INTERNSHIP EXPERIENCE AT GULF STATES UTILITIES COMPANY

An Internship Report

by

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ABSTRACT

Internship Experience at Gulf States Utilities Company (May 1985)

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This report discusses the author's internship with Gulf States Utilities Company in the In-Core Nuclear Fuels Group at St. Francisville, Louisiana, and demonstrates how the internship fulfilled the requirements of the Doctor of Engineering Program and at the same time met the author's internship objectives. In discussing the internship, the author recounts his experience and relates what knowledge was gained and the value of that knowledge. The author's position as a Doctoral Intern enabled him to experience a broad mixture of tasks requiring the use of both technical and non-technical skills. The author concludes that the internship was beneficial to both himself and Gulf States Utilities, and the experience the author gained will prove valuable in furthering the author's career.

DEDICATION

TO MY FATHER, THE ENGINEER, WHO ALWAYS SAID:

"YOU DON'T WANT TO BE AN ENGINEER; YOU WANT TO BE A DOCTOR,

OR A DENTIST, OR A . . . "

AND TO MY WIFE, JULIE, WHO ALWAYS SAYS:

"ENGINEERS ARE WEIRD."

ACKNOWLEDGEMENTS

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I also wish to thank the management of Gulf States Utilities Company for making the internship possible. My internship supervisor, James E. Booker, deserves a vote of thanks for his part in helping me through my internship. Also, Lynn A. Leatherwood, my immediate supervisor, is due thanks for his help and support while I was at GSU.

Finally, words cannot express the debt of gratitude that I owe my wife, Julie, for it was her moral as well as financial support that truly allowed me to complete my Doctor of Engineering program.

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I. INTRODUCTION

I.A. General

The Doctor of Engineering Program is designed to prepare individuals for professional engineering activities in industry and the public sector. The program emphasizes engineering practice instead of research; research is the purpose of the Ph.D. An important part of the Doctor of Engineering Program is the professional internship. The internship is a professional engineering experience of at least one year duration during which the student actually works in industry under the supervision of a practicing engineer. The objectives of this internship are:

1. to enable the student to demonstrate and enhance his or her abilities to apply both knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization or industry in which the internship is served, and

2. to enable the student to function in a non-academic environment in a position in which he or she will become aware of the employer's approach to problems, in addition to those approaches of traditional engineering design or analysis.[1]

Obtaining an internship can be a difficult task in itself; many companies are hesitant to hire an engineer whom they know is only going to stay for one year. The student must demonstrate to the potential employer that the internship will benefit his company. The employer then has a reason to hire the student on a temporary basis,

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This report follows the general style and format of <u>Nuclear Technology</u>.

and at the same time bestow upon the student the real responsibilities of a professional engineer. The author served his internship with Gulf States Utilities Company (GSU) in the In-Core Nuclear Fuels Department of the River Bend Nuclear Group. A special position was created, and the author was given the title "Doctoral Intern." As a Doctoral Intern the author was given the same responsibilities as the other members of the In-Core Nuclear Fuels Group who had the title "Nuclear Fuels Engineer."

Before presenting the author's specific internship objectives, an overview of GSU describing the company's business and overall organization will be presented. A summary of the responsibilities of the In-Core Nuclear Fuels Department will also be presented.

I.B. Gulf States Utilities Company

Gulf States Utilities Company was incorporated in 1925 and is primarily in the business of generating, transmitting and distributing electricity to Southeast Texas and South Louisiana. The service area extends 350 miles westward from Baton Rouge, Louisiana, to a point about 50 miles east of Austin, Texas.[2] GSU's corporate headquarters is located near the center of its service area in Beaumont, Texas. The company's service area includes such major cities as Baton Rouge and Lake Charles, Louisiana and Orange, Beaumont, Port Arthur, Conroe, Huntsville, and the northern suburbs of Houston, Texas. GSU also sells electricity to municipalities and rural electrical cooperatives in both states. In Baton Rouge GSU supplies steam and electricity to industrial customers through a cogeneration facility. The company also owns a natural gas retail distribution system and a subsidiary, Prudential Drilling Company, which is engaged in exploration, development, and operation of oil and gas properties.[2]

Gulf States Utilities has eight departments organized under the Board of Directors. The departments are: Executive Projects, External Affairs, Finance, Administration and Technical Services, Human Resources, Operations, River Bend Nuclear Group, and Prudential Drilling Company. The relative position of these departments with respect to the Chief Executive Officer, P. W. Murrill, is shown in Fig. 1. The River Bend Nuclear Group was created for the sole purpose of building and operating the River Bend nuclear power plant located at St. Francisville, Louisiana. The power plant and the group are the responsibilities of Senior Vice President William J. Cahill. A part of the River Bend Nuclear Group is the Engineering, Nuclear Fuels, and Licensing Group. Within the Engineering, Nuclear Fuels, and Licensing Group are: Emergency Planning, Nuclear Licensing, Nuclear Plant Engineering, and Nuclear Fuels. Nuclear Fuels is further subdivided into Out-of-Core Nuclear Fuels and In-Core Nuclear Fuels. The organizational configuration of the Engineering, Nuclear Fuels, and Licensing Group is shown in Fig. 2. As stated earlier, the author served his internship in the In-Core Nuclear Fuels Group.

