.3541 cm at t plus 1164.0076 s and 30.2738 psia
Maximum Smoothed Cold SP Level is 79.3261 cm at t plus 1.5891 s and 30.7742 psia
Maximum Smoothed Hot SP Level is 79.963 cm at t plus 9422.855 s and 30.6347 psia
SP 12 Temperature at the beginning is 34.8532 C, and at the end is 118.5262 C
At plume detection, the Mixing Number is 40.4185
The Mixing Number ranges from a minimum of 38.3773 at (KEY POINT #12) t plus 0 s to a maximum of 583.4237 at (KEY POINT #13) t plus 9482.5534 s; it had a mean value of 113.3299 +/- 99.1442 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 38.3773): 51.61938384 0.040894
0.00925 0.3937 0.7932564766 0.7947342414 0.5868551578
0.5868551578 0.9990816679 24.68923522 159225.3684 0.07034558419
0.05434626122 0.04366747656 0.02413130405 0.06779878061 35.35368584
123.0761222 123.0761222 36.22099008 35.39245315 35.58442203
33.33701237 4.178601485 4.251781049 2.19225813 0.6225949036
0.6840952704 0.6840952704 4.792192796 1.403384126 0.04185890043
993.9621641 940.605982 1.228103912 2.090764796 0.0007140175541
0.0002257991256 1.306209128e-005 1.325745453e-005 1522.918193
1516.348739 483.1267616 471.7915116 2.188044249 2.121881199

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      2.158881199     0.0573965824     0.0602000977       1804.74482      1804.135262
      148.3117326     516.8692535      2710.367924      368.5575209      1287.875567
      151.935807      148.4721994      149.2774996      139.8902388
KEY POINT #2 (t plus 542.398 s with a Mixing Number of 40.4185):  51.28695416
      0.040894         0.00925          0.3937     0.7920800712      0.793987005
      0.5744083845     0.5744083845     0.9990430608      24.24283087      158230.0388
      0.06947846325    0.05441309924    0.04238613268    0.02497602266    0.06736215534
      40.72419355      122.7464548      122.7464548      42.7248134       40.59399978
      40.73459913      37.01691815      4.178271373      4.251189874      2.190254118
      0.6296066732     0.6840484513     0.6840484513     4.274004634      1.40734148
      0.04178709498     991.9903877      940.8758131      1.216354424      2.115551374
      0.0006440323279  0.0002264518378  1.3050722e-005 1.325493389e-005
      1532.724721      1516.859025      482.9852923      471.128454       2.165696465
      2.101140773      2.138140773    0.07674339216    0.08526843347     1776.552799
      1775.965084      170.7498922      515.466124       2709.89607       344.7162318
      1261.086675      179.109063       170.2044031      170.7949616      155.2653368
KEY POINT #3 (t plus 686.2982 s with a Mixing Number of 40.9697):  51.14460326
      0.040894         0.00925          0.3937     0.7917913134     0.7938306137
      0.575828478      0.575828478      0.9990501853     24.27443902      157830.4865
      0.06926728228    0.05442434812    0.04229689891    0.02487828756    0.06717518648
      42.01755417      122.6909496      122.6909496      44.0852386       42.04225952
      42.42583275      38.276308        4.178296981      4.25109061       2.189917829
      0.6312213286     0.6840404471     0.6840404471     4.162534591      1.408010218
      0.04177503992     991.4832383      940.9211981      1.214385146      2.106932449
      0.0006288400817   0.000226562082 1.304880786e-005  1.32516059e-005
      1534.813687      1516.944673      482.9614322      471.181127       2.1619522
      2.096978914      2.133978914    0.08216585225    0.09152103728     1779.524638
      1778.93539      176.1535483      515.2299031      2709.816547     339.0763548
      1264.294735      184.7930538      176.2552764      177.861045       160.527153
KEY POINT #4 (t plus 3779.2502 s with a Mixing Number of 58.2357):  52.91184064
      0.040894         0.00925          0.3937     0.7891938375     0.7950549434
      0.601095449      0.601095449      0.9991528273     26.47098274      163690.7537
      0.06475212379    0.05449237775    0.04443841982    0.02505792066    0.06949634049
      68.47474203      122.3551369      122.3551369      82.18995367      71.87441763
      65.13728686      54.93148523      4.186905951      4.250491707      2.187890127
      0.6584171999     0.6839912734     0.6839912734     2.623236294      1.412071299
      0.04170231771     978.6932233      941.1955012      1.202525579      1.998861968
      0.0004125203468   0.000227231227 1.303722753e-005 1.321868684e-005
      1557.499127      1517.461203      482.8168228      472.2292458      2.139411366
      2.074579069      2.111579069     0.2919896802     0.5177886107     1834.227117
      1833.526404      286.7782673      513.8008642      2709.334937      227.0225968
      1320.426253      344.2685301      301.0146443      272.8093969      230.1262248
KEY POINT #5 (t plus 5512.7823 s with a Mixing Number of 87.4956):  53.07010672
      0.040894         0.00925          0.3937     0.7883994802     0.7970683337
      0.606009545      0.606009545      0.9991649094     26.60721043      164129.1807
      0.06114123039    0.05445092153    0.04464206782    0.0250621451     0.06970421293
      88.26713918      122.5598037      122.5598037      100.1653134      89.3271145
      74.93662202      60.84324562      4.202975751      4.250856381      2.18912454
      0.6721284592     0.6840213958     0.6840213958     2.006000555      1.409593108
      0.04174659617     966.5302044      941.02838        1.209742416      1.994576127
      0.0003207941568  0.0002268229643 1.304428527e-005 1.322280983e-005
      1553.984128      1517.146732      482.9050092      472.4963984      2.15312633
      2.088224968      2.125224968     0.6568837521     1.020177418      1845.544488
      1844.836544      369.7938555      514.671791       2709.628561      144.8779355
      1330.872697      419.8796437      374.2481655      313.8496954      254.8484434
KEY POINT #6 (t plus 6779.0087 s with a Mixing Number of 129.16):  52.80108413
      0.040894         0.00925          0.3937     0.7872182389     0.7981209898
      0.6173351977     0.6173351977     0.9992032713     26.94982351      163390.1536
      0.05882997271    0.05444675092    0.04495793161    0.02439293723    0.06935086884
      100.4247128      122.580389       122.580389       114.1007998      101.3567555
      84.06056191      64.32434071      4.216932083      4.250893118      2.189248939
      0.6779937123     0.6840243991     0.6840243991     1.744749959      1.409344388
      0.04175105716     958.1008501      941.0115611      1.210470211      1.959236731
      0.0002805189836  0.0002267819777 1.304499515e-005 1.321528554e-005
      1544.922675      1517.115044      482.91387        472.9763724      2.154509733
      2.08833131       2.12533131       1.029647699      1.642757849     1870.473899
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       1869.747606      420.9734778      514.7593928      2709.658077      93.78591498
       1355.714506      478.7736918      424.9031234      352.1238848      269.4122751
KEY POINT #7 (t plus 6907.4091 s with a Mixing Number of 133.6578):  52.87329607
       0.040894         0.00925          0.3937     0.7869133958      0.79804722
       0.6163495364     0.6163495364     0.9992008082      26.97196513      163621.7151
       0.05867343587    0.05445403177    0.04494099579    0.02450471884    0.06944571463
       101.2353299      122.5444516      122.5444516      114.8876533      101.9853803
       92.31076105      64.55557651      4.217976827      4.25082899       2.189031794
       0.678318562     0.6840191528     0.6840191528      1.72963767       1.409778661
       0.04174327015      957.5141445      941.040922      1.209199871      1.960305666
       0.0002781535758  0.0002268535403 1.304375586e-005 1.321463088e-005
       1544.151519      1517.170357      482.8984       472.9255679      2.15209509
       2.085808582      2.122808582      1.05971228       1.685581983      1868.221233
       1867.493746      424.3920264      514.60646      2709.606547      90.2144336
       1353.614773      482.107529       427.5548171      386.7988607      270.3796979
KEY POINT #8 (t plus 7897.6257 s with a Mixing Number of 177.7726):  53.48734038
       0.040894         0.00925          0.3937     0.7855636453     0.7978241553
       0.613797252      0.613797252     0.9991935521      27.21822585      165526.2206
       0.05754835964    0.05446570826    0.04518883044    0.02506339237    0.07025222281
       107.0168519      122.4868124      122.4868124      119.1186582      107.4672096
       106.8028952      67.20661634      4.225849245      4.250726205      2.188683802
       0.6804022275     0.6840107077     0.6840107077      1.628924908      1.410475806
       0.04173078943      953.2432305      941.0880018      1.207164643      1.965129567
       0.0002622725212  0.0002269684068  1.30417682e-005 1.321428889e-005
       1538.085003      1517.259004      482.8735774      472.8036064      2.148226898
       2.080895024      2.117895024      1.29589119       1.93183231       1862.486845
       1861.746013      448.8003606      514.3611792      2709.52388       65.56081866
       1348.125665      500.0519859      450.7023997      447.8975688      281.4749362
KEY POINT #9 (t plus 7919.0259 s with a Mixing Number of 178.8376):  53.82352507
       0.040894         0.00925          0.3937     0.7855951359     0.7978771977
       0.6092714002     0.6092714002     0.9991777497      27.17801401      166518.9246
       0.05752923197    0.05446321964    0.04518751595    0.0255062641     0.07069378005
       107.1144836      122.4990977      122.4990977      119.1462322      107.5593338
       107.0005947      67.36716224      4.225988454      4.250748105      2.188757945
       0.6804339666     0.6840125109     0.6840125109      1.627324759      1.410327152
       0.04173344868      953.1698498      941.0779683      1.207598201      1.980406848
       0.0002620184728   0.000226943915 1.304219185e-005 1.321807259e-005
       1537.974334      1517.240116      482.8788692      472.6177024      2.149050892
       2.081656951      2.118656951      1.300223534      1.93352854       1852.580839
       1851.842195      449.2129997      514.413458       2709.541502      65.20045832
       1338.167381      500.1690868      451.0918235      448.7330389      282.1470738
KEY POINT #10 (t plus 8227.6366 s with a Mixing Number of 203.3194):  54.69693197
       0.040894         0.00925          0.3937       0.78582987     0.7986176845
       0.606751811      0.606751811     0.9991642209      27.35173209      169103.6924
       0.05709810698    0.05442441375    0.04520691391    0.02663403061    0.07184094452
       109.3093397      122.6906258      122.6906258      120.2053698      109.6702226
       109.6687926      94.6569311      4.229176821      4.251090031      2.189915868
       0.6811168625     0.6840404003     0.6840404003      1.592175534      1.408014122
       0.04177496962      951.5085784      940.9214629      1.214373664      1.999761178
       0.0002564228573  0.0002265627255 1.304879669e-005 1.322724716e-005
       1535.413353      1516.945172      482.961293       472.5642494      2.16193037
       2.093847077      2.130847077      1.400814048      1.999609326      1847.546617
       1846.7985      458.4927922      515.2285249      2709.816083      56.73573275
       1332.318092      504.6668045      460.0178852      460.014386       396.6769497
KEY POINT #11 (t plus 9482.5534 s with a Mixing Number of 583.4237):  53.7204065
       0.040894         0.00925          0.3937     0.7845087997     0.7995926354
       0.6947403698     0.6947403698     0.9994281523      30.48507654      166669.6897
       0.0551810531    0.05436408253    0.04874604206    0.0218122983    0.07055834036
       118.9424089      122.9882434      122.9882434      122.4884303      119.176448
       119.1291505      116.2077451      4.244523212      4.251623192      2.191722809
       0.6834338266     0.6840829106     0.6840829106      1.454862826      1.404436601
       0.04183972494         943.9614      940.6779558      1.224962961       1.76218703
       0.0002342553966   0.000225972772 1.305906052e-005 1.318081475e-005
       1522.586218      1516.485031      483.0890914      475.9570751      2.182068751
       2.112538085      2.149538085      1.92101894       2.148335395      2041.509158
       2040.579818      499.3060988      516.4952038      2710.242221      17.18910502
       1525.013954      514.3681475      500.2983279      500.1000233      487.7095958
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KEY POINT #12 (t plus 0 s with a Mixing Number of 38.3773):  51.61938384        0.040894
       0.00925          0.3937      0.7932564766     0.7947342414     0.5868551578
       0.5868551578     0.9990816679      24.68923522      159225.3684    0.07034558419
       0.05434626122    0.04366747656    0.02413130405    0.06779878061      35.35368584
       123.0761222      123.0761222      36.22099008      35.39245315      35.58442203
       33.33701237      4.178601485      4.251781049       2.19225813     0.6225949036
       0.6840952704     0.6840952704      4.792192796      1.403384126    0.04185890043
       993.9621641       940.605982      1.228103912      2.090764796  0.0007140175541
       0.0002257991256 1.306209128e-005 1.325745453e-005      1522.918193
       1516.348739      483.1267616      471.7915116      2.188044249      2.121881199
       2.158881199     0.0573965824     0.0602000977      1804.74482      1804.135262
       148.3117326      516.8692535      2710.367924      368.5575209      1287.875567
       151.935807      148.4721994      149.2774996      139.8902388
KEY POINT #13 (t plus 9482.5534 s with a Mixing Number of 583.4237):  53.7204065
       0.040894          0.00925          0.3937     0.7845087997     0.7995926354
       0.6947403698     0.6947403698     0.9994281523      30.48507654      166669.6897
       0.0551810531    0.05436408253    0.04874604206     0.0218122983    0.07055834036
       118.9424089      122.9882434      122.9882434      122.4884303      119.176448
       119.1291505      116.2077451      4.244523212      4.251623192      2.191722809
       0.6834338266     0.6840829106     0.6840829106      1.454862826      1.404436601
       0.04183972494        943.9614      940.6779558      1.224962961       1.76218703
       0.0002342553966   0.000225972772 1.305906052e-005 1.318081475e-005
       1522.586218      1516.485031      483.0890914      475.9570751      2.182068751
       2.112538085      2.149538085      1.92101894      2.148335395      2041.509158
       2040.579818      499.3060988      516.4952038      2710.242221      17.18910502
       1525.013954      514.3681475      500.2983279      500.1000233      487.7095958
KEY POINT #14 (t plus 3452.1455 s with a Mixing Number of 55.4679):  52.91740319
       0.040894          0.00925          0.3937     0.7894573864     0.7948432033
       0.5992279607     0.5992279607     0.9991446419      26.34457172      163661.4614
       0.06529216246    0.05447999258    0.04437189128    0.02513175526    0.06950364654
       65.41933003      122.4162908      122.4162908      80.6975432      68.65102938
       63.48493482      53.77164539      4.18515054      4.25060056      2.188258507
       0.6558162391     0.6840003238     0.6840003238      2.748467845      1.411329808
       0.04171553383      980.3861871      941.1455847       1.2046783      2.008664394
       0.0004306869796  0.0002271090948 1.303933633e-005 1.322244264e-005
       1556.631008       1517.36735      482.8431896      472.1652043      2.143501874
       2.078614769      2.115614769     0.2551453655     0.4876992607      1830.277188
       1829.583151      273.9886114      514.0610864      2709.422704       240.072475
       1316.216101      338.0059213      287.5153112      265.8953657      225.2779473
End
```

D.30 TEST #30 -

T30_RCIC_080GPM_57KW_COOLSTART_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T30_RCIC_080GPM_57kW_coolstart\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2203.474 s, and ending (KEY POINT #11) at t
       plus 20182.1884 s, for a time period of 17978.7144 s.
Original Data Record Time:  22790.5595 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       5335.5922 s, T_bulk = 55.5341 C and T_out = 53.0125 C
Stratification Beginning SP12 Temperature = 55.3239 C
Stratification Beginning Pressure = 17.4069 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       13152.6443 s, T_bulk = 92.4014 C and T_out = 69.3727 C
Stratification Ending SP12 Temperature = 92.3024 C
Stratification Ending Pressure = 27.9687 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 3516.9612 s.
At t = 3516.9612 s, the pool pressure is 16.2641 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 47.5369, 47.2643, 49.2782, 47.5057, and
       45.3062 C, respectively.
```

Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9 temperatures were 11.3906 +/- 4.409 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper temperatures were 10.8656 +/- 4.3628 C.
Minimum Steam Quality: 0.17554 at t plus 45.5286 s
Maximum Steam Quality: 0.30659 at t plus 17511.5326 s
Time-Averaged Steam Quality: 0.2401 +/- 0.029898
Minimum Turbine Outlet Steam Quality: 0.20004 at t plus 46.4067 s
Maximum Turbine Outlet Steam Quality: 0.31816 at t plus 17511.5326 s
Time-Averaged Turbine Outlet Steam Quality: 0.26127 +/- 0.025091
Smoothed Changerates may not fully include test beginning and end periods, analysis ending at t plus 17888.8122 s; using 300 s smoothing
Max and min smoothed upper level changerates: 0.41347 degrees/min at t plus 7413.231 s and 0.15204 degrees/min at t plus 12456.6285 s, respectively
Max and min smoothed mid (SP9) level changerates: 0.35502 degrees/min at t plus 7484.4301 s and 0.20614 degrees/min at t plus 12964.3235 s, respectively
Max and min smoothed upper-mid level changerate differences: 0.1197 degrees/min at t plus 5012.1877 s and -0.10849 degrees/min at t plus 6272.4088 s, respectively
Max and min smoothed lower level changerates: 1.5163 degrees/min at t plus 10824.8982 s and -0.0086167 degrees/min at t plus 7619.7588 s, respectively
Max and min smoothed mid-lower level changerate differences: 0.31882 degrees/min at t plus 7541.0333 s and -1.2499 degrees/min at t plus 10824.8982 s, respectively
Max and min smoothed outlet level changerates: 2.3593 degrees/min at t plus 13515.3351 s and -0.071645 degrees/min at t plus 8405.6438 s, respectively
Max and min smoothed lower-outlet level changerate differences: 1.4504 degrees/min at t plus 10824.9892 s and -2.084 degrees/min at t plus 13518.0372 s, respectively
Max and min smoothed hot (SP8) level changerates: 0.93189 degrees/min at t plus 7355.6277 s and -0.10359 degrees/min at t plus 14853.6576 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.61636 degrees/min at t plus 7355.6277 s and -0.40199 degrees/min at t plus 8603.5471 s, respectively
The mean steam flow rate was 23.2712 +/- 0.79276 g/s
The mean feedwater flow rate was 23.0286 +/- 0.8109 g/s
The mean water injection to steam flow rate was 49.8132 +/- 0.91985 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 13.1511 +/- 2.6857 C over the Stratification Period, beginning at 5.6683 C and ending at 15.1888 C
Mean Smoothed SP8-Upper Pool delta T is 12.5868 +/- 2.7378 C over the Stratification Period, beginning at 5.078 C and ending at 14.6728 C
The stratification period begins and ends with Smoothed SP8 readings of 61.4696 and 107.6154 C, respectively
The stratification period begins and ends with condensing flows of 0.19641 and 0.36325 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 2.2983 and 0.71181 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 1049.0672 +/- 15.0896 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.16529 and 6.6239 kg/s, respectively
The plume period had a mean steam enthalpy of 1037.8013 +/- 27.4779 kJ/kg.
Maximum Smoothed Top-Mid delta T is 1.1354 degrees C at t plus 16775.2245 s with T_upper = 108.9385 C and T_mid = 107.8032 C
At t plus 16775.2245 s, Smoothed SP8-SP9 is 13.1269 C and Smoothed SP8-Top is 11.9916 C, where Smoothed SP8 is 120.9301 C and Pool P = 36.8361 psia
Maximum Smoothed Top-Lower delta T is 9.4607 degrees C at t plus 10442.7803 s with T_upper = 81.9627 C and T_low = 72.502 C
At t plus 10442.7803 s, Smoothed SP8-SP9 is 15.0273 C and Smoothed SP8-Top is 14.6305 C, where Smoothed SP8 is 96.5932 C and Pool P = 23.4475 psia
Maximum Smoothed Mid-Lower delta T is 9.0729 degrees C at t plus 10444.2864 s with T_mid = 81.5728 C and T_low = 72.4999 C
At t plus 10444.2864 s, Smoothed SP8-SP9 is 15.0588 C and Smoothed SP8-Top is 14.6842 C, where Smoothed SP8 is 96.6316 C and Pool P = 23.4519 psia
Maximum Smoothed Top-Outlet delta T is 24.0711 degrees C at t plus 12943.7224 s with T_upper = 92.1655 C and T_out = 68.0944 C
At t plus 12943.7224 s, Smoothed SP8-SP9 is 15.3027 C and Smoothed SP8-Top is 14.7665 C, where Smoothed SP8 is 106.932 C and Pool P = 27.6062 psia
Maximum Smoothed Mid-Outlet delta T is 23.5371 degrees C at t plus 12941.9273 s with T_mid = 91.6242 C and T_out = 68.0871 C

At t plus 12941.9273 s, Smoothed SP8-SP9 is 15.2672 C and Smoothed SP8-Top is 14.7385 C, where Smoothed SP8 is 106.8914 C and Pool P = 27.605 psia
Maximum Smoothed Lower-Outlet delta T is 23.2967 degrees C at t plus 12950.1247 s with T_low = 91.4378 C and T_out = 68.1412 C
At t plus 12950.1247 s, Smoothed SP8-SP9 is 15.2654 C and Smoothed SP8-Top is 14.7128 C, where Smoothed SP8 is 106.9165 C and Pool P = 27.618 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 16.1228 degrees C at (KEY POINT #14) t plus 12191.4123 s with T_SP8 = 104.892 C and T_SP9 = 88.7692 C and Pool P = 26.3161 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 15.6608 degrees C at t plus 12191.4123 s with T_SP8 = 104.892 C and T_upper = 89.2312 C and Pool P = 26.3161 psia
Maximum Top-Mid delta T is 1.3333 degrees C at (KEY POINT #4) t plus 2083.2402 s ignoring SP 4, with temperatures of 41.2251 and 39.8918 C, respectively, at Set # 2, where Pool P = 15.5929 psia and T_outlet = 38.845 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 2083.2402 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.87451 C and a raw SP12 Reading of 39.8918 C.
Maximum Top-Lower delta T is 11.2421 degrees C at t plus 10759.8935 s, with temperatures of 83.766 and 72.5239 C, respectively, at Set # 1, where Pool P = 23.967 psia and T_outlet = 65.4585 C
Maximum Mid-Low delta T is 10.1362 degrees C at (KEY POINT #6) t plus 10686.0862 s ignoring SP 4, with temperatures of 82.4498 and 72.3136 C, respectively, at Set # 2, where Pool P = 23.8429 psia and T_outlet = 65.4195 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 11029.4949 s with a Smoothed Mid-Axis Mid-Low Delta T of 3.377 C and a raw SP12 Reading of 84.01 C.
Maximum Top-Outlet delta T is 24.4647 degrees C at t plus 12881.3238 s, with temperatures of 92.3755 and 67.9109 C, respectively, at Set # 1, where Pool P = 27.4961 psia
Maximum Mid-Outlet delta T is 23.5644 degrees C at t plus 12922.2261 s ignoring SP 4, with temperatures of 91.4505 and 67.8861 C, respectively, at Set # 2, where Pool P = 27.5643 psia
Maximum Lower-Outlet delta T is 24.1744 degrees C at (KEY POINT #8) t plus 12900.1239 s, with temperatures of 92.2558 and 68.0814 C, respectively, at Set # 1, where Pool P = 27.5365 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 13699.6426 s with a Smoothed Mid-Axis Low-Outlet Delta T of 8.0547 C and a raw SP12 Reading of 94.352 C.
Minimum SP Pressure is 14.925 psia at t plus 10.7026 s
Maximum SP Pressure is 40.8153 psia at t plus 17976.9253 s
Beginning SP Pressure is 14.9295 psia
Ending SP Pressure is 40.8146 psia
Time-Average SP Pressure is 23.3253 +/- 7.3439 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.1382 cm (cold) / 77.2197 cm (hot) at 14.6029 psia
Beginning Smoothed SP Level is 77.6995 cm (cold) / 77.8002 cm (hot) at 14.9309 psia
Ending Smoothed SP Level is 78.9924 cm (cold) / 80.4052 cm (hot) at 40.8193 psia
Minimum Smoothed Cold SP Level is 77.3953 cm at t plus 10615.4882 s and 23.729 psia
Minimum Smoothed Hot SP Level is 77.7365 cm at t plus 3076.854 s and 16.0403 psia
Maximum Smoothed Cold SP Level is 79.0062 cm at t plus 17225.5983 s and 38.2605 psia
Maximum Smoothed Hot SP Level is 80.4069 cm at t plus 17949.9147 s and 40.7204 psia
SP 12 Temperature at the beginning is 29.8168 C, and at the end is 112.9885 C
At plume detection, the Mixing Number is 39.8935
The Mixing Number ranges from a minimum of 30.2892 at (KEY POINT #12) t plus 0 s to a maximum of 222.6332 at (KEY POINT #13) t plus 17978.7144 s; it had a mean value of 88.3793 +/- 52.6148 over the test period.
Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam

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        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 30.2892):  56.95591238        0.040894
        0.00925         0.3937     0.7769951224     0.7780023228     0.2049962995
        0.2049962995    0.9974288322     18.40175324      179006.6465    0.07112475445
        0.05855346127   0.02215293418    0.05265503756    0.07480797173      30.44163519
        101.8555658     101.8555658      30.73900902      30.60077491      30.78287799
        28.69206289     4.179875241      4.219024305      2.084971587     0.6156755065
        0.678502554     0.678502554      5.360423464       1.7183048    0.03789734629
        995.5148047      957.014117     0.6361268311      3.095135101   0.000789564578
        0.0002763373973 1.233275619e-005 1.301155642e-005      1512.082966
        1543.335556     473.1992278      431.8513333      1.083203125      1.029447646
        1.066447646    0.04355539483    0.04430192944     888.8309391      888.4923146
        127.6845771     426.9307822      2678.491096      299.2462051      461.9001569
        128.9275523     128.3482109      129.1125536      120.3768921
KEY POINT #2 (t plus 3516.9612 s with a Mixing Number of 39.8935):  55.19298357
        0.040894        0.00925          0.3937     0.7752555653     0.7776907489
        0.2397336965    0.2397336965     0.9977206111      19.27128767      173604.5635
        0.06840129971   0.05808750599    0.0224592477    0.05003322907    0.07249247677
        47.26431198     104.2559384      104.2559384      49.27821725      47.53692459
        47.50572445      45.3062175       4.17902222      4.222213445      2.095058431
        0.6374361397     0.679403823      0.679403823      3.755333451       1.67557036
        0.03828347294     989.2613594      955.2574705     0.6881661001      2.864000814
        0.0005728098901  0.0002696189861 1.241489855e-005  1.30011667e-005
        1542.102424      1540.91111      474.4023978      438.6885783      1.178211169
        1.121453697      1.158453697     0.1076906648      0.119156121      975.6830616
        975.3116791      197.9923229      437.0688828      2682.238436      239.0765599
        538.6141789      206.4088135      199.1301063      199.0027579      189.815173
KEY POINT #3 (t plus 5335.5922 s with a Mixing Number of 46.9918):  54.82921649
        0.040894        0.00925          0.3937     0.7754163643     0.7788044915
        0.2539324454    0.2539324454     0.9977537515      19.09152109      171879.7106
        0.06696079705   0.05772395357    0.02279875002     0.0492159418    0.07201469182
        55.80135967      106.119568       106.119568      61.46963658      56.39164762
        55.87077062      53.00367442      4.181106078      4.224777023      2.103220986
        0.6466879905    0.6800553118     0.6800553118      3.217098108      1.643821721
        0.03859329769     985.3247898      953.8758594     0.7309140899      2.871914513
        0.0004975857277   0.000264603241 1.247875391e-005 1.304508817e-005
        1550.940752      1538.912808      475.3230232      441.0580751      1.25662891
        1.200006437      1.237006437     0.1637658888     0.2134239057      1014.164339
        1013.799853      233.6833294      444.9456959      2685.124796      211.2623665
        569.2186433      257.3890714      236.150003       233.975073      221.9925539
KEY POINT #4 (t plus 2083.2402 s with a Mixing Number of 35.4803):  55.86745454
        0.040894        0.00925          0.3937     0.7766152805     0.7784227918
        0.2266843735    0.2266843735     0.9976414423      19.15849104      175884.3354
        0.06951492442   0.05831311387    0.02231691075    0.05106144077    0.07337835152
        40.50032392     103.0953923      103.0953923      41.20744002      40.95573348
        40.88005788     38.80015699      4.178523081      4.22065577       2.090122634
        0.6292711254    0.6789768428     0.6789768428      4.294322014      1.695966196
        0.0380949959     992.0315436      956.1100123     0.6625897077      2.916067577
        0.0006467100443  0.0002728300615 1.237516863e-005 1.298946652e-005
        1532.186448      1542.104493      473.8231069      436.3203098      1.131451985
        1.075352216      1.112352216    0.07583688012    0.07873212918      942.179726
        941.8126782      169.7237132      432.1662441      2680.430764      262.4425309
        510.0134819      172.6784146      171.6251497      171.3120318      162.6251034
KEY POINT #5 (t plus 2083.2402 s with a Mixing Number of 35.4803):  55.86745454
        0.040894        0.00925          0.3937     0.7766152805     0.7784227918
        0.2266843735    0.2266843735     0.9976414423      19.15849104      175884.3354
        0.06951492442   0.05831311387    0.02231691075    0.05106144077    0.07337835152
        40.50032392     103.0953923      103.0953923      41.20744002      40.95573348
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      40.88005788      38.80015699      4.178523081       4.22065577      2.090122634
      0.6292711254     0.6789768428     0.6789768428      4.294322014      1.695966196
      0.0380949959     992.0315436      956.1100123      0.6625897077      2.916067577
      0.0006467100443  0.0002728300615 1.237516863e-005 1.298946652e-005
      1532.186448      1542.104493      473.8231069      436.3203098      1.131451985
      1.075352216      1.112352216     0.07583688012    0.07873212918      942.179726
      941.8126782      169.7237132      432.1662441      2680.430764      262.4425309
      510.0134819      172.6784146      171.6251497      171.3120318      162.6251034
KEY POINT #6 (t plus 10686.0862 s with a Mixing Number of 89.7776):  55.9626866
      0.040894         0.00925           0.3937     0.7739801112     0.7811046688
      0.2585312297     0.2585312297     0.9970789935      15.00017441      170052.4764
      0.06218037776    0.0559566424     0.02341527953    0.05008815326    0.07350343279
      82.67773936      115.0693335      115.0693335      98.10316741      83.09160971
      74.96262041      65.38045016      4.197707797      4.238182616      2.146742609
      0.6687688906     0.6826060358     0.6826060358      2.152013393      1.506969503
      0.04021164302     970.1467049      947.0275029       0.96735458      3.730802395
      0.0003428536904  0.0002427140526 1.278621392e-005 1.345783463e-005
      1556.395022      1527.95808       479.5737739      441.2377324      1.695598722
      1.644117303      1.681117303      0.527954306     0.9474259494      1055.936016
      1055.711011      346.2819547      482.8469277      2698.687867      136.564973
      573.0890881      411.1535268      348.0179981      313.9228275      273.7951381
KEY POINT #7 (t plus 11029.4949 s with a Mixing Number of 93.5363):  56.30264141
      0.040894         0.00925           0.3937     0.7740220113     0.7814137458
      0.2577510938     0.2577510938     0.9970022245      14.72888212      170616.2536
      0.06190561403    0.05581656944    0.02355366766    0.05039627417    0.07394994183
      84.16354061      115.7711973      115.7711973      99.25793142      84.53114482
      81.54718217      65.81600161      4.199061894      4.239312513      2.150474769
      0.6696978711     0.6827661799     0.6827661799      2.111359169      1.497231732
      0.04034819334     969.1965722      946.4756541     0.9882421502      3.822601129
      0.000336735389  0.0002411379645 1.281037203e-005 1.349484688e-005
      1555.847455      1527.006979      479.8948587      441.022747      1.734754543
      1.683571141      1.720571141     0.5599554652     0.9876156513      1056.678075
      1056.461135      352.5230264      485.8247471      2699.729562      133.3017208
      570.8533277      416.0236377      354.0653468      341.5413288      275.6213266
KEY POINT #8 (t plus 12900.1239 s with a Mixing Number of 115.7613):  55.65684625
      0.040894         0.00925           0.3937     0.7766321077     0.7854125707
      0.2600221681     0.2600221681     0.9966893073      13.18339808      166568.4601
      0.06054310975    0.05509358056    0.02362844675    0.04947328418    0.07310173093
      91.44849588      119.3772306      119.3772306      105.986528      92.01565467
      91.2333894      67.98508439      4.206365626      4.245303972      2.170421112
      0.6738346996     0.6834989092     0.6834989092      1.930805773      1.449250314
      0.04107317533     964.3824116      943.6068059      1.101391712      4.221737516
      0.0003093035755   0.000233330997  1.29345731e-005 1.366423793e-005
      1552.042347      1521.916875      481.515546      441.03629      1.947786407
      1.897931794      1.934931794     0.7413289525      1.250891899      1074.371893
      1074.198091      383.1556288      501.1376558      2705.028345      117.982027
      573.2342374      444.4336399      385.540174      382.252225      284.7188458
KEY POINT #9 (t plus 13152.6443 s with a Mixing Number of 119.494):  56.54583692
      0.040894         0.00925           0.3937     0.7776949126     0.7866962506
      0.2551285464     0.2551285464      0.996552995      12.95476221      168694.8508
      0.06035825522    0.05499544804    0.02363321724    0.05063614644    0.07426936368
      92.42661194      119.8645701      119.8645701      107.6153837      92.9425614
      92.5187384      69.38536616      4.207431052      4.246137928      2.173217443
      0.6743379389     0.6835864323     0.6835864323      1.908727674      1.443019324
      0.04117422027     963.7166478      943.2147966      1.117454495      4.364868766
      0.0003059176656  0.0002323119145 1.295136777e-005 1.370750467e-005
      1551.39439       1521.20315       481.7308172      440.014325      1.978148258
      1.92841095       1.96541095     0.7690393072      1.322638735      1065.304641
      1065.136815      387.2728075      503.2088997      2705.737481      115.9360921
      562.0957412      451.3187379      389.4424732      387.6618106      290.5844062
KEY POINT #10 (t plus 13699.6426 s with a Mixing Number of 125.9496):  56.2006634
      0.040894         0.00925           0.3937      0.780510294     0.7900521412
      0.2722201049     0.2722201049     0.9967357761      13.29716992      167784.9397
      0.0599607914    0.05477415557    0.02367830071    0.05013769948    0.07381600019
      94.52171363      120.9617188      120.9617188      109.1611881      95.25928609
      94.60524108      86.16711783      4.209780703      4.248036848      2.179601995
      0.6753750274     0.6837735083     0.6837735083      1.863000053      1.429203655
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       0.04140443145      962.2755718      942.3285317      1.154309776       4.22651314
       0.0002988810582  0.0002300478155 1.298918491e-005 1.369771288e-005
       1549.901677      1519.574132      482.2121503      443.1197692      2.047918392
       1.997704557      2.034704557      0.8313032162     1.393828739      1106.785968
       1106.609153      396.0955563      507.8734781      2707.327757      111.7779218
       598.9124894      457.8592362      399.1995939      396.4485667      360.9675751
KEY POINT #11 (t plus 17978.7144 s with a Mixing Number of 222.6332):  56.62461293
       0.040894          0.00925          0.3937     0.7899237898     0.8040518497
       0.3082379359     0.3082379359     0.9962135263      11.08578704      164101.0007
       0.05634888756    0.05253057691    0.02491916468    0.04945366628    0.07437283096
       113.0982131      131.9490016      131.9490016      124.9167751      114.1361116
       113.8531733      112.1344495      4.234772387      4.268755511      2.250561699
       0.6822005151     0.6848960599     0.6848960599      1.534984846      1.305615967
       0.04392809906      948.6230236      933.169441      1.580419459      5.107856818
       0.000247278332  0.0002094782025 1.336829911e-005 1.411086411e-005
       1530.827029      1501.612954      486.7745333      448.1608166        2.8639031
       2.814390816      2.851390816       1.58948918      2.316301191        1223.1102
       1222.987305      474.5792804      554.7146869      2722.756126      80.13540656
       668.3955129      524.7441738      478.9741617      477.7780975      470.5032459
KEY POINT #12 (t plus 0 s with a Mixing Number of 30.2892):  56.95591238         0.040894
       0.00925          0.3937     0.7769951224     0.7780023228     0.2049962995
       0.2049962995     0.9974288322      18.40175324      179006.6465    0.07112475445
       0.05855346127    0.02215293418    0.05265503756    0.07480797173      30.44163519
       101.8555658      101.8555658      30.73900902      30.60077491      30.78287799
       28.69206289      4.179875241      4.219024305      2.084971587     0.6156755065
       0.678502554      0.678502554      5.360423464       1.7183048     0.03789734629
       995.5148047       957.014117     0.6361268311      3.095135101   0.000789564578
       0.0002763373973 1.233275619e-005 1.301155642e-005      1512.082966
       1543.335556      473.1992278      431.8513333      1.083203125      1.029447646
       1.066447646    0.04355539483    0.04430192944      888.8309391      888.4923146
       127.6845771      426.9307822      2678.491096      299.2462051      461.9001569
       128.9275523      128.3482109      129.1125536      120.3768921
KEY POINT #13 (t plus 17978.7144 s with a Mixing Number of 222.6332):  56.62461293
       0.040894          0.00925          0.3937     0.7899237898     0.8040518497
       0.3082379359     0.3082379359     0.9962135263      11.08578704      164101.0007
       0.05634888756    0.05253057691    0.02491916468    0.04945366628    0.07437283096
       113.0982131      131.9490016      131.9490016      124.9167751      114.1361116
       113.8531733      112.1344495      4.234772387      4.268755511      2.250561699
       0.6822005151     0.6848960599     0.6848960599      1.534984846      1.305615967
       0.04392809906      948.6230236      933.169441      1.580419459      5.107856818
       0.000247278332  0.0002094782025 1.336829911e-005 1.411086411e-005
       1530.827029      1501.612954      486.7745333      448.1608166        2.8639031
       2.814390816      2.851390816       1.58948918      2.316301191        1223.1102
       1222.987305      474.5792804      554.7146869      2722.756126      80.13540656
       668.3955129      524.7441738      478.9741617      477.7780975      470.5032459
KEY POINT #14 (t plus 12191.4123 s with a Mixing Number of 106.859):  56.47477422
       0.040894          0.00925          0.3937     0.7745828627     0.7827992936
       0.2558202449     0.2558202449     0.9967539814      13.7053415      169656.5151
       0.06104715772    0.05536674004    0.02362994431    0.05054608303    0.07417602733
       88.76920108      118.0180441      118.0180441      104.8920043      89.23117024
       88.16798741      67.09580228      4.203550702      4.243008758      2.162749752
       0.6723932429     0.6832403736     0.6832403736      1.993792399      1.466941841
       0.04079525532      966.182699      944.6947178      1.057575967      4.120639694
       0.0003189238412  0.0002362177287 1.288774416e-005 1.361267745e-005
       1553.653428      1523.875148      480.910408       440.3969687      1.865113666
       1.814780668      1.851780668     0.6696497137      1.204508005      1060.319914
       1060.132078      371.8829063      495.3632247       2703.04172      123.4803184
       564.9566897      439.8045866      373.8236095      369.3572589      280.9891261
End
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D.31 TEST #31 -

T31_RCIC_STD_32KW_COOLSTART_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T31_RCIC_STD_32kW_coolstart\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 2098.074 s, and ending (KEY POINT #11) at t
       plus 33496.2229 s, for a time period of 31398.1489 s.
Original Data Record Time:  33936.8281 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       1785.2331 s, T_bulk = 39.6457 C and T_out = 37.5095 C
Stratification Beginning SP12 Temperature = 39.4586 C
Stratification Beginning Pressure = 14.8741 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       24369.6199 s, T_bulk = 96.8123 C and T_out = 70.2051 C
Stratification Ending SP12 Temperature = 96.6826 C
Stratification Ending Pressure = 29.3707 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 8700.9447 s.
At t = 8700.9447 s, the pool pressure is 17.0445 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 57.8431, 57.647, 59.6496, 57.826, and 54.8411
       C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 9.1649 +/- 3.2151 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 8.7328 +/- 3.1822 C.
Minimum Steam Quality:  0.97819 at t plus 30952.3414 s
Maximum Steam Quality:  1.0121 at t plus 4513.2741 s
Time-Averaged Steam Quality:  0.9978 +/- 0.0052489
Minimum Turbine Outlet Steam Quality:  0.97902 at t plus 30952.3414 s
Maximum Turbine Outlet Steam Quality:  1.0149 at t plus 4896.7931 s
Time-Averaged Turbine Outlet Steam Quality:  0.99981 +/- 0.005897
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 31308.1447 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.25507 degrees/min at t plus 20567.4534 s
       and 0.045959 degrees/min at t plus 20785.0578 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.19846 degrees/min at t plus
       11272.1907 s and 0.096896 degrees/min at t plus 11455.6932 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.11527 degrees/min at t
       plus 20568.5555 s and -0.082531 degrees/min at t plus 20807.3551 s, respectively
Max and min smoothed lower level changerates:  0.77139 degrees/min at t plus 18260.1144 s
       and -0.10524 degrees/min at t plus 14062.8384 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.26889 degrees/min at t
       plus 14062.9404 s and -0.62679 degrees/min at t plus 18260.1144 s, respectively
Max and min smoothed outlet level changerates:  1.0021 degrees/min at t plus 26303.4505 s
       and -0.051996 degrees/min at t plus 16183.2856 s, respectively
Max and min smoothed lower-outlet level changerate differences:  0.76157 degrees/min at t
       plus 18260.0134 s and -0.82459 degrees/min at t plus 26309.7528 s, respectively
Max and min smoothed hot (SP8) level changerates:  0.71492 degrees/min at t plus
       14038.342 s and -0.18381 degrees/min at t plus 20538.3537 s, respectively
Max and min smoothed hot-mid (SP8-SP9) level changerate differences:  0.55299 degrees/min
       at t plus 14038.342 s and -0.35225 degrees/min at t plus 14272.1433 s,
       respectively
The mean steam flow rate was 13.0481 +/- 1.678 g/s
The mean feedwater flow rate was 12.9251 +/- 1.0638 g/s
The mean water injection to steam flow rate was 0.0080696 +/- 0.028074 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 6.5608 +/- 4.7612 C over the
       Stratification Period, beginning at -0.17248 C and ending at 10.5221 C
Mean Smoothed SP8-Upper Pool delta T is 6.2063 +/- 4.6492 C over the Stratification
       Period, beginning at -0.39035 C and ending at 9.9383 C
The stratification period begins and ends with Smoothed SP8 readings of 39.6888 and
       107.4244 C, respectively
The stratification period begins and ends with condensing flows of 0.10439 and 0.28054
       kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of -41.56 and
       0.66621 kg/s, respectively.
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The stratification period had a mean sparger steam enthalpy of 2696.2221 +/- 1.5699 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.14268 and 3.6798 kg/s, respectively
The plume period had a mean steam enthalpy of 2696.8901 +/- 0.87338 kJ/kg.
Maximum Smoothed Top-Mid delta T is 0.75585 degrees C at t plus 29905.9155 s with T_upper = 110.0453 C and T_mid = 109.2894 C
At t plus 29905.9155 s, Smoothed SP8-SP9 is 8.8729 C and Smoothed SP8-Top is 8.117 C, where Smoothed SP8 is 118.1623 C and Pool P = 36.9998 psia
Maximum Smoothed Top-Lower delta T is 7.9672 degrees C at t plus 17544.2995 s with T_upper = 81.594 C and T_low = 73.6268 C
At t plus 17544.2995 s, Smoothed SP8-SP9 is 11.7292 C and Smoothed SP8-Top is 11.2546 C, where Smoothed SP8 is 92.8486 C and Pool P = 22.6633 psia
Maximum Smoothed Mid-Lower delta T is 7.4926 degrees C at t plus 17544.2005 s with T_mid = 81.1191 C and T_low = 73.6265 C
At t plus 17544.2005 s, Smoothed SP8-SP9 is 11.7328 C and Smoothed SP8-Top is 11.2582 C, where Smoothed SP8 is 92.8519 C and Pool P = 22.6623 psia
Maximum Smoothed Top-Outlet delta T is 27.7072 degrees C at t plus 23726.3071 s with T_upper = 96.1003 C and T_out = 68.3931 C
At t plus 23726.3071 s, Smoothed SP8-SP9 is 10.212 C and Smoothed SP8-Top is 9.5637 C, where Smoothed SP8 is 105.664 C and Pool P = 28.6505 psia
Maximum Smoothed Mid-Outlet delta T is 27.0832 degrees C at t plus 23893.1126 s with T_mid = 95.7958 C and T_out = 68.7126 C
At t plus 23893.1126 s, Smoothed SP8-SP9 is 10.9947 C and Smoothed SP8-Top is 10.4773 C, where Smoothed SP8 is 106.7905 C and Pool P = 28.8354 psia
Maximum Smoothed Lower-Outlet delta T is 27.2708 degrees C at t plus 24069.6127 s with T_low = 96.5325 C and T_out = 69.2617 C
At t plus 24069.6127 s, Smoothed SP8-SP9 is 10.2955 C and Smoothed SP8-Top is 9.7132 C, where Smoothed SP8 is 106.48 C and Pool P = 29.0298 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 12.9435 degrees C at (KEY POINT #14) t plus 20075.5453 s with T_SP8 = 100.2562 C and T_SP9 = 87.3127 C and Pool P = 24.9855 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 12.51 degrees C at t plus 20075.5453 s with T_SP8 = 100.2562 C and T_upper = 87.7462 C and Pool P = 24.9855 psia
Maximum Top-Mid delta T is 1.0492 degrees C at (KEY POINT #4) t plus 4918.4833 s ignoring SP 4, with temperatures of 48.2987 and 47.2495 C, respectively, at Set # 2, where Pool P = 15.686 psia and T_outlet = 45.5399 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 4918.4833 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.62768 C and a raw SP12 Reading of 47.2495 C.
Maximum Top-Lower delta T is 9.2105 degrees C at t plus 18013.7083 s, with temperatures of 82.4772 and 73.2667 C, respectively, at Set # 1, where Pool P = 23.0954 psia and T_outlet = 67.6531 C
Maximum Mid-Low delta T is 8.3812 degrees C at (KEY POINT #6) t plus 17588.201 s ignoring SP 4, with temperatures of 81.0458 and 72.6646 C, respectively, at Set # 2, where Pool P = 22.7017 psia and T_outlet = 67.6774 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 18411.8171 s with a Smoothed Mid-Axis Mid-Low Delta T of 2.7924 C and a raw SP12 Reading of 83.1785 C.
Maximum Top-Outlet delta T is 28.0253 degrees C at t plus 23966.8098 s, with temperatures of 96.672 and 68.6467 C, respectively, at Set # 1, where Pool P = 28.9211 psia
Maximum Mid-Outlet delta T is 27.1363 degrees C at t plus 23561.7057 s ignoring SP 4, with temperatures of 94.9386 and 67.8023 C, respectively, at Set # 2, where Pool P = 28.4729 psia
Maximum Lower-Outlet delta T is 27.9004 degrees C at (KEY POINT #8) t plus 23750.5085 s, with temperatures of 96.2528 and 68.3524 C, respectively, at Set # 1, where Pool P = 28.6776 psia
Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 26532.8566 s with a Smoothed Mid-Axis Low-Outlet Delta T of 9.2992 C and a raw SP12 Reading of 101.4608 C.
Minimum SP Pressure is 14.5772 psia at t plus 23.4023 s
Maximum SP Pressure is 39.5948 psia at t plus 31397.6508 s
Beginning SP Pressure is 14.6026 psia
Ending SP Pressure is 39.5933 psia
Time-Average SP Pressure is 23.0621 +/- 7.1829 psia
SP Levels are fully corrected and compensated
Pre-Start SP Level is 77.3013 cm (cold) / 77.4171 cm (hot) at 14.5352 psia
Beginning Smoothed SP Level is 77.4816 cm (cold) / 77.6167 cm (hot) at 14.5987 psia
Ending Smoothed SP Level is 78.8823 cm (cold) / 80.2758 cm (hot) at 39.5891 psia
Minimum Smoothed Cold SP Level is 77.4169 cm at t plus 19138.8277 s and 24.1219 psia