I.C. In-Core Nuclear Fuels

In-Core Nuclear Fuels is primarily responsible for fuel cycle

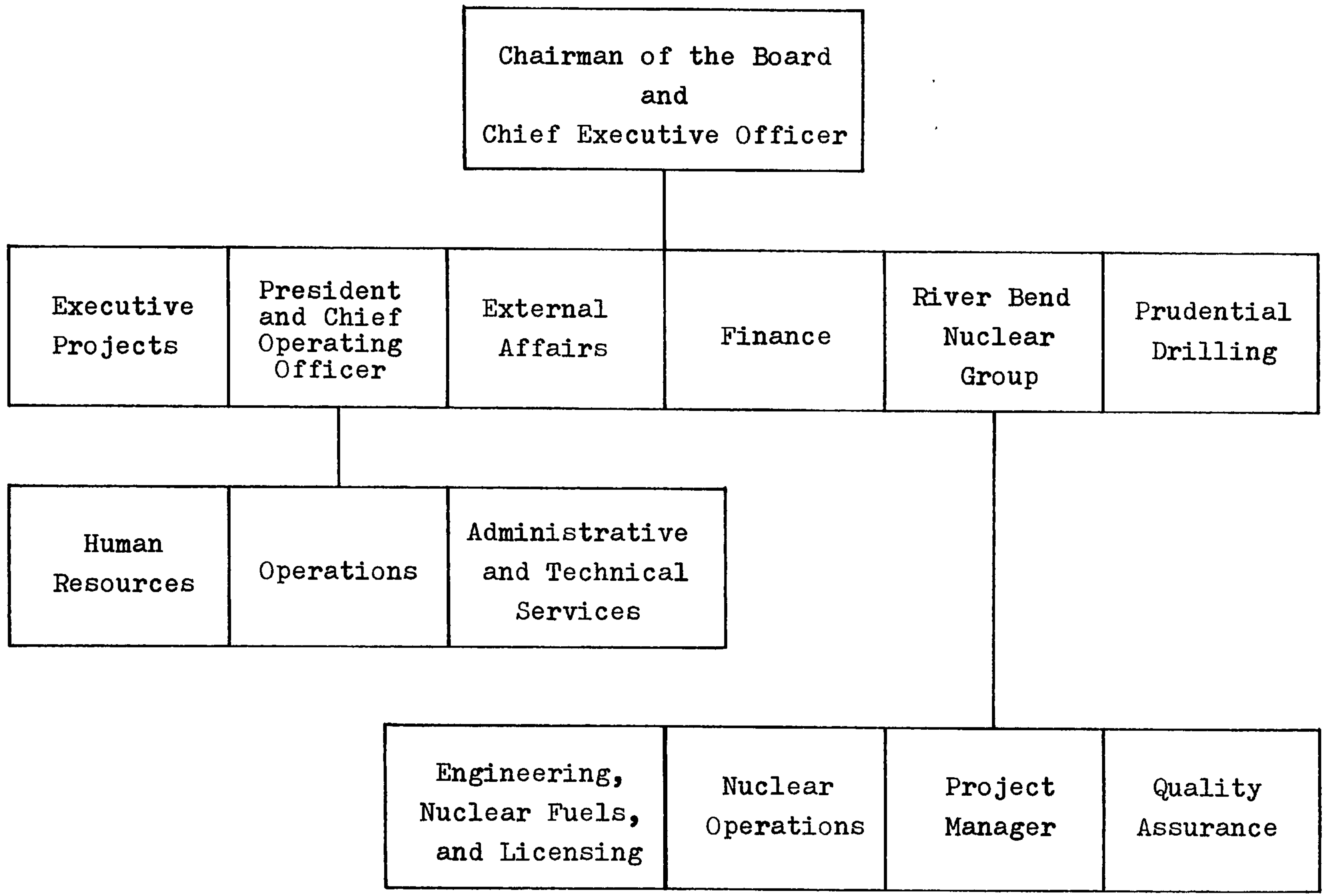

Fig. 1 Organizational Chart of GSU

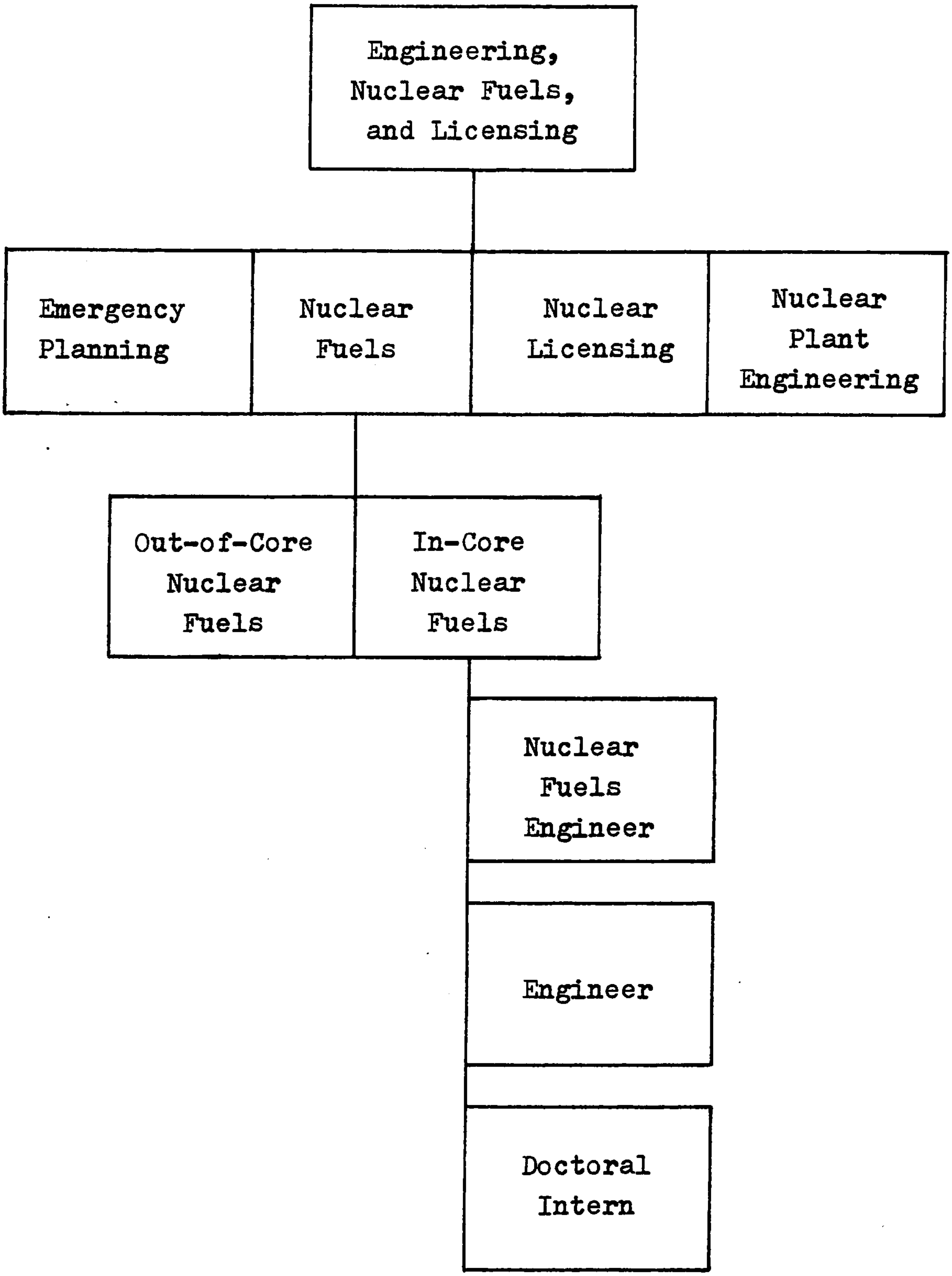

Fig. 2 Organizational Chart of Engineering, Nuclear Fuels, and Licensing

planning and support of other groups such as Out-of-Core Nuclear Fuels, Operations, Licensing, Quality Assurance, and Engineering Analysis. Fuel cycle planning involves such areas as fuel design, fuel reload batch size and loading pattern determination, cycle length calculations, and cycle operating alternatives. Table 1 is a partial list of some of the areas of responsibility of the In-Core Nuclear Fuels Group. The supervisor of the In-Core Nuclear Fuels Group, and the author's immediate supervisor, was Lynn A. Leatherwood. The author's internship supervisor was James E. Booker, manager of Engineering, Nuclear Fuels, and Licensing.

I.D. The Internship

As stated above, the author served his internship with the title Doctoral Intern and with responsibilities equal to those of a Nuclear Fuels Engineer. The author was employed at GSU for the period from February 2, 1983 to May 31, 1984. The "official" internship period was from June 1, 1983 to May 31, 1984. During the first few months of the author's employment, the author along with Mr. Booker and Mr. Leatherwood developed a set of specific internship objectives which were designed to satisfy the requirements of the Doctor of Engineering Program. The objectives were also designed to provide professional experience that was useful to both the author and GSU. These objectives are divided into four categories according to subject. These are: internship objectives (the general objectives stated earlier), in-core fuel management objectives, contract management objectives, and civic and professional objectives.

TABLE 1

AREAS OF RESPONSIBILITY OF THE IN-CORE NUCLEAR FUELS GROUP

FUEL CYCLE PLANNING

- o Fuel Design
- o Batch Size and Reload Patterns
- o Cycle Length
- o Cycle Operating Alternatives

INTERFACE WITH OUT-OF-CORE FUELS

- o Technical Responsibilities in Fuel Fabrication Contract
- o Fuel Cycle Planning
- o Material Accountability
- o Cost Accountability
- o Material Requirements
- o Spent Fuel Schedules

OPERATIONS SUPPORT

- o Core Analysis Predictions
- o Control Rod Pattern Optimization
- o Operating Margins
- o Abnormal Occurrences
- o Reactor Anomalies
- o Comparisons With Process Computer
- o Core Follow
- o Fuel Cycle Plans
- o Fuel Shipment, Receipt, Inspection
- o Fuel Handling, Storage, Loading, Shuffling
- o Spent Fuel Isotopics
- o Fuel Channel Management
- o Control Rod Management
- o Decay Heat Calculations

OTHER SUPPORT

- o Licensing
- o Quality Assurance
- o Startup and Test
- o Transient Analysis
- o Outage Planning

The in-core fuel management objectives were:

1. Learn to use and understand industry fuel management computer codes.

2. Learn to evaluate the need for, operation of, and costs of using a computer code for analyses.

3. Learn the philosophy behind successful management of company resources and assets; specifically, management of nuclear fuel for the River Bend nuclear reactor.

The contract management objectives were:

1. Learn to perform necessary economic and technical analyses required to support contract administration and negotiation.

2. Learn to perform contract administration and evaluation through participation in this function of the In-Core Nuclear Fuels Group.

The civic and professional objectives were:

1. Address civic or professional organizations on subjects which will illustrate Mr. Laub's expertise, and which will increase the appreciation of the engineering profession.

2. Participate in professional activities such as state and national engineering societies.

In addition to the formal internship objectives, a synopsis of the proposed work plan for the author was also submitted with the internship proposal. The full internship proposal may be seen in Appendix A.

The remainder of this report describes how each objective was met by the activities of the author during the internship. There is a section for each type of work responsibililty experienced by the author. There is also a section discussing steady state core analysis in general and a section containing experience that did not constitute a major portion of the internship, yet is worthy of mention. The conclusion of the report shows specifically how each objective was fulfilled and identifies any objective which was not attained. The conclusion also makes a few recommendations that the author feels will improve the Doctor of Engineering Program.

II. STEADY STATE CORE ANALYSIS

II.A. Introduction

The author's first responsibility to GSU was to perform steady state core analysis for the River Bend nuclear power plant. The term "steady state" implies a time-independent analysis; this is not strictly true. "Steady state" refers to the manner in which the reactor is operated. Steady state core analysis involves, as one part, the calculation of effective microscopic and macroscopic cross sections used in analyzing the behavior of the reactor core over a period that may span eighteen months or more. Obviously these cross sections will change during operation; however, they will change very slowly. Instead of calculating the cross sections as a function of time, the cross sections are calculated as a function of fuel exposure which is directly related to time. Fuel exposure is generally stated in units of megawatt-days per metric tonne uranium (MWD/MTU) and is a measure of how much fission has taken place in the fuel. The analysis of core behavior during fast changing or abnormal conditions is called transient analysis. It will be shown later in this section that the results of transient analyses depend significantly on the preceding steady state core analysis; and therefore, an important interface exists between the steady state and transient analysis groups.

Performing steady state core analysis, generally referred to simply as core analysis (transient analysis is generally referred to as safety analysis), is a very long and complex process. Core analysis involves five major functions. These are: gathering and collating of information and data necessary to calculate the input for the various computer codes used during core analysis, development of methods to calculate the actual input to the codes, running the codes, documenting all of the above, and interfacing with the transient analysis group.

During the performance of core analysis, it is easy for one to become lost in the details of each code and lose touch with the requirements of the remaining codes in the process. This should be avoided at all times because the needs of future codes in the process have an effect on the input to the present code. One must keep in mind the whole picture; that is, while concentrating on the leaves, do not forget that there is a tree and even a whole forest to be dealt with.

This section is devoted to elaborating on each function of the core analysis process. The author explains what each function involves, the computer codes employed at GSU for core analysis and what each code is used for, and how the computer codes and core analysis functions are interdependent upon one another. Finally, the author will explain the significance of this portion of his internship experience and what objectives were satisfied by the experience.

II.B. Gathering and Collating Information

The first step in any analysis is a thorough search of available literature, and it is no different with core analysis. Before any input can be calculated or any codes run, the necessary information to perform these tasks must be obtained. For core analysis this means an exhaustive search through all possible sources. The search begins with the user's manuals of each code that will be used in the analysis. One must command a thorough understanding of what data are required by the codes and how the codes are going to use that data in order to understand what supplementary data are required. Supplementary data are data that are used to make assumptions, calculate other input parameters, or verify data obtained through other sources. Sources of data include: the Final Safety Analysis Report, other utilities which have similar reactors, experts such as consultants, any of many reference materials available, textbooks and college notes, and most importantly the vendor of the reactor. The vendor is by far the most difficult source of data with which to deal. Usually any piece of information that cannot be obtained through some other source must be requested of the vendor. Many times the vendor will consider that piece of information proprietary; in which case, unless the vendor can be convinced to release the information, it must be purchased.