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Minimum Smoothed Hot SP Level is 77.6122 cm at t plus 42.1054 s and 14.5954 psia
Maximum Smoothed Cold SP Level is 78.9679 cm at t plus 29185.9113 s and 35.8581 psia
Maximum Smoothed Hot SP Level is 80.2794 cm at t plus 30826.2392 s and 38.567 psia
SP 12 Temperature at the beginning is 35.0053 C, and at the end is 112.4948 C
At plume detection, the Mixing Number is 47.8841
The Mixing Number ranges from a minimum of 31.346 at (KEY POINT #12) t plus 16.6109 s to
        a maximum of 245.9829 at (KEY POINT #13) t plus 31373.4515 s; it had a mean value
        of 95.1452 +/- 58.2319 over the test period.
Key Points have Data Dumps of the following for each Key Point:  Sparger Massflux (kg/m2-
        s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet
        Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1,
        Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1,
        Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat
        Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2,
        Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger
        Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-
        Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity
        (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat
        Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal
        Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1,
        Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1,
        Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam
        Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water
        Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool
        Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat
        Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool
        Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor
        Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2,
        Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid
        Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8,
        Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool
        Outlet Smoothed Enthalpy e11
KEY POINT #1 (t plus 0 s with a Mixing Number of 31.3518):  8.85144695       0.040894
        0.00925         0.3937     0.774815585     0.776167201     1.00379484
        1               1      14.6478339      29084.7682    0.0703301793    0.0587874192
        0.0116258131 -7.01938007e-006    0.0116258131      35.4499599      104.774786
        100.645227      35.2669174      35.5482218      35.7910568      33.1457519
        4.17887484      4.21746395      2.08006201     0.622666977     0.678021384
        0.678021384      4.78271276      1.74067693    0.0377080203      993.877852
        957.890036     0.611130484     0.603918825   0.00071264094  0.000279840253
        1.22913855e-005 1.24453827e-005      1522.93188      1544.49315      472.585242
        475.509961      1.03775545      1.00654739      1.04354739    0.0577020963
        0.0571224349      2685.36027      2685.14571      148.613894      421.821881
        2676.58922      273.207987      2263.53839      147.84898      149.022992
        150.040903      138.990181
KEY POINT #2 (t plus 8700.9447 s with a Mixing Number of 47.8841):  9.59622503
        0.040894        0.00925         0.3937     0.774903865     0.778467507
        1.00502958              1               1        13.75486      31022.2345
        0.0666443233    0.0579091928    0.0126040318 6.88554843e-006    0.0126040318
        57.6469674      110.573179      105.170999      59.6495713      57.8431002
        57.8259622      54.8411216      4.18177292      4.22346257      2.09902947
        0.64853704     0.679728958     0.679728958      3.11729659      1.65982964
        0.038434485      984.410443      954.581019     0.708893967     0.698041811
        0.000483451002  0.000267134905 1.24462437e-005 1.26498955e-005      1552.34468
        1539.94246      474.855923      478.669415      1.21619426      1.17529091
        1.21229091     0.178718546     0.196245321      2695.12737      2694.93817
        241.398518      440.935843      2683.65822      199.537325      2254.19153
        249.773735      242.217271      242.148559      229.671887
KEY POINT #3 (t plus 1785.2331 s with a Mixing Number of 33.6881):  9.03814845
        0.040894        0.00925         0.3937     0.776756462     0.778486913
        1.0053576              1               1      14.7706352      29500.3238
        0.0696188514    0.0586767087    0.0118710337 1.27706999e-005    0.0118710337
        39.8612946      107.046741      101.218398      39.6888117      40.0791628
        40.2118187      37.4793476      4.17854265      4.21819891      2.08237251
        0.628457714      0.67825149      0.67825149      4.35160121      1.73001164
        0.037797236      992.273059      957.476059     0.622866015     0.612558056
        0.000654485924  0.000278171561 1.23109729e-005 1.25288809e-005      1531.09898
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     1543.95043      472.876608      476.98027      1.05907695       1.0253472
     1.0623472    0.0732999321    0.0726278674      2689.78109      2689.56292
     167.049079      424.241014      2677.4909      257.191936      2265.54007
     166.328351      167.957943      168.515352      157.101524
KEY POINT #4 (t plus 4918.4833 s with a Mixing Number of 38.9251):  9.57763488
     0.040894         0.00925         0.3937     0.776088908     0.778586356
     1.00698612               1               1      14.9255859       30963.942
     0.068297711    0.0583728038    0.0125796148 4.81467796e-006    0.0125796148
     47.8859808      110.362779      102.787818      48.1407893      48.1827555
     48.1938079      45.4779868      4.17913074       4.2202479      2.08883312
     0.638146545     0.678860933     0.678860933      3.71131102      1.70145432
     0.0380456092      988.987846      956.334946      0.65594272     0.641937987
     0.000566711225  0.000273692658 1.23646439e-005 1.26491582e-005      1542.87246
     1542.41414      473.668817      478.974057      1.11932002      1.08131913
     1.11831913     0.111124156     0.112558392      2695.88552      2695.66274
     200.586839      430.867239      2679.95039        230.2804      2265.01828
     201.651721      201.825632      201.874856      190.529451
KEY POINT #5 (t plus 4918.4833 s with a Mixing Number of 38.9251):  9.57763488
     0.040894         0.00925         0.3937     0.776088908     0.778586356
     1.00698612               1               1      14.9255859       30963.942
     0.068297711    0.0583728038    0.0125796148 4.81467796e-006    0.0125796148
     47.8859808      110.362779      102.787818      48.1407893      48.1827555
     48.1938079      45.4779868      4.17913074       4.2202479      2.08883312
     0.638146545     0.678860933     0.678860933      3.71131102      1.70145432
     0.0380456092      988.987846      956.334946      0.65594272     0.641937987
     0.000566711225  0.000273692658 1.23646439e-005 1.26491582e-005      1542.87246
     1542.41414      473.668817      478.974057      1.11932002      1.08131913
     1.11831913     0.111124156     0.112558392      2695.88552      2695.66274
     200.586839      430.867239      2679.95039        230.2804      2265.01828
     201.651721      201.825632      201.874856      190.529451
KEY POINT #6 (t plus 17588.201 s with a Mixing Number of 88.2999):  9.80910747
     0.040894         0.00925         0.3937     0.774361468     0.781256269
     1.0002555               1               1      10.6704742      31483.0714
     0.0624428489    0.0562755357    0.0128836394 1.46232866e-005    0.0128836394
     81.2529731      113.732155      113.467466      93.4469246      81.7136946
     74.0897712      67.6714783      4.19646154      4.23564742      2.13840395
     0.667848281     0.682218998     0.682218998      2.19234108      1.52970401
     0.0399054172      971.045148      948.278985     0.921019291      0.92031909
     0.000348901381  0.000246383382 1.27310996e-005 1.27412487e-005      1556.83674
     1530.07968      478.834162       479.02629      1.60894064      1.56544897
     1.60244897     0.498721403     0.798858357      2696.97918      2696.86532
     340.295867      476.053746      2696.29806      135.757879      2220.92544
     391.53848      342.228014      310.258313      283.378562
KEY POINT #7 (t plus 18411.8171 s with a Mixing Number of 93.7839):  9.85101667
     0.040894         0.00925         0.3937     0.774224989      0.78147161
     0.999702767     0.999702767     0.999999702      10.3894415      31560.0854
     0.0620585625    0.0560830159    0.0129386844 1.22453158e-005    0.0129386844
     83.3371755      114.435199      114.435199      95.6063229      83.7503854
     80.283618      67.5503733      4.19831284      4.23717178      2.14341191
     0.669182445     0.682456406     0.682456406      2.13379688      1.51588375
     0.0400895202      969.723923      947.524262     0.948791317     0.949073131
     0.000340112675  0.000244154504  1.2764392e-005 1.27644609e-005      1556.15352
     1528.80616       479.28211      479.277814      1.66084705      1.61744429
     1.65444429     0.541962716      0.86514722      2697.19265      2697.08471
     349.048169      480.157185      2697.74385      131.109016      2217.03546
     400.633263      350.781694      336.233977      282.875838
KEY POINT #8 (t plus 23750.5085 s with a Mixing Number of 137.1581):  9.88862396
     0.040894         0.00925         0.3937     0.780535556     0.790204112
     0.995491771     0.995491771     0.999994525      8.64212589      31165.4502
     0.0597760795      0.05486163    0.0129880792 6.30573355e-006    0.0129880792
     95.491705      120.528329      120.528329      106.119915      96.1288229
     95.4756223      68.4405822      4.21091225      4.24728319       2.1770652
     0.675833418     0.683701257     0.683701257      1.84252492      1.43462625
     0.041313041      961.598501      942.679237      1.13963591      1.14479065
     0.000295717375   0.00023093722 1.29742454e-005 1.29754387e-005      1549.15191
     1520.22128      482.022565      481.950635      2.02012201      1.97705753
     2.01405753     0.861517503      1.25664388      2696.85417      2696.77948
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       400.17798      506.030636      2706.70061      105.852656      2190.82353
       445.002964      402.859774      400.111628      286.632409
KEY POINT #9 (t plus 24369.6199 s with a Mixing Number of 143.538):  10.0217448
       0.040894         0.00925          0.3937     0.782676899     0.792717471
       0.995317388     0.995317388     0.999994182      8.56444696      31522.1769
       0.059506685     0.054710556    0.0131629249 4.31311638e-006    0.0131629249
       96.9023023      121.276576      121.276576       107.42436      97.4860728
       96.7486498      70.2603898      4.21257612      4.24858731      2.18145715
       0.676483155     0.683824652     0.683824652      1.81350268      1.42529234
       0.0414712      960.610253      942.073239       1.1650657       1.1705401
       0.000291224177  0.000229405674 1.30000394e-005 1.30012985e-005      1548.02364
       1519.10099      482.349434      482.273852      2.06830759      2.02523753
       2.06223753      0.907079439      1.31405322      2697.56083      2697.48748
       406.12271      509.212518      2707.78253      103.089809      2188.34832
       450.518462      408.580806      405.476817      294.256708
KEY POINT #10 (t plus 26532.8566 s with a Mixing Number of 164.0653):  11.3174859
       0.040894         0.00925          0.3937     0.787617306     0.798917043
       0.995103175     0.995103175       0.9999934      8.93464731      35344.4563
       0.0585965787    0.0541638315    0.0148647986 1.14019925e-006    0.0148647986
       101.632764      123.974795      123.974795      111.248308      102.177157
       101.796277      92.0614742      4.21846589       4.2534066      2.19777915
       0.678481729     0.684216638     0.684216638      1.72230173      1.39272164
       0.0420564382     957.229755      939.868063      1.26059865       1.2667936
       0.000277008346  0.000224037673 1.30930875e-005 1.30944798e-005      1543.79146
       1514.94392      483.510271      483.427935       2.2499205      2.20708224
       2.24408224      1.07471568      1.49492206      2701.00121      2700.92139
       426.07756      520.695234      2711.65011      94.6176736      2180.30598
       466.70403      428.372987      426.768694      385.762868
KEY POINT #11 (t plus 31398.1489 s with a Mixing Number of 245.9767):  10.1130884
       0.040894         0.00925          0.3937     0.788822594      0.80275799
       0.988658526     0.988658526     0.999981175      6.52592889      31015.4346
       0.0564340074    0.0527567729     0.013282899 6.81528223e-006     0.013282899
       112.669346      130.852077      130.852077      120.548441       113.33915
       113.010355      108.970263       4.2341232      4.26654293      2.24289134
       0.682086194     0.684844644     0.684844644         1.54124      1.31684228
       0.0436576399     948.952096      934.106948      1.53291733      1.55047312
       0.00024828246  0.000211373095 1.33304277e-005 1.33341559e-005      1531.36511
       1503.5375      486.340452      486.128275      2.77218507      2.72957406
       2.76657406      1.56713998       2.0214051      2696.67576      2696.63318
       472.757157      550.027232      2721.25813      77.2700752      2146.64853
       506.168407      475.592312      474.202416      457.109873
KEY POINT #12 (t plus 16.6109 s with a Mixing Number of 31.346):  8.85705877
       0.040894         0.00925          0.3937     0.774783855     0.776135639
       1.00388439               1               1      14.6722676      29095.3093
       0.0703270624    0.0587890113    0.0116331839 -1.44666333e-006    0.0116331839
       35.4694354      104.864429      100.636979      35.3818169      35.5988143
       35.8139952      33.1663456      4.17887235      4.21745343      2.08002895
       0.622693276     0.678018043     0.678018043      4.78066194      1.74083134
       0.0377067422     993.871082      957.895983     0.610962934     0.603584776
       0.000712365873  0.000279864397 1.22911037e-005 1.24487613e-005       1522.9707
       1544.50089      472.581041      475.574022      1.03745125      1.00634236
       1.04334236    0.0577640704    0.0574857076      2685.54998      2685.33471
       148.695262      421.787072      2676.57624      273.091811      2263.76291
       148.329114      149.234393       150.13674      139.076228
KEY POINT #13 (t plus 31373.4515 s with a Mixing Number of 245.9829):  10.1333046
       0.040894         0.00925          0.3937     0.788850767     0.802776094
       0.988721298     0.988721298     0.999981302      6.55052237      31080.7767
       0.0564356283    0.0527651844    0.0133094517 1.43077903e-005    0.0133094517
       112.661175       130.81124       130.81124      120.541022      113.285114
       112.887068      108.908946      4.23411131       4.2664612      2.24260834
       0.682083893     0.684842473     0.684842473      1.54135984      1.31726464
       0.0436476529     948.958281      934.141751      1.53117135      1.54860902
       0.000248301625  0.000211444271 1.33290179e-005 1.33327222e-005      1531.37493
       1503.6086      486.324199      486.113332      2.76881715      2.72620253
       2.76320253      1.56671671      2.02093174      2696.75508      2696.71218
       472.722319      549.852777      2721.20218      77.1304579      2146.90231
       506.136662      475.363218      473.680107      456.850348
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KEY POINT #14 (t plus 20075.5453 s with a Mixing Number of 105.3569):  9.98248593
       0.040894         0.00925          0.3937     0.774331328     0.782263829
       0.999100848     0.999100848     0.999999044      9.92930058      31818.5801
       0.0613197362     0.055705462     0.013111361 7.73225155e-006     0.013111361
       87.3126934      116.327171      116.327171      100.256207      87.746219
       86.6714653      67.2133022      4.20209428      4.24021587      2.1534655
       0.671568125     0.682888968     0.682888968      2.02965183      1.48961253
       0.0404574007      967.144308      946.036999      1.00504576      1.0059493
       0.000324373844  0.000239902872 1.28295125e-005 1.28297296e-005      1554.41768
       1526.24434      480.147906      480.134511      1.76629439     1.72282587
       1.75982587     0.633174809      1.02348758      2698.6617      2698.56311
       365.754312      488.184192      2700.55236      122.429879     2210.47751
       420.23549      367.574798      363.061421      281.473425
End
```

D.32 TEST #32 - T32_RCIC_STD_107KW_A_RESULTS_RCICLAND.TXT

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Output Saved to C:\Local Files\RCICLAND_NOTITLES\Export\T32_RCIC_STD_107kW_A\
Using 20-second SP 12 averages for beginning detection
Beginning (KEY POINT #1) detected at t plus 1954.1718 s, and ending (KEY POINT #11) at t
       plus 11629.1311 s, for a time period of 9674.9593 s.
Original Data Record Time:  12941.0732 s
Bulk Pool to Outlet Thermal Stratification Detected beginning (KEY POINT #3) at t plus
       2701.3515 s, T_bulk = 63.6862 C and T_out = 61.262 C
Stratification Beginning SP12 Temperature = 63.4018 C
Stratification Beginning Pressure = 17.8864 psia
Bulk Pool to Outlet Thermal Destratification Detected beginning (KEY POINT #9) at t plus
       8695.3573 s, T_bulk = 116.0703 C and T_out = 73.9835 C
Stratification Ending SP12 Temperature = 115.8425 C
Stratification Ending Pressure = 42.6547 psia
Plume detected!  Setting t_plume (KEY POINT #2) to 2213.4416 s.
At t = 2213.4416 s, the pool pressure is 17.1663 psia while the Smoothed Upper, Mid, SP8,
       Lower, and Outlet Temperatures are 59.8221, 59.8394, 61.8401, 59.7449, and
       57.0339 C, respectively.
Over the Plume Period (Plume Detected to Destratification), the mean Smothed SP8-SP9
       temperatures were 10.9686 +/- 2.5661 C.
Over the Plume Period (Plume Detected to Destratification), the mean Smoothed SP8-Upper
       temperatures were 10.07 +/- 2.3683 C.
Minimum Steam Quality:  0.99525 at t plus 9513.5751 s
Maximum Steam Quality:  1.0039 at t plus 5638.2005 s
Time-Averaged Steam Quality:  1.0004 +/- 0.0013441
Minimum Turbine Outlet Steam Quality:  1.0001 at t plus 9513.5751 s
Maximum Turbine Outlet Steam Quality:  1.024 at t plus 934.4185 s
Time-Averaged Turbine Outlet Steam Quality:  1.0145 +/- 0.0066662
Smoothed Changerates may not fully include test beginning and end periods, analysis
       ending at t plus 9584.9852 s; using 300 s smoothing
Max and min smoothed upper level changerates:  0.77924 degrees/min at t plus 3928.0687 s
       and 0.3485 degrees/min at t plus 7716.6404 s, respectively
Max and min smoothed mid (SP9) level changerates:  0.71413 degrees/min at t plus
       4253.5753 s and 0.34052 degrees/min at t plus 8787.1576 s, respectively
Max and min smoothed upper-mid level changerate differences:  0.32523 degrees/min at t
       plus 3885.8693 s and -0.13587 degrees/min at t plus 4478.0831 s, respectively
Max and min smoothed lower level changerates:  3.0133 degrees/min at t plus 6822.2252 s
       and 0.036062 degrees/min at t plus 3830.1681 s, respectively
Max and min smoothed mid-lower level changerate differences:  0.58748 degrees/min at t
       plus 5868.4057 s and -2.5671 degrees/min at t plus 6822.2252 s, respectively
Max and min smoothed outlet level changerates:  7.1719 degrees/min at t plus 9023.0791 s
       and -0.023147 degrees/min at t plus 5083.9898 s, respectively
Max and min smoothed lower-outlet level changerate differences:  2.979 degrees/min at t
       plus 6822.1242 s and -6.6032 degrees/min at t plus 9019.0658 s, respectively
Max and min smoothed hot (SP8) level changerates:  1.206 degrees/min at t plus 2633.9497
       s and 0.17506 degrees/min at t plus 8093.2499 s, respectively
```

Max and min smoothed hot-mid (SP8-SP9) level changerate differences: 0.70373 degrees/min at t plus 2635.3487 s and -0.27746 degrees/min at t plus 4438.0849 s, respectively
The mean steam flow rate was 44.6769 +/- 0.96462 g/s
The mean feedwater flow rate was 44.2747 +/- 1.3646 g/s
The mean water injection to steam flow rate was 0.012706 +/- 0.026273 g/s
Mean Smoothed Condensing Region SP8-SP9 delta T is 11.5424 +/- 1.6214 C over the Stratification Period, beginning at 5.8519 C and ending at 12.4361 C
Mean Smoothed SP8-Upper Pool delta T is 10.5838 +/- 1.5711 C over the Stratification Period, beginning at 5.7071 C and ending at 11.3279 C
The stratification period begins and ends with Smoothed SP8 readings of 69.8175 and 128.4867 C, respectively
The stratification period begins and ends with condensing flows of 0.56653 and 1.3444 kg/s, respectively.
The stratification period begins and ends with condensing+cooling flows of 4.4037 and 1.8817 kg/s, respectively.
The stratification period had a mean sparger steam enthalpy of 2734.0399 +/- 0.84684 kJ/kg.
At plume detection, the condensing and condensing+cooling flows are 0.53105 and 13.0722 kg/s, respectively
The plume period had a mean steam enthalpy of 2734.8343 +/- 0.5093 kJ/kg.
Maximum Smoothed Top-Mid delta T is 2.1961 degrees C at t plus 4011.4715 s with T_upper = 76.7591 C and T_mid = 74.563 C
At t plus 4011.4715 s, Smoothed SP8-SP9 is 10.9754 C and Smoothed SP8-Top is 8.7793 C, where Smoothed SP8 is 85.5384 C and Pool P = 20.8173 psia
Maximum Smoothed Top-Lower delta T is 20.1396 degrees C at t plus 6540.0151 s with T_upper = 101.9118 C and T_low = 81.7722 C
At t plus 6540.0151 s, Smoothed SP8-SP9 is 12.6153 C and Smoothed SP8-Top is 11.8422 C, where Smoothed SP8 is 113.754 C and Pool P = 31.2785 psia
Maximum Smoothed Mid-Lower delta T is 19.3683 degrees C at t plus 6540.3181 s with T_mid = 101.141 C and T_low = 81.7728 C
At t plus 6540.3181 s, Smoothed SP8-SP9 is 12.6263 C and Smoothed SP8-Top is 11.8574 C, where Smoothed SP8 is 113.7673 C and Pool P = 31.2788 psia
Maximum Smoothed Top-Outlet delta T is 43.1546 degrees C at t plus 8676.7573 s with T_upper = 117.0273 C and T_out = 73.8726 C
At t plus 8676.7573 s, Smoothed SP8-SP9 is 12.5786 C and Smoothed SP8-Top is 11.4574 C, where Smoothed SP8 is 128.4847 C and Pool P = 42.5499 psia
Maximum Smoothed Mid-Outlet delta T is 42.1452 degrees C at t plus 8667.1607 s with T_mid = 115.9591 C and T_out = 73.8139 C
At t plus 8667.1607 s, Smoothed SP8-SP9 is 12.4101 C and Smoothed SP8-Top is 11.4321 C, where Smoothed SP8 is 128.3692 C and Pool P = 42.5049 psia
Maximum Smoothed Lower-Outlet delta T is 42.103 degrees C at t plus 8699.7596 s with T_low = 116.1975 C and T_out = 74.0945 C
At t plus 8699.7596 s, Smoothed SP8-SP9 is 12.4388 C and Smoothed SP8-Top is 11.3697 C, where Smoothed SP8 is 128.5735 C and Pool P = 42.6806 psia
Maximum Smoothed Condensing Region SP8-SP9 delta T is 13.8692 degrees C at (KEY POINT #14) t plus 7691.6389 s with T_SP8 = 123.2067 C and T_SP9 = 109.3375 C and Pool P = 37.1837 psia
Maximum Smoothed Condensing Region SP8-Upper delta T is 12.9936 degrees C at t plus 7315.9625 s with T_SP8 = 120.711 C and T_upper = 107.7175 C and Pool P = 35.2766 psia
Maximum Top-Mid delta T is 2.8241 degrees C at (KEY POINT #4) t plus 4013.1715 s ignoring SP 4, with temperatures of 76.9067 and 74.0826 C, respectively, at Set # 2, where Pool P = 20.8168 psia and T_outlet = 67.9043 C
Top-Mid Reconvergence Detected at (KEY POINT #5) t plus 5122.393 s with a Smoothed Mid-Axis Top-Mid Delta T of 0.9996 C and a raw SP12 Reading of 86.5765 C.
Maximum Top-Lower delta T is 22.5262 degrees C at t plus 6644.6211 s, with temperatures of 103.088 and 80.5618 C, respectively, at Set # 1, where Pool P = 31.8519 psia and T_outlet = 71.947 C
Maximum Mid-Low delta T is 20.6545 degrees C at (KEY POINT #6) t plus 6616.0364 s ignoring SP 4, with temperatures of 101.7052 and 81.0507 C, respectively, at Set # 2, where Pool P = 31.6993 psia and T_outlet = 71.8616 C
Mid-Low Reconvergence Detected at (KEY POINT #7) t plus 6961.3292 s with a Smoothed Mid-Axis Mid-Low Delta T of 6.8836 C and a raw SP12 Reading of 104.308 C.
Maximum Top-Outlet delta T is 43.5673 degrees C at t plus 8683.4596 s, with temperatures of 117.4591 and 73.8918 C, respectively, at Set # 1, where Pool P = 42.5899 psia