Once all information has been gathered, it must be compiled and verified; usually verification takes place at the time of acquisition. Compiling includes putting the information in a usable form such as a table or chart. Figure 3 is an example of such a table. The information gathering and collating process is by no means finished here. The process is ongoing; as new information is

Core Analysis Data Table

Reactor:____________________

Table No.:________

Item	Value	Reference	Comments
1.0 Fuel Rod			
1.1 Active Fuel Hgt			
1.2 Clad O. D.			
1.3 Clad I. D.			
1.4 Clad Material			
1.5 Pellet Dia.			
1.6 Pellet Hgt.			
1.7 Pellet Density			

Prepared by:____________Date:______ Verified by:____________Date:______

Fig. 3 Example of Core Analysis Data Table obtained during the analysis, the tables and charts are revised and updated. Should any data change, the impact of this change on the accuracy of the results obtained so far must be evaluated. Based on this evaluation, a decision is made on the course of action to follow, i.e., begin again or accept any errors as insignificant.

Gathering and compiling data into a single source serves several purposes. First, since all necessary data can be found in one place, the preparation of input is much faster. The actual calculation is facilitated by having a single source and not having to find each piece of information each time it is needed. The verification of input calculations and datasets is also facilitated for the same reason. Secondly, a single source of data ensures traceability; that is, subsequent reviews of computations for various reasons are easily performed. Traceability is a major asset when answering questions of safety review boards or the Nuclear Regulatory Commission (NRC). Finally, this function is a must for documentation purposes. Documentation has many uses itself and will be discussed later in this section.

II.C. Development of Input Calculational Methods

Once all the necessary data are collected and compiled, the engineer must then create the actual input datasets to be used by the various codes. Much of the input data can be taken directly from the data tables prepared earlier with a units conversion being the only necessary manipulation. However, many times the type of data required for input must be calculated using data from the data tables or new data obtained from the results of the previous code in the sequence. It is at this point that the expertise of the engineer really begins to play an important role. In order to calculate new input, methods and equations must be developed. The author spent many hours developing these equations for calculating input to MICBURN, CASMO, and SIMULATE. MICBURN, CASMO, and SIMULATE are computer programs which are distributed by the Electric Power Research Institute (EPRI). More details about these codes is given later is this section. A good example of method development is the set of equations developed for calculating the weight percentage of each of the isotopes in the reactor fuel. The programs MICBURN and CASMO both required this type of information.[3,4] A second example is the calculation of the average temperatures of the fuel, cladding , and moderator during reactor operation.[5] This calculation required knowledge of heat transfer and neutronics in order of make the assumptions necessary to enable the author to perform the calculations without the use of yet another detailed computer program.

One of the things that the engineer must guard against is using too much detail in his preparation of input for these codes. This may sound a little backwards because detail is usually very desirable; however, in this case, the complexity of an input calculation must be warranted. There are times when more detailed input will result in longer running time for the code. For example, for lattice physics calculations the composition of fuel cladding is needed to account for neutronic effects of some of the components. The more constituents that are given for the composition, the more calculations the code must perform, hence, run time may be increased significantly. If the detail will make a real difference in the end results, then of course the detail is warranted. However, if the more detailed input does not significantly change the results of the calculations or if the effects of the detailed input are lost in subsequent code approximations and assumptions, then the extra effort is useless and the extra costs unwarranted. The author had to develop his engineering judgement in order to deal with just this type of decision in preparing input for the computer codes used at GSU. Many times the author had to evaluate the trade-offs between a technically correct and detailed method and a faster method that employed an assumption or judgement about later effects. Experience is the only way to develop these skills.

One of the most important properties these methods must have is consistency. Consistency means using the same methods to calculate similar parameters from code to code. Consistency also refers to using the same methods that may be employed internally by the code or some past or future code. A very good example of this, which was experienced by the author, deals with the thermal expansion of the fuel, cladding, and structural components. The MICBURN code did not perform thermal expansion calculations internally; therefore, the component lengths and radii had to be expanded manually as part of the input preparation. However, the CASMO code, which was the next code in the sequence, did perform these expansion calculations internally. Therefore, to be consistent in his methodology, the author had to determine how the CASMO code performed its thermal expansion calculation for each component and use the same method in preparing input for MICBURN.

Review and verification is one way to ensure consistency. Verification also performs several other functions. First, the verification ensures that all of the number crunching is correct; the most intelligent engineer can push the wrong button on a calculator. Having another engineer perform the same calculations eliminates errors of this type. Secondly, verification ensures that data and references are accurate. In the same way that the data and references for the core analysis data tables are verified, data and references used to derive calculational methods must be verified. Thirdly, the verification ensures that any assumptions used in determining equations are valid. Finally, the verification ensures that traceability is maintained; the importance of traceability was discussed earlier.

Verification is performed by another engineer who did not work on the derivation of the methods being verified. In verifying a calculation or equation, the engineer performs the entire calculation or derivation himself to make sure that every part of the calculation or derivation is valid.

II.D. Running The Codes

The actual running of the codes is usually a fairly mechanical procedure--once all the bugs have been ironed out. However, the author learned a very important lesson: programs do not always run the way the user's manual says they do. Problems always arise when "production" running is begun. Production running refers to the large number of executions of a program necessary to perform all necessary calculations to analyze a reactor core. It is always wise to make test runs during the input methods development stage to try and ensure smooth running during production. Even then, problems will occur and should be documented. When problems are encountered, and solutions discovered, devised, or obtained, the problems and their solutions should be made a part of the analysis report. Problems will appear in the future use of the code by other engineers, and this documentation will provide a source of solutions and insights. As stated earlier, once all the problems have been solved, the production running of the codes is really mechanical.

Another part of running the codes is the analysis and interpretation of the results. At each step along the way results must be analyzed to make sure that there are no problems with the code or the input. Here the old saying "garbage in, garbage out" truly applies, and analysis of the results is one way to determine if there is "garbage in" and a foolproof way to determine if there is "garbage out." In performing the analysis of the code results there are basically two things the engineer can do: check to see if there are any results that are significantly different from expected results, and compare the results to the reactor vendor data or data obtained from a similar plant. Again, engineering judgement plays an important role in determining what constitutes a significant deviation from expected results or vendor data, or even what results are expected. Any deviations from vendor data that are discovered must be explained, usually in terms of differing input or differences in the codes used to perform the calculations. If a deviation cannot be explained in these terms then there is a problem with the input or the code itself.

At this point the author would like to take the opportunity to present a list of the core analysis codes used at GSU along with a brief explanation of the function of each code.

II.D.1 MICBURN

The first code in the core analysis sequence, MICBURN, was developed by a Swedish firm called Studsvik. EPRI purchased MICBURN and distributes the code to its members. MICBURN is a two-dimensional multi-group transport theory computer code used to calculate effective microscopic cross sections for gadolinia (Gd_2O_3) at selected burnup steps during the operating cycle. Gadolinia is a burnable absorber which is mixed in with some of the higher enriched fuel to help control the excess reactivity. The gadolinia is also used to some extent as an aid in power shaping by smoothing out power peaks in high enriched regions of the core. Gadolinia is a strong neutron absorber and as such causes strong flux perturbations within the fuel assembly. These perturbations must be modeled on the basis of individual fuel pins; that is MICBURN's job. MICBURN looks at only one fuel pin at a time, and only those containing gadolinia. The MICBURN code accounts for energy shielding by heavy metals in the fuel and spatial shielding by the burnable absorber.[6] The result of the calculations performed by MICBURN is a two-dimensional table of effective microscopic cross sections for gadolinia in twenty-five energy groups and at selected fuel burnup points. This table is part of the input for CASMO.

II.D.2 CASMO

The second code in the sequence, CASMO, was also developed by Studsvik and is also distributed by EPRI. CASMO is also a multi-group two-dimensional transport theory code; however, CASMO calculates effective macroscopic cross sections for an entire fuel assembly. Actually CASMO deals with lattice types. A lattice type is a unique arrangement of fuel enrichments or burnable absorber concentrations. A full set of effective two-group macroscopic cross sections are generated for each lattice type in the core for each of several sets of operating conditions. These conditions cover the whole range of conditions that the core will experience during operation and include such things as: control, whether a control rod is present or not; the void percent; the power level; fuel and moderator temperature; and many others. CASMO generates a huge amount of information concerning cross sections, isotopic densities, and kinetics type data at many different core conditions. This information is not in a form that is usable by the next large code, SIMULATE-E, therefore the program NORGE-B is needed.

II.D.3 NORGE-B

NORGE-B is specifically designed for BWR's and is a special version of a former code called simply NORGE. This code was developed by EPRI and is a part of EPRI's standard core analysis package. NORGE-B is what is termed a linkage code, and as the name implies, NORGE-B links larger codes together by manipulating output from one to produce input for the other. It is here that all of CASMO's output is correlated and manipulated into either polynomial representations of dependencies or large tables of cross sections whose rows and columns represent core conditions. The cross sections in this form are now ready for use by SIMULATE-E, the work horse of the core analysis code package.

II.D.4 SIMULATE-E

SIMULATE-E is the latest version of the SIMULATE line of codes originally developed at Yankee Atomic Electric Company. Since the first version of SIMULATE, EPRI has sponsored the development of subsequent versions and now distributes SIMULATE-E. SIMULATE-E is a three-dimensional steady state nodal core simulator. This code models the entire reactor core complete with control rods and flowing coolant. The primary function of SIMUALTE-E is the analysis of light water reactor power distributions, but the code is also used to predict cycle length, exposure distributions, control rod patterns, shutdown margins, control rod worths, and just about anything else one might want to know about the steady state operation of the core. The neutron balance equation used in SIMULATE-E is an extension of the method used in TRILUX.[7] It is basically a one group method; however, with the two-group cross sections obtained from CASMO, a thermal leakage correction factor may be calculated and applied to yield an approximate two-group result. The nodal parameters needed in the neutron balance equation are calculated using response matrix techniques developed by Ancona and Becker.[8] SIMULATE-E includes both neutronic and hydraulic models in its calculations and is a very sophisticated and very fast core simulator. Figure 4 illustrates the manner in which the above codes link together.

II.D.5 Other Codes

There are other codes that are used along the path to SIMULATE-E that are worthy of mention. First, a set of auxiliary codes were developed at GSU which automated almost the entire process leading up to SIMULATE-E. After the author and his coworkers developed the input methodology for MICBURN and CASMO, this methodology was programmed in FORTRAN as two auxiliary codes, MICPREP and CASPREP. MICPREP generates entire MICBURN input datasets automatically; however, CASPREP generates only partial CASMO input datasets because of the complexity of the CASMO code. Another auxiliary code, developed by a coworker at GSU, called MICGRAF automates the graphing of MICBURN results. A similar code was being developed to graph CASMO results but was not completed before the end of the author's internship. A code called CAROLE is used to calculate albedo boundary conditions for SIMULATE-E. These boundary conditions are needed to terminate the neutron balance equations at the core-

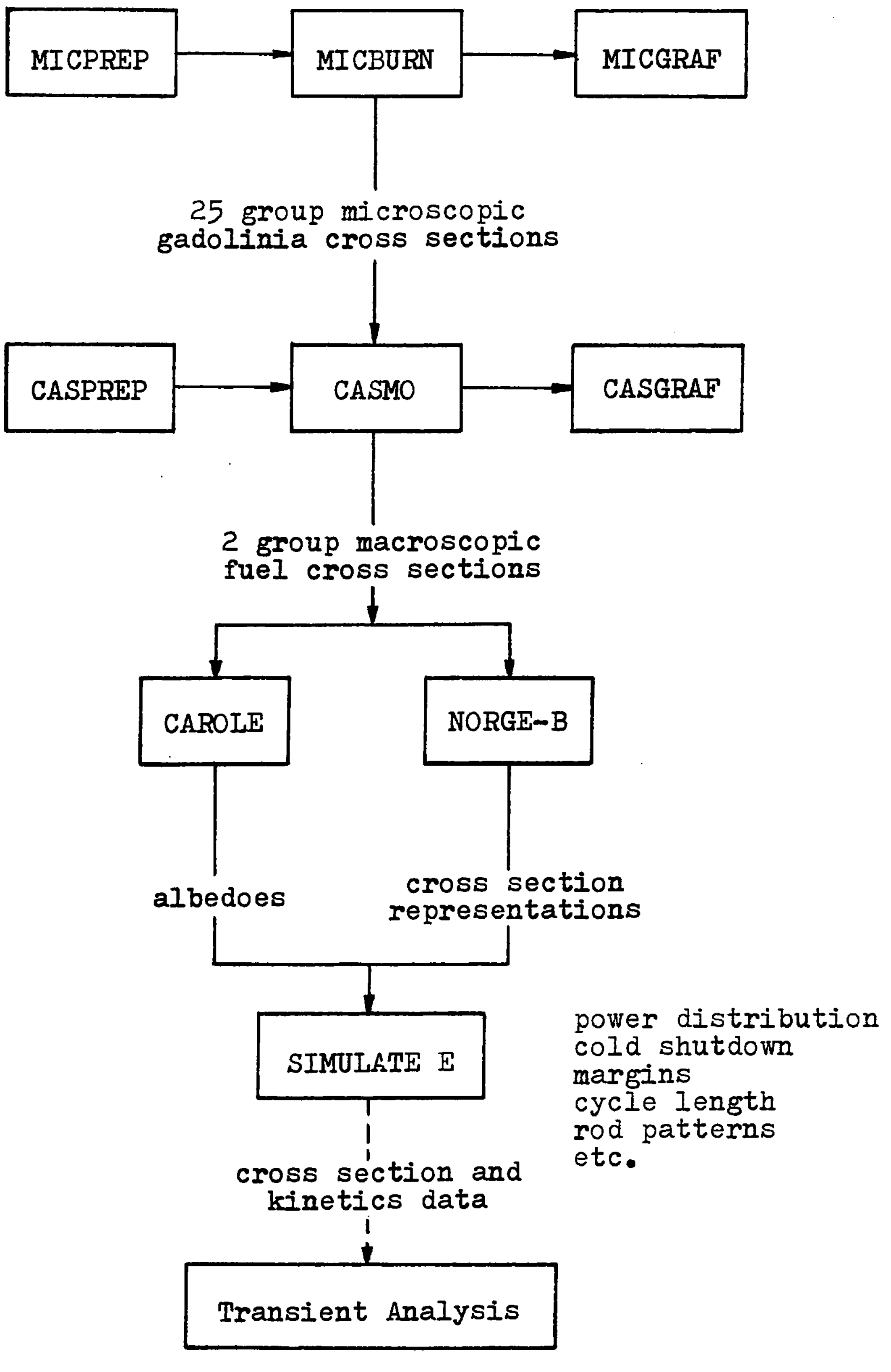

Fig. 4 Core Analysis Code Flow Chart

reflector interface. An albedo is simply a ratio of the number of neutrons leaving a surface to the number entering that surface. There is another program that will perform this same function called ABLE. GSU was just beginning to look at ABLE at the time of the author's departure. Finally, the author used a code called FUELCOSTIV in performing economic evaluations of cash-flow timings and proposals connected with the fuel fabrication contract. FUELCOSTIV is a nuclear fuel cost accounting code designed to calculate fuel costs based on the time value of money and on amortization of the fuel. The fuel is amortized according to fuel bundle burnups which are input to the code. At the time the author used the code the burnup data was taken from cycle data supplied by GE; however, after GSU finalizes its core model, the bundle burnup data for FUELCOSTIV will be generated by In-Core Nuclear Fuels.

One last code which is a part of the core analysis package is a fuel cycle scoping code. GSU did not have a fuel cycle scoping code, and the author was assigned the task of investigating the possible alternatives and making a recommendation on the acquisition of such a code. This topic is discussed in detail in a later section of this report.

II.E. Documentation

Documentation is one of the most important parts of the core analysis process. In each of the preceding steps documentation was mentioned; however, the importance of documentation cannot be overemphasized. Everything that is done must be documented.

Documentation performs five basic functions. First, documentation provides a guide for future analyses. It helps new engineers develop a plan for performing their analysis by listing what was done at each of the steps of previous analyses. Sources of data are known, and therefore, data acquisition is facilitated. The documentation of preceding analyses also helps avoid problems in the future by alerting engineers to possible solutions to problems that were encountered before. Secondly, documentation provides proof of verification as well as being a form of verification itself. Thirdly, documentation aids in tracing problems that do occur during analysis. When problems arise, it is useful to have a record of what was done during earlier steps in the process. This record might give a clue to what is causing the problem and how to solve it. Fourthly, documentation is absolutely necessary if the utility plans to become qualified by the NRC to perform its own licensing safety analysis, and this is usually the case. Finally, as discussed earlier, documentation ensures consistency in data and in methods of input preparation. Therefore, documentation is not only an aid, but really a necessity in order to assure the quality of the analysis.

II.F. Interfacing With Transient Analysis

It was mentioned earlier that the results of any transient analysis depend significantly on the preceding steady state analysis. This dependence results from the fact that the steady state analysis produces the cross sections that are used in the transient analysis. At GSU the link between SIMULATE and RETRAN, SIMTRAN, is the only connection between steady state analysis and transient analysis. Ideally, the transient and steady state analyses should be performed by the same group; however, at GSU this is not the case. Therefore, because of the dependence of the transient analysis on the steady state analysis results, there exists a very important interface. Communication between the two analysis groups must be free and total, or problems could arise. The steady state analysis group must be sensitive to the needs of the transient analysis group and must make provisions for these needs during the input methods development stage of their analysis. On the other hand, the transient analysis group must be sure to communicate their needs to the steady state analysis group to be sure that all necessary data are generated for later transmittal through whatever link exists.

The author served as the interface with the Engineering Analysis Group at GSU during his internship. Since Engineering Analysis was only just getting started at GSU, they did not really know what they needed. The author had to try and figure this out through studying the SIMTRAN code manual. By the time the internship ended, the author had generated some datasets to be used by SIMTRAN; however, these datasets had not been tested. Because of this experience, the author became painfully aware of the importance of the interface between engineering groups. There was much additional work that had to be done by the author that could have been avoided if a proper interface had been established early in the steady state analysis process.

II.G. Summary

Steady state core analysis was the author's first responsibility at GSU during his internship. The author learned much about core analysis, both specific to River Bend and in general. The preceding discussion has been of a general nature with specific examples used as illustrations. It was shown that the core analysis process consists of five major functions: gathering and collating data, development of input methods, running the codes, documentation, and interfacing with the transient analysis group. Gathering and collating data is the first step of the process and is an ongoing process. Data may be revised, added, or even deleted during any stage of the core analysis process. Development of input calculational methods is the first place that engineering judgement truly comes into play. Assumptions must be made, and equations must be derived. Consistency of methods from one code to the next is a major concern. Also, the engineer must pay attention to the needs of future codes, including transient analysis codes. The actual running of the codes can be fairly mechanical, although problems always arise. Much is learned about the codes in devising solutions to these problems, and the problems and solutions should be documented for future reference and the benefit of others. Documentation is one of the most important functions of the core analysis process. Without documentation much of the work would be lost, and verification of data, references, methods, and results would be impossible. Documentation cannot be overemphasized. The last function of core analysis, interfacing with transient analysis, is also very important. The results of the steady state core analysis form the basis of the transient analysis. The needs of the transient analysis group must be known to the core analysis group, and this can only be accomplished through a good interface where information flows freely. Throughout the core analysis process the author found it necessary to maintain an understanding of the whole package, including transient analysis. While it is usually easy to see the trees when looking at the forest, many engineers fail to see the forest when looking at their tree. Maintaining a good interface with those outside your group is one of the best ways to prevent this type of blindness.