Maximum Mid-Outlet delta T is 42.0022 degrees C at t plus 8686.1768 s ignoring SP 4, with temperatures of 115.9094 and 73.9072 C, respectively, at Set # 2, where Pool P = 42.6129 psia

Maximum Lower-Outlet delta T is 43.4992 degrees C at (KEY POINT #8) t plus 8670.9689 s, with temperatures of 117.3156 and 73.8164 C, respectively, at Set # 1, where Pool P = 42.5111 psia

Low-Outlet Reconvergence Detected at (KEY POINT #10) t plus 9079.9673 s with a Smoothed Mid-Axis Low-Outlet Delta T of 14.4908 C and a raw SP12 Reading of 118.3743 C.

Minimum SP Pressure is 15.1382 psia at t plus 6.4004 s

Maximum SP Pressure is 49.5608 psia at t plus 9674.9593 s

Beginning SP Pressure is 15.142 psia

Ending SP Pressure is 49.5608 psia

Time-Average SP Pressure is 26.6507 +/- 10.201 psia

SP Levels are fully corrected and compensated

Pre-Start SP Level is 78.6067 cm (cold) / 78.7386 cm (hot) at 14.5982 psia

Beginning Smoothed SP Level is 78.806 cm (cold) / 78.9919 cm (hot) at 15.1426 psia

Ending Smoothed SP Level is 77.9987 cm (cold) / 79.6061 cm (hot) at 49.5514 psia

Minimum Smoothed Cold SP Level is 77.9987 cm at t plus 9674.9593 s and 49.5514 psia

Minimum Smoothed Hot SP Level is 78.9359 cm at t plus 264.1111 s and 15.2993 psia

Maximum Smoothed Cold SP Level is 78.8063 cm at t plus 3.1012 s and 15.1442 psia

Maximum Smoothed Hot SP Level is 79.6803 cm at t plus 7491.5355 s and 36.1836 psia

SP 12 Temperature at the beginning is 40.8764 C, and at the end is 122.8031 C

At plume detection, the Mixing Number is 44.7729

The Mixing Number ranges from a minimum of 33.1644 at (KEY POINT #12) t plus 0 s to a maximum of 243.5675 at (KEY POINT #13) t plus 9674.9593 s; it had a mean value of 98.2305 +/- 60.6178 over the test period.

Key Points have Data Dumps of the following for each Key Point: Sparger Massflux (kg/m2-s) g1, Sparger Diameter (m) d1, Water Injection Pipe Diameter d2, Sparger Outlet Elevation d3, Pool Cold Level d4, Pool Hot Level d5, Sparger Steam Quality x1, Bounded Quality x2, Sparger Void Fraction vf1, Sparger fluid velocity (m/s) v1, Two phase Re re_tp, Pool Mid T Tsat Surface Tension (N/m) sig1, Sparger P Psat Surface Tension sig2, Steam at Flowmeter mdot (kg/s) md1, Water mdot to Steam md2, Sparger mdot md3, Pool Mid T (C) t1, Estimated Sparger Steam T t2, Sparger Saturation T t3, Smoothed Plume T t4, Upper-Level Pool Rear Smoothed T t5, Lower-Level Pool Rear Smoothed T t6, Pool Outlet Smoothed T t7, Pool Mid Heat Capacity (kJ/kg-K) cp1, Sparger Sat Water Heat Capacity cp2, Sparger Sat Steam Heat Capacity cp3, Pool Mid Thermal Conductivity (W/m-K) k1, Sparger Sat Water Thermal Conductivity k2, Sparger Sat Steam Thermal Conductivity k3, Pool Mid Water Pr pr1, Sparger Sat Water Pr pr2, Sparger Sat Steam Pr pr3, Pool Mid Density (kg/m3) rho1, Sparger Sat Water Density rho2, Sparger Sat Steam Density rho3, Sparger Steam Density rho4, Sparger Subcooled T_mid Viscosity (Pa-s) mu1, Sparger Sat Water Viscosity mu2, Sparger Sat Steam Viscosity mu3, Sparger Steam Viscosity mu4, Pool Mid Sonic Velocity (m/s) cs1, Sparger Sat Water Sonic Velocity cs2, Sparger Sat Steam Sonic Velocity cs3, Sparger Sonic Velocity cs4, Sparger P (bar) p1, Pool Airspace P p2, Approx Pool Mid P p3, T_mid Vapor Pressure p4, T_Plume Vapor Pressure p5, Sparger Total Stagnation h (kJ/kg) e1, Sparger Steam Flowing h e2, Pool Mid h e3, Sparger Water Sat h e4, Sparger Steam Sat h e5, Pool Mid Subcooling delta h e6, Steam Condensation delta h e7, Smooth Plume Enthalpy e8, Pool Rear Upper Smoothed Enthalpy e9, Pool Rear Lower Smoothed Enthalpy e10, Pool Outlet Smoothed Enthalpy e11

KEY POINT #1 (t plus 0 s with a Mixing Number of 33.1644): 32.80995373 0.040894
0.00925 0.3937 0.7880599336 0.7899191954 1.020410194
1 1 53.24343762 101551.1707 0.06956965481
0.0583732639 0.04309378937 1.63106753e-005 0.04309378937 40.16396699
125.1571847 102.7854462 40.43445979 40.11370202 39.89608901
37.65113799 4.178533363 4.220244767 2.088823208 0.6288435919
0.6788600348 0.6788600348 4.324377485 1.701496771 0.03804522926
992.160429 956.3366785 0.6558916774 0.6164585443 0.0006507922358
0.0002736993281 1.236456276e-005 1.321235628e-005 1531.616427
1542.416514 473.6676261 488.7936379 1.119226894 1.04404443
1.08104443 0.07449225453 0.07557194351 2728.685897 2725.851033
168.3154639 430.8572225 2679.946682 262.5417586 2297.828674
169.4457268 168.1039237 167.1977222 157.8210413

KEY POINT #2 (t plus 2213.4416 s with a Mixing Number of 44.7729): 33.68821498
0.040894 0.00925 0.3937 0.7868786938 0.7909158031
1.020487821 1 1 48.63508038 103311.2465
0.0662660613 0.05767614921 0.0442473297 9.184716526e-006 0.0442473297

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        59.83944234      128.5833492      106.3640298      61.84008672      59.82205134
        59.74490196      57.03394964       4.1826508       4.225119024       2.10431373
        0.6506685008     0.6801376599     0.6801376599      3.005310885       1.639746332
        0.03863460483      983.3023639      953.6934801     0.7366782287     0.6928169461
        0.000467517185  0.0002639578262 1.248713504e-005 1.333490699e-005
        1553.800379      1538.643262      475.4428994      490.4868707      1.267227256
        1.183545357      1.220545357      0.197980526     0.2170726895      2733.750197
        2731.384826      250.5685847      445.979315      2685.501889      195.4107302
        2287.770882      258.9374557      250.494416      250.1746701      238.8411193
KEY POINT #3 (t plus 2701.3515 s with a Mixing Number of 48.3268):  33.66537618
        0.040894          0.00925          0.3937     0.7868468087     0.7914691163
        1.020176924              1                1      47.15887766      103108.0879
        0.06554744288    0.05749735234     0.0442173324 1.862756065e-005     0.0442173324
        63.96555427      129.0934705      107.277156      69.81747139      64.11033093
        63.70506808      61.29138746      4.184571106      4.226408296      2.108441303
        0.6544872075     0.6804388942     0.6804388942      2.811861085      1.624702177
        0.03879028348      981.1366769      953.0099044     0.7585364665     0.7141721805
        0.0004397887055   0.000261572114 1.251845027e-005  1.33521232e-005
        1555.924549      1537.621363      475.8888329      490.6774283      1.307468513
        1.232918172      1.269918172     0.2390493838     0.3095514747      2734.268327
        2732.044367      267.834627      449.8409267      2686.90725      182.0062997
        2284.4274      292.3318434      268.4390482      266.7461185      256.6514246
KEY POINT #4 (t plus 4013.1715 s with a Mixing Number of 60.4446):  34.13431466
        0.040894          0.00925          0.3937     0.7858982686     0.7923887331
        1.017928652              1                1      41.74750414      104229.5827
        0.06365817109    0.05669904614     0.0448332533 6.098129919e-007     0.0448332533
        74.58409468      130.4377023      111.3313816      85.47440632      76.77608419
        73.02341779      67.94185115      4.191137404      4.232359976      2.127665379
        0.6631872073     0.6816560328     0.6816560328      2.400401725      1.561163688
        0.03950857364      975.126918      949.9304531      0.862044969      0.8176483758
        0.0003798290447  0.0002514381226 1.265765653e-005 1.339244222e-005
        1557.927289      1532.801281      477.8333272      490.8888218      1.499067219
        1.435576879      1.472576879     0.3792867226     0.5895219472      2734.738588
        2732.995733      312.3180423      467.0016468      2693.085059      154.6836045
        2267.736941      358.0088059      321.5054057      305.7793705      284.4998272
KEY POINT #5 (t plus 5122.393 s with a Mixing Number of 80.9034):  34.91678199
        0.040894          0.00925          0.3937     0.7855352791     0.7938135772
        1.015598562              1                1      36.73264136      106157.2549
        0.06144810532    0.05577411016    0.04586097442 1.738503914e-007    0.04586097442
        86.62487943      132.3186498      115.9837388      97.21876077      87.60747789
        79.25172467      70.74187287      4.201420567      4.239656983      2.151614491
        0.6711692073     0.6828135443     0.6828135443      2.047012932      1.494309221
        0.04038983287      967.5963203       946.30812     0.9946388987     0.9505691142
        0.0003270065504  0.0002406644169 1.281768879e-005  1.34506764e-005
        1554.754306      1526.716394      479.9917309      491.2724657      1.746756897
        1.68568188       1.72268188      0.6165359273     0.9175707788      2735.918217
        2734.56893      362.8613854      486.7266695      2700.044357      123.8652841
        2249.191547      407.4301557      366.9888499      331.910445      296.2455313
KEY POINT #6 (t plus 6616.0364 s with a Mixing Number of 125.1763):  34.42187643
        0.040894          0.00925          0.3937     0.7847472083     0.7958652135
        1.010628369              1                1      28.24675616      104182.5689
        0.05857940942    0.05418832042     0.0452109474 1.124056638e-005     0.0452109474
        101.7214975      134.6161052      123.854255      114.419825      102.5485956
        83.00310555      71.92953599      4.21858694      4.253187365      2.197033663
        0.6785151447     0.6842008899     0.6842008899      1.720684699      1.394141255
        0.04202978903      957.1649804      939.967241      1.256200273      1.218916408
        0.0002767539567   0.000224272435 1.308892965e-005  1.35113602e-005
        1543.700292      1515.133516      483.4590125      491.0968078      2.241539153
        2.185092089      2.222092089      1.078089283      1.660011809      2735.566264
        2734.768385      426.4502399      520.181961      2711.478477      93.73172113
        2215.384303      480.1322652      429.9386055      347.6919118      301.2610395
KEY POINT #7 (t plus 6961.3292 s with a Mixing Number of 136.1769):  34.1864965
        0.040894          0.00925          0.3937     0.7846293809     0.7963934631
        1.009318937              1                1      26.58783071      103426.6198
        0.05805226366    0.05383598476    0.04490179083 1.869802967e-005    0.04490179083
        104.4369467      134.9436638      125.5856895      117.8535403      105.3776217
        96.24332838      72.14233982      4.222190709      4.256372185      2.207889843
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0.6795356273    0.6844113284    0.6844113284    1.672365901    1.374057933
0.04241717527    955.1778884    938.5366884    1.320580017    1.286330308
0.0002691570064  0.000220944216 1.314866109e-005 1.351704803e-005
1540.96124    1512.375589    484.1898674    490.8864131    2.364400354
2.308555994    2.345555994    1.185645866    1.855305442    2735.014937
2734.308024    437.9196299    527.5573047    2713.933325    89.63767478
2207.457632    494.6992776    441.8906875    403.369883    302.1625467
KEY POINT #8 (t plus 8670.9689 s with a Mixing Number of 194.3171):  34.47857482
0.040894    0.00925    0.3937    0.7818464342    0.7960722388
1.004994035    1    1    21.28030361    103599.9227
0.05578340656    0.05223875871    0.04528541714 1.922033254e-005    0.04528541714
115.9372115    138.1859942    133.3607342    128.4682863    116.9645074
115.892045    73.83548443    4.239289146    4.271652155    2.26062793
0.6828768032    0.6849426769    0.6849426769    1.494893055    1.29149925
0.04428245389    946.3998493    931.955354    1.64328906    1.620898323
0.0002408016428  0.0002070868416 1.341704316e-005 1.360972868e-005
1527.041818    1499.094285    487.3260974    490.9182626    2.985546773
2.93187807    2.96887807    1.74412367    2.581067935    2735.929137
2735.476285    486.6165423    560.7512031    2724.669601    74.13466078
2175.177933    539.8757616    490.9711924    486.4263543    309.3069184
KEY POINT #9 (t plus 8695.3573 s with a Mixing Number of 194.861):  34.48959795
0.040894    0.00925    0.3937    0.7818262266    0.7960988348
1.004971116    1    1    21.22203964    103612.4531
0.05576075138    0.05221690525    0.04529989533  1.52418031e-005    0.04529989533
116.0505898    138.2670156    133.4663012    128.4866616    117.1587208
116.0673718    74.04391359    4.239472405    4.271871002    2.261389485
0.6829021125    0.6849452807    0.6849452807    1.493337614    1.290458341
0.04430923793    946.3105402    931.8642264    1.648069941    1.625725098
0.0002405496048  0.0002069101221  1.34206883e-005 1.361243341e-005
1526.887169    1498.904063    487.3670207    490.9425437    2.994808579
2.941167329    2.978167329    1.750546039    2.582499072    2736.017957
2735.567582    487.0978568    561.2027777    2724.812029    74.10492091
2174.815179    539.9547046    491.7955367    487.1702864    310.1810564
KEY POINT #10 (t plus 9079.9673 s with a Mixing Number of 212.7324):  34.27586652
0.040894    0.00925    0.3937    0.7813015169    0.7963316473
1.003753362    1    1    19.98253608    102850.5202
0.05523229313    0.05183365248    0.04501917267 1.661252027e-005    0.04501917267
118.6875121    138.9007005    135.3142291    130.3924866    120.0039415
119.2420592    103.8079016    4.243835314    4.27575297    2.274919564
0.6834454802    0.684971042    0.684971042    1.458117496    1.272561335
0.0447845923    944.2150227    930.2613895    1.733585511    1.715924071
0.0002348215091  0.0002038629616 1.348449824e-005 1.362829553e-005
1523.183172    1495.532147    488.0760997    490.780938    3.160738423
3.107642131    3.144642131    1.905467888    2.734472158    2735.78992
2735.390619    498.2945023    569.1114772    2727.290193    70.81697492
2166.678443    548.0917329    503.8814801    500.6494305    435.3279421
KEY POINT #11 (t plus 9674.9593 s with a Mixing Number of 243.5675):  35.05771019
0.040894    0.00925    0.3937    0.7799869868    0.7960607647
1.002134922    1    1    18.64131533    104821.6095
0.05434288241    0.05115963256    0.04604607465 8.060347328e-006    0.04604607465
123.0927817    140.5495616    138.5486426    134.2357791    124.7627974
124.4340637    119.1459569    4.251501994    4.282784812    2.299510559
0.684175195    0.6849263276    0.6849263276    1.403136772    1.242659245
0.04564663633    940.6478101    927.4210386    1.891822092    1.880974943
0.0002258005232  0.0001987328503 1.359619023e-005 1.367704624e-005
1516.597833    1489.440358    489.2839192    490.8255199    3.469014281
3.416445369    3.453445369    2.189178547    3.063022949    2736.492739
2736.14524    517.027997    582.9725646    2731.558178    65.94456754
2153.520175    564.5209875    524.1294122    522.733318    500.2664478
KEY POINT #12 (t plus 0 s with a Mixing Number of 33.1644):  32.80995373    0.040894
0.00925    0.3937    0.7880599336    0.7899191954    1.020410194
1    1    53.24343762    101551.1707    0.06956965481
0.0583732639    0.04309378937  1.63106753e-005    0.04309378937    40.16396699
125.1571847    102.7854462    40.43445979    40.11370202    39.89608901
37.65113799    4.178533363    4.220244767    2.088823208    0.6288435919
0.6788600348    0.6788600348    4.324377485    1.701496771    0.03804522926
992.160429    956.3366785    0.6558916774    0.6164585443  0.0006507922358
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     0.0002736993281 1.236456276e-005 1.321235628e-005      1531.616427
     1542.416514      473.6676261      488.7936379      1.119226894       1.04404443
     1.08104443    0.07449225453    0.07557194351      2728.685897      2725.851033
     168.3154639      430.8572225      2679.946682      262.5417586      2297.828674
     169.4457268      168.1039237      167.1977222      157.8210413
KEY POINT #13 (t plus 9674.9593 s with a Mixing Number of 243.5675):  35.05771019
     0.040894          0.00925           0.3937     0.7799869868     0.7960607647
     1.002134922              1                1      18.64131533      104821.6095
     0.05434288241    0.05115963256    0.04604607465 8.060347328e-006    0.04604607465
     123.0927817      140.5495616      138.5486426      134.2357791      124.7627974
     124.4340637      119.1459569      4.251501994      4.282784812      2.299510559
     0.684175195     0.6849263276     0.6849263276      1.403136772      1.242659245
     0.04564663633      940.6478101      927.4210386      1.891822092      1.880974943
     0.0002258005232  0.0001987328503 1.359619023e-005 1.367704624e-005
     1516.597833      1489.440358      489.2839192      490.8255199      3.469014281
     3.416445369      3.453445369      2.189178547      3.063022949      2736.492739
     2736.14524       517.027997      582.9725646      2731.558178      65.94456754
     2153.520175      564.5209875      524.1294122      522.733318      500.2664478
KEY POINT #14 (t plus 7691.6389 s with a Mixing Number of 157.617):  34.35908956
     0.040894          0.00925           0.3937     0.7836062695     0.7964596392
     1.007348434              1                1      24.13439553      103676.6953
     0.05709255659    0.05314662014    0.04512848084  1.20489133e-005    0.04512848084
     109.3375261      136.2169209      128.9560082      123.2067284      110.3770482
     108.5171097       72.5539576      4.229105265      4.262795833      2.229943215
     0.6811522316     0.6847243012     0.6847243012      1.591701253      1.336795397
     0.04320007067      951.5090112      935.7153953      1.453521147      1.424036624
     0.0002563641225  0.0002147267498 1.326497375e-005 1.355252117e-005
     1535.480771      1506.796584      485.5788145      490.8579704      2.619272675
     2.564393276      2.601393276      1.402146285      2.196949718      2735.223954
     2734.641485      458.646306      541.9307981      2718.646038      83.28449212
     2193.293156      517.4532808      463.0421142      455.1784961      303.9077334
End
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