In performing his core analysis responsibilities, the author was able to achieve some of his internship objectives; specifically, the in-core fuel management objectives. The author learned to use industry fuel management codes and gained a thorough understanding of the methods and ideas employed by these codes. An appreciation was also gained for the need for, operation of, and costs of using these codes. This particular objective was also satisfied by a specific task the author was assigned: that of evaluating fuel cycle scoping codes and recommending a course of action in obtaining such a code for use at GSU. As stated earlier, this matter will be discussed in detail in a later section. The philosophy behind successful management of company resources and assets was partially understood during this portion of the author's internship. A more thorough understanding of this philosophy was gained when the author completed his task of investigating fuel cycle scoping codes and also when the author was involved in the fuel fabrication contract administration and negotiation. Again, more about these subjects will be presented in a later sections.

III. SPECIFIC CORE CALCULATIONS

III.A. Introduction

In the previous section a general discussion of steady state core analysis was presented with some specifics as to the codes that are used by GSU. This section deals with more specific material. In this section the author will discuss the types of calculations that he performed during his internship as well as the procedures that were followed in performing these calculations. Some of these procedures were already well known to the members of the In-Core Nuclear Fuels Group from past experience and earlier training; however, many of the procedures were devised by the author in his work with SIMULATE-2 prior to using the more powerful SIMULATE-E. Even though some of the procedures were well known, improvements were made by the author and his coworkers during a complete recalculation of cross sections. The recalculation was necessary because the design of the initial core was changed from the standard GE BWR/6 624 assembly core to the more efficient GE BWR/6 624 assembly Control Cell Core. This design change not only altered some fuel assembly enrichments, but also had a major impact on the operating strategy. The author is not at liberty to discuss the details of the Control Cell Core concept because it is considered proprietary by GE, but can mention that the new operating strategy greatly simplifies the operator's job and increases thermal margins between normal operating levels and operating limits. The author will now begin the discussion of specific calculations and procedures. No River Bend specific numbers or graphs will be given as these numbers are considered proprietary by GSU; however, typical values and illustrations will be provided for clarification of explanations.

III.B. Microscopic Gadolinia Cross Sections

It was mentioned in the previous section that the MICBURN code is used to calculate effective microscopic cross sections for gadolinia at selected burnup points and in twenty-five energy groups. The calculations are performed on a pin-by-pin basis using only those pins containing gadolinia as the fuel pin of interest in any one calculation. During the calculation the fuel pins surrounding the fuel pin of interest are homogenized into one zone called the buffer zone using volume and flux weighting procedures.[9] The buffer zone surrounds the fuel pin in an annular ring thus simplifying the geometry of the calculation. The buffer zone is thick enough to approximate the actual environment that neutrons would encounter in reality. Figure 5 is an illustration of the geometry employed by MICBURN in performing the calculation. There was essentially one type of calculation performed. This one calculation might be called a depletion case which is similar to the depletion case that is performed by CASMO and is discussed later in this section. In this calculation the fuel pin is "burned" using a flux spectrum calculated internally by MICBURN. This spectrum can be adjusted by using an input if the person performing the analysis does not feel the unadjusted spectrum is sufficient to model all void conditions likely in the core. Generally CASMO is used to account for void effects,

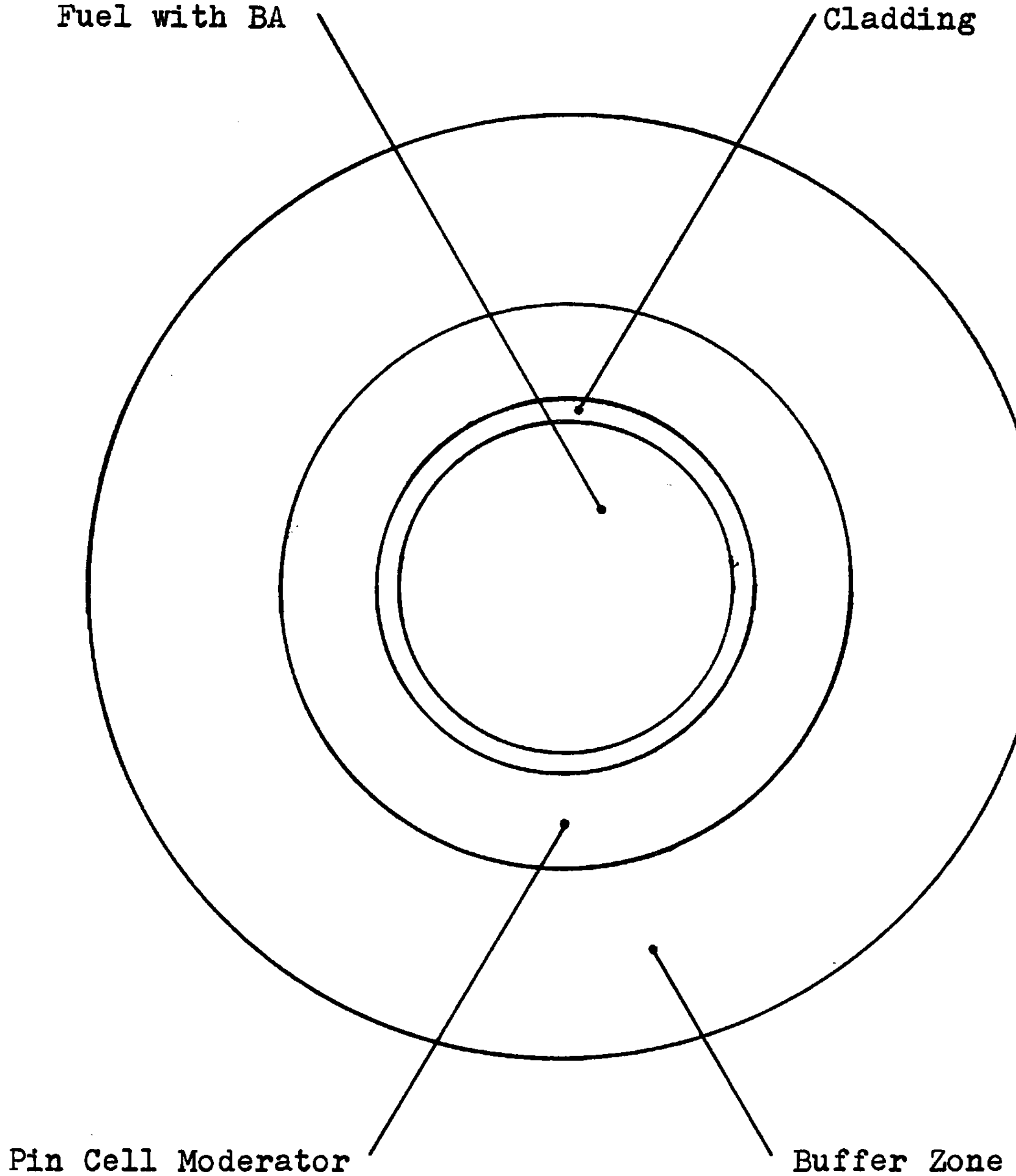

Fig. 5 MICBURN Problem Geometry

and the results from MICBURN are somewhat insensitive to the flux spectrum since the absorber in the fuel pin is essentially black to neutrons. During the burnup of the fuel pin, isotopic concentrations of all important isotopes are maintained internally by MICBURN. The calculation is usually carried out until the two important isotopes of gadolinium, Gd-155 and Gd-157, are depleted and a low equilibrium level of burnable absorber is established. This equilibrium level of burnable absorber is due to a combination of all the isotopes of gadolinium that are formed as a result of irradiation of gadolinia. The calculation typically is run out to anywhere between 10,000 MWD/MTU and 25,000 MWD/MTU depending on the initial concentration of gadolinia, the enrichment of the fuel pin, and the enrichment of the surrounding fuel pins which make up the buffer zone. All burnup steps are not equal in length. Early in the depletion burnup steps are shorter because the gadolinium is burning out very rapidly. Later, as the rate of burnout slows, the step length is increased. As a rule of thumb, the step length at any one point should be such that the concentration of gadolinium does not change by more than five percent. The results of the calculations were in the form of two-dimensional tables where rows and columns represented fuel burnup and energy group. These tables became cross section libraries for use as input to CASMO.

III.C. Two-Group Macroscopic Cross Sections

CASMO is the computer code used to calculate the two-group macroscopic cross sections to be used by SIMULATE-E. Unlike MICBURN which calculates only one type of cross section, CASMO calculates many different cross sections as well as other important parameters such as kinetics data. The major division of the core that CASMO considers is the lattice type. As stated earlier, a lattice type is a unique arrangement of fuel enrichments or burnable absorber concentrations. Figure 6 is an illustration of the geometry of the lattice that CASMO uses. Fuel assemblies are diagonally symmetric, and this fact is utilized to reduce the size of the necessary calculations. Figure 7 is an illustration depicting how a single fuel assembly may contain more than one lattice type. Another difference between CASMO and MICBURN is the different types of calculations that are performed by CASMO. Whereas, MICBURN performs only the depletion calculation, CASMO performs both depletion and branch calculations. Branch calculations, or branch cases, are needed to calculate the effects of changing conditions on a lattice type after it has been depleted in a certain manner. For example, the cross sections at 10 MWD/MTU of a lattice type that had been burned for 10 MWD/MTU and then had a control rod inserted beside it are different from those of the same lattice type that had been burned for 10 MWD/MTU with the control beside it the whole time. For this reason depletion cases are run for each major condition of the lattice type. These conditions are: unrodded (or uncontrolled) at each of three void conditions (usually 0%, 40%, and 70% void fraction) and rodded at zero void fraction; therefore, there are four depletion cases for each lattice type. After the depletion

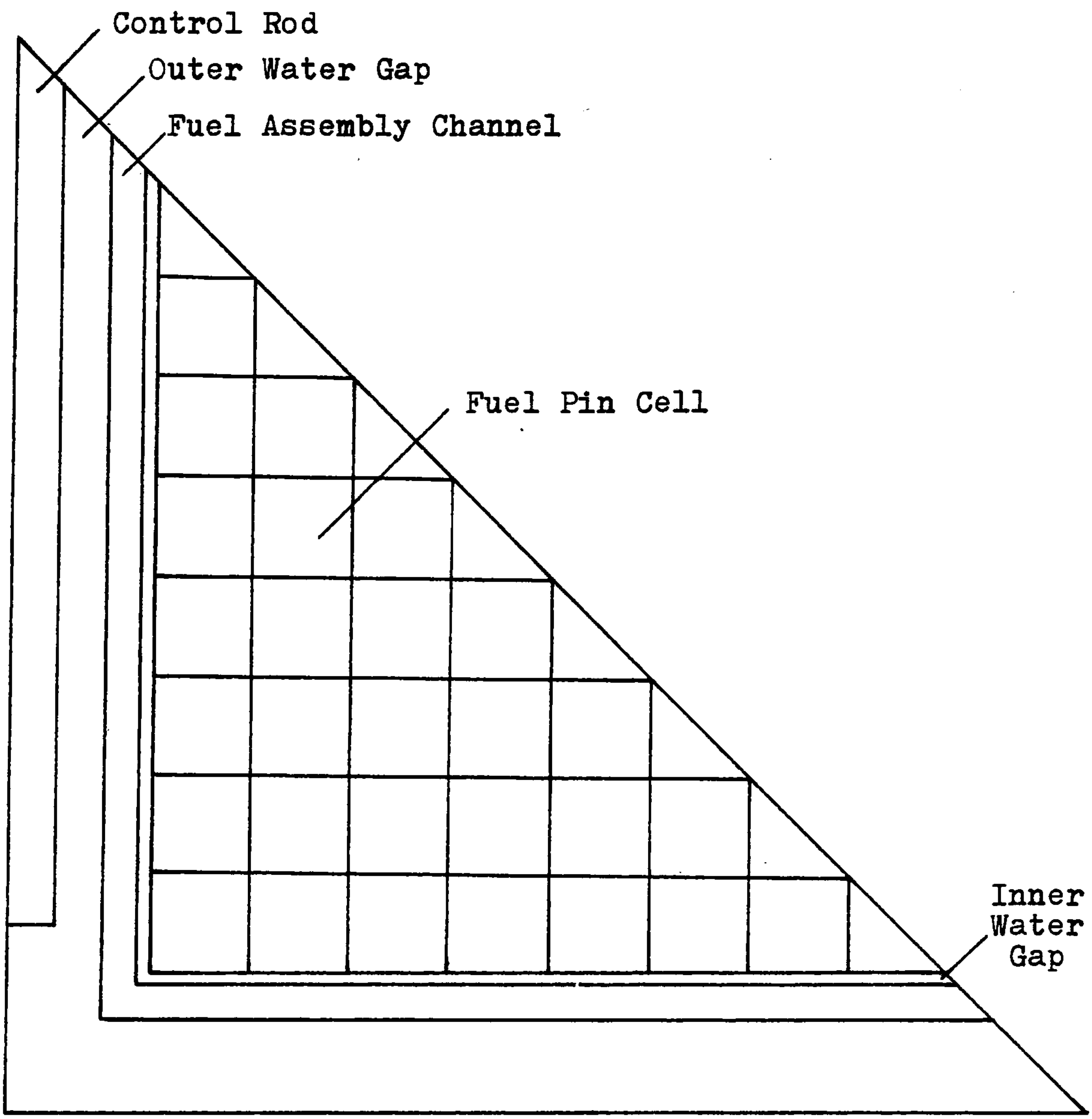

Fig. 6 CASMO Problem Geometry

Pellet Type	U-235 wt. %	Gd_2O_3 wt. %
A	.711	0
B	1.4	0
C	2.0	0
D	3.0	2.0

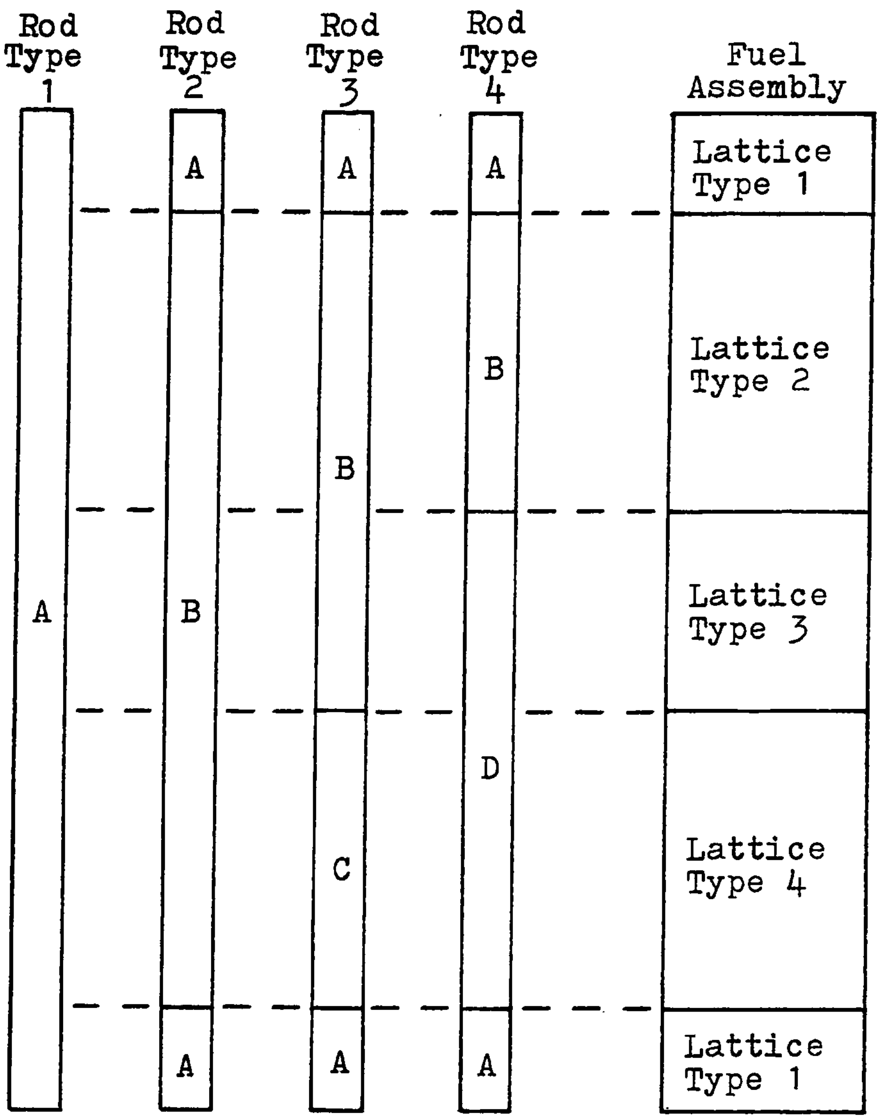

Fig. 7 Illustration of Lattice Types

cases are run, a multitude of branch cases are run off of each depletion case. Branch cases include: void branches where the void condition is changed, doppler branches where the fuel temperature is changed, control branches where the control condition is changed, cold branches where the branch simulates a shutdown, and many others. After all depletions and branch cases are run there may be as many as 45 cases for each lattice type. Considering that River Bend has seven lattice types in the initial core, that makes a possible grand total of 315 CASMO cases required to make all the necessary calculations to produce the two-group cross sections to use in SIMULATE-E.[10,11] Some utilities use more cases and some use less depending on the engineer's judgement of the necessary detail weighed against more computer run time.

The form in which the cross sections are output from CASMO is not suitable for direct use in SIMULATE-E; therefore, the linkage code NORGE-B is used to manipulate and correlate all the output from CASMO. In order to use NORGE-B effectively the author had to determine what cross section dependencies were to be used. After reviewing the data, making graphs, and conferring with colleagues, the dependencies decided on were: fuel exposure, control rod presence, instantaneous relative moderator density (void fraction), exposure averaged relative moderator density, and fuel temperature. The thermal absorption cross section was also made dependent on the concentration of Xe-135. After all of these dependencies were correlated and tabulated by NORGE-B, there were twenty-seven tables of cross section data for each lattice type ready for SIMULATE-E.

III.D. Steady State Core Analysis

It is at this point that the core analysis really begins using the work horse of the code package: SIMULATE-E. All calculations so far have been for the purpose of preparing input to SIMULATE-E, and now the true core analysis can begin. In each of the preceding subsections a figure was shown depicting the problem being solved by the code; therefore, Figure 8 is presented here depicting the problem that is solved by SIMULATE-E. As can be seen, the core is broken up into small boxes called nodes. At River Bend there are twenty-five nodes per assembly and 624 assemblies. There are therefore 15,600 nodes in the River Bend core; however, since the core is symmetric only one quarter of the core is used for most calculations thus saving much time and space.

As with CASMO, there is a central or main calculation from which all other calculations spring. This main calculation in the case of SIMULATE-E is usually known as the cycle depletion; however, before the cycle depletion can be performed, a Haling power distribution must be calculated. This power distribution was developed by R. K. Haling and is calculated such that if the reactor is operated with this power shape at all times, then over the course of the cycle, power peaking factors will be minimized and the end-of-cycle (EOC) all-rods-out (ARO) power distribution will be the Haling power distribution.[12] The advantage of this is that maximum thermal limits margins are maintained throughout the cycle and at EOC the reactor

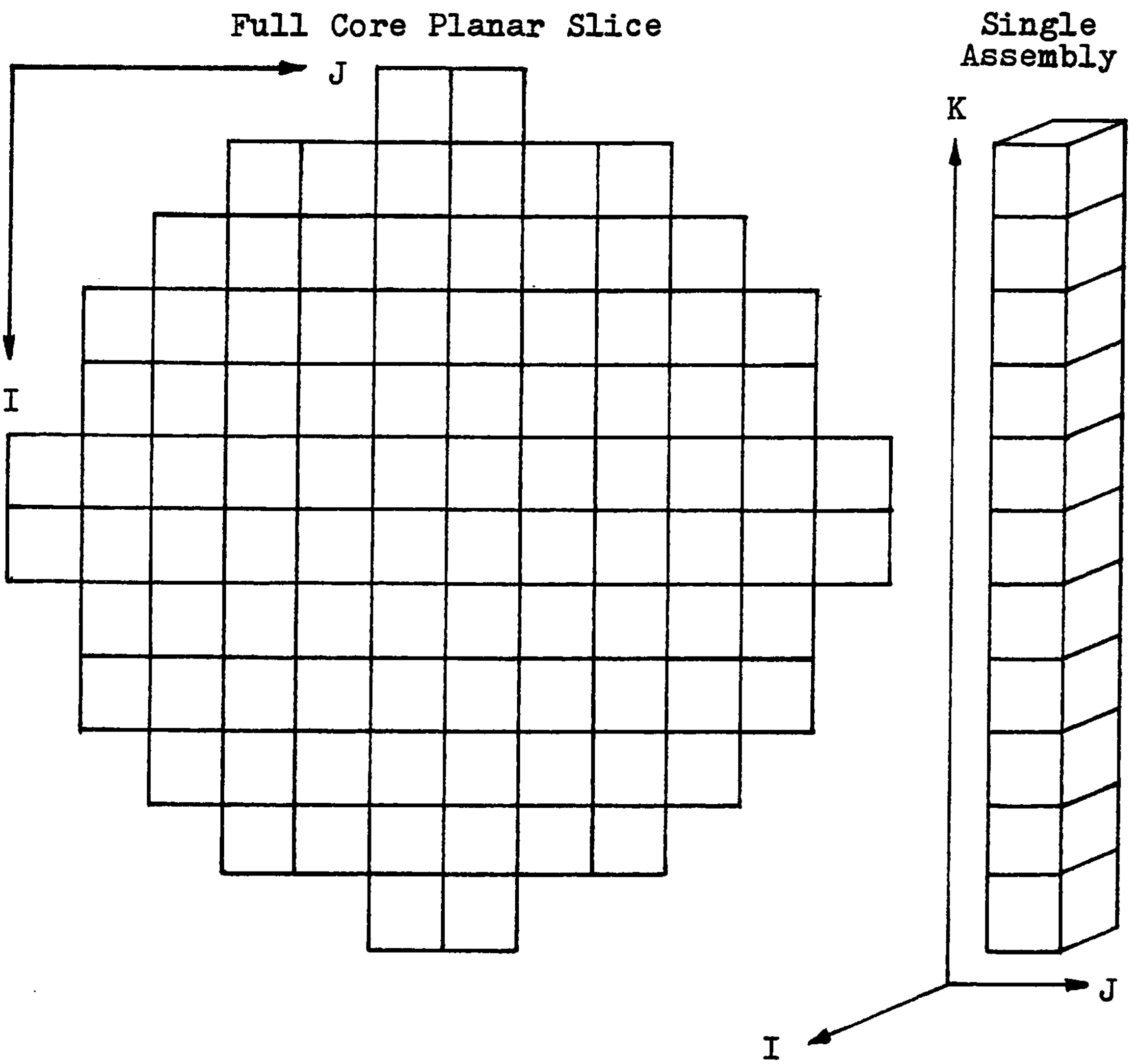

Fig. 8 SIMULATE-E Problem Geometry

can be operated ARO without violating any thermal limits. This also assures that, if desired or needed, the reactor coastdown strategy can be used. Reactor coastdown will be discussed later. The Haling power distribution is then used as the target power shape when determining the target rod patterns to be used during the cycle depletion calculation. Target rod patterns are the predicted configurations of the control blades required to maintain criticality at selected burnup steps. In practice target rod patterns are developed to produce a slightly more bottom-peaked power distribution than the Haling. This is to aid in the coastdown portion of a cycle where the feedwater temperature may be reduced causing high reactivity in the lower portion of the core. The selected burnup steps are usually at intervals of 500 or 1000 MWD/MTU with an extra step at 200 MWD/MTU when equilibrium levels of xenon have been established in the core. Figure 9 and Fig. 10 are illustrations of typical axial and radial Haling power distributions, respectively.

Other predictions that come directly from the cycle depletion calculation are power and exposure distributions at the selected burnup steps, cycle length, cycle thermal margins, and total energy generation. Probably the most important of these with respect to operation is the prediction of cycle thermal margins. The reactor must be operated in such a manner as to guarantee that no thermal operating limits are violated. The transient analysis group does much more work on thermal limits which are safety concerns; the function of thermal limits is to ensure that radiation boundary

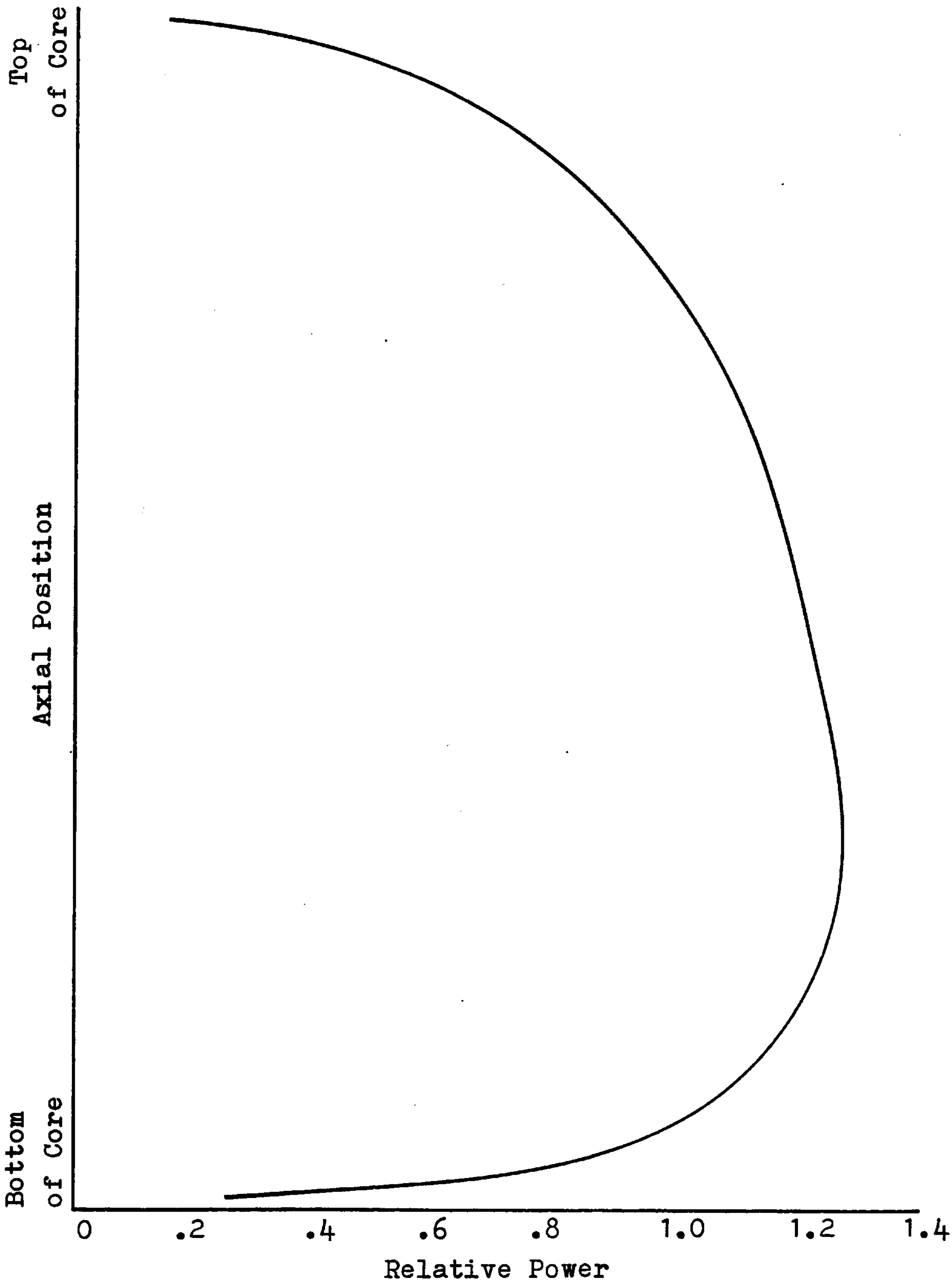

Fig. 9 Typical Axial Haling Power Distribution

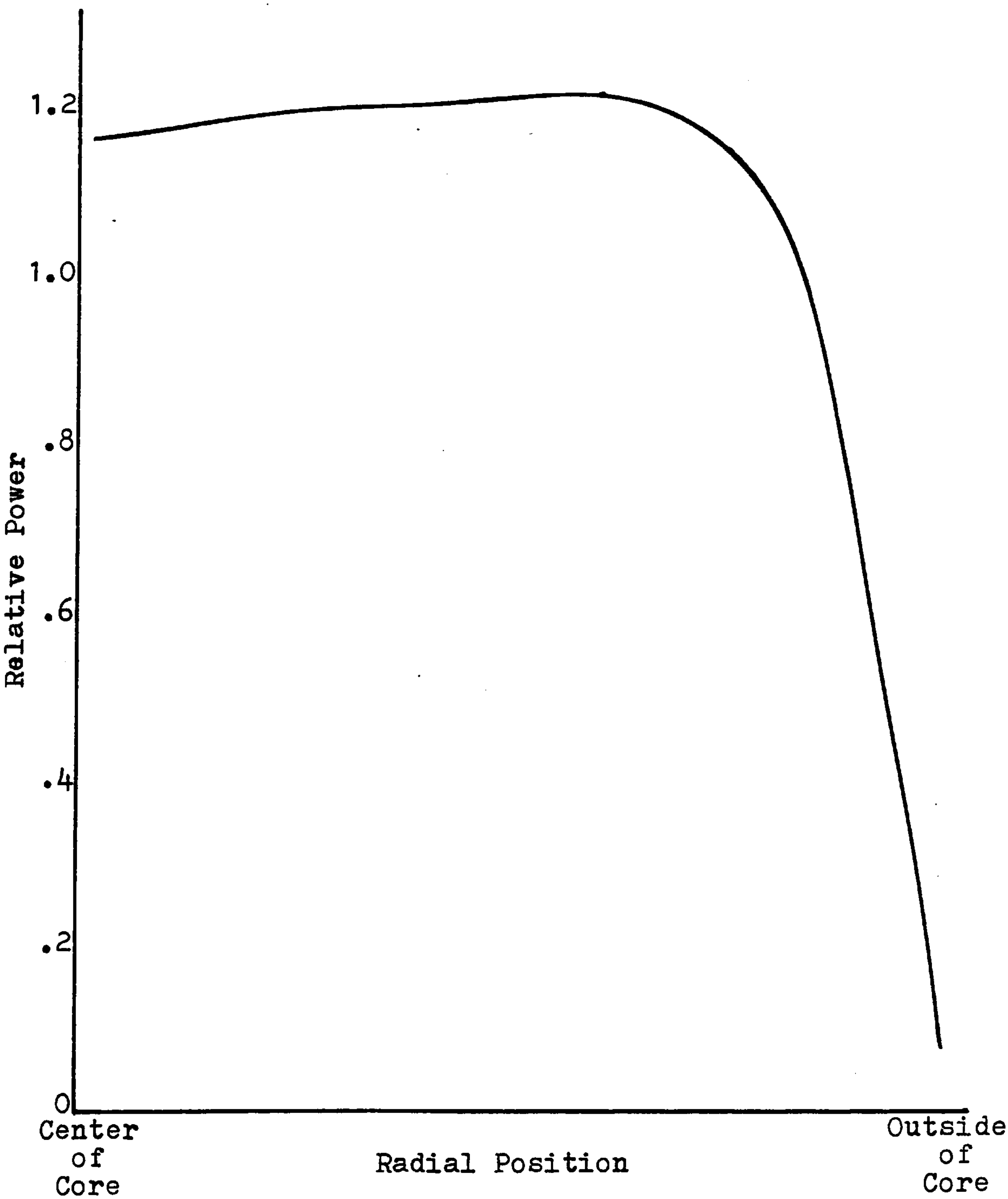

Fig. 10 Typical Radial Haling Power Distribution

integrity is maintained even during during abnormal operating conditions.

The cycle depletion is by far the most involved calculation performed and requires engineering judgement in determining the target rod patterns. The process is essentially trial and error with the engineer testing different patterns until he can produce a suitable power distribution and keep the reactor critical. The experienced engineer can keep the number of trials to a minimum. The next most involved calculation is the strongest rod calculation. This is the calculation of the worth of the strongest control blade in the reactor at each of the burnup steps. The particular rod can change from burnup step to burnup step because of changes in flux distributions and power distributions due to uneven depletion of isotopes, but the strongest rod usually stays in the same general area of the reactor. The calculation is performed at cold conditions with the reactor shutdown, and no credit for xenon is allowed. The process is essentially a search for the strongest rod with the rod worth being calculated as the search parameter. The preliminary steps of the search involve quarter-core calculations where all-rods-in and all-rods-out cases are run, and assembly k-infinities are the important parameters. Toward the end, full-core calculations are required to accurately determine the worth of a single control blade and the worth is determined by differences in k-effectives. Once the worth of the strongest control blade has been determined, the next important parameter can be calculated: cold shutdown margin. Cold shutdown margin (CSDM) represents the amount of reactivity needed by a reactor core to reach criticality with the strongest rod out (SRO) and all other rods fully inserted. The purpose of CSDM is to assure that a core can always be brought and held subcritical with the control system alone. A single failure is postulated and assumed to be the strongest worth control blade failed in the full out position. Plant technical specifications require CSDM to be no less than 0.38% delta k/k at any time during the cycle. This number is based on the evaluation of cold criticals performed at the Quad Cities Unit 1 plant in 1972. The value is assumed to be sufficient based on design policy and an assumed envelope of calculational uncertainties and manufacturing tolerances.[13] The design basis for CSDM is 1% delta k/k. Typical curves for CSDM as a function of core average exposure for an initial cycle and subsequent cycles are shown in Fig. 11 and Fig. 12, respectively.

Hot excess reactivity is another parameter that is calculated during steady state core analysis. Hot excess reactivity is the amount of reactivity being controlled by the control rods.[14] The remaining reactivity is controlled by burnable poisons, reactivity coefficient effects, and fission product poisoning. A typical hot excess reactivity curve is shown in Fig. 14. The curve calculated at GSU for River Bend was very similar to this curve.

Other calculations that are usually performed during steady state core analysis give batch averages, thermal peaking parameters, predicted energy generation, the reactor anomalies curve, and the

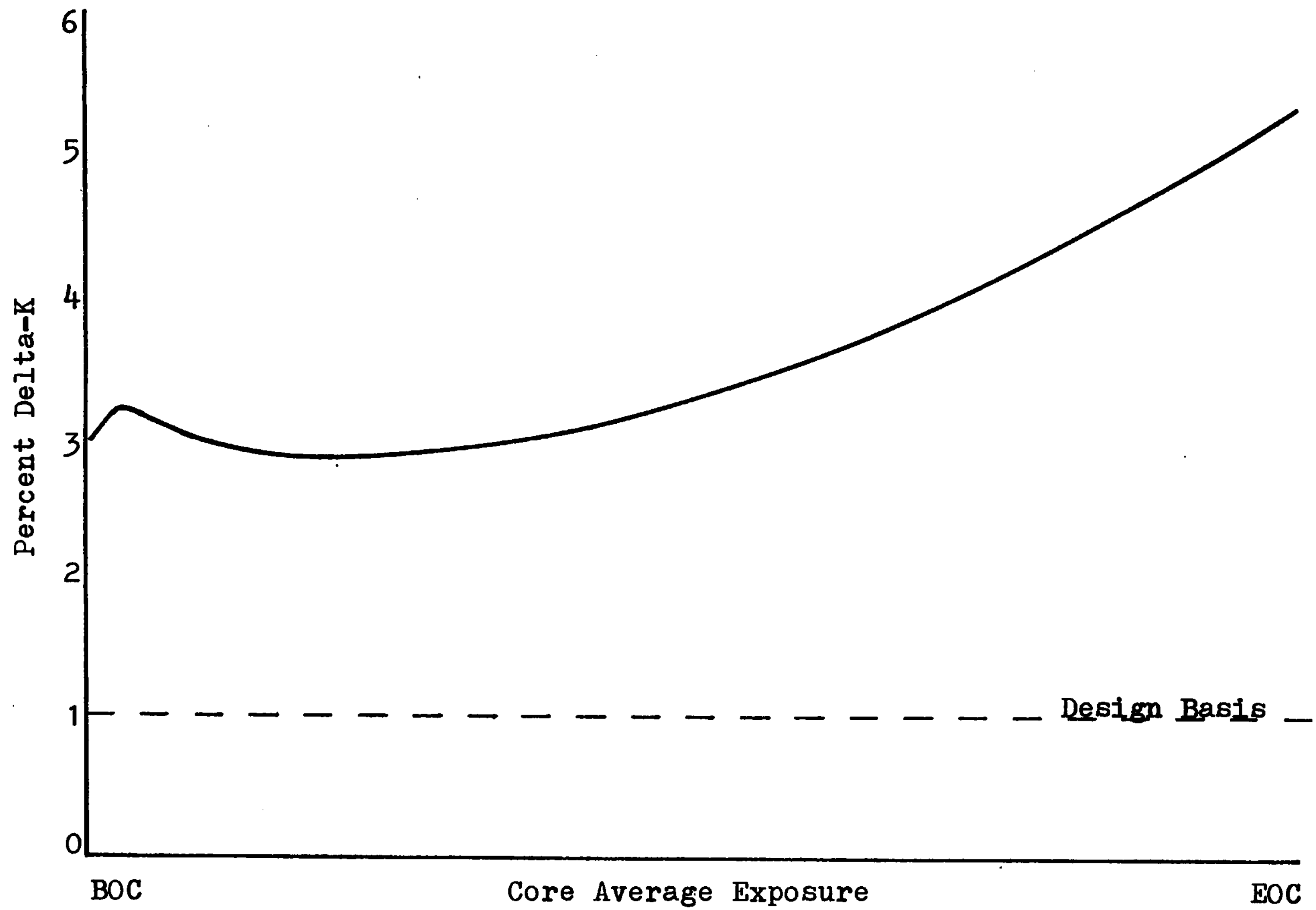

Fig. 11 Typical Initial Cycle Cold Shutdown Margin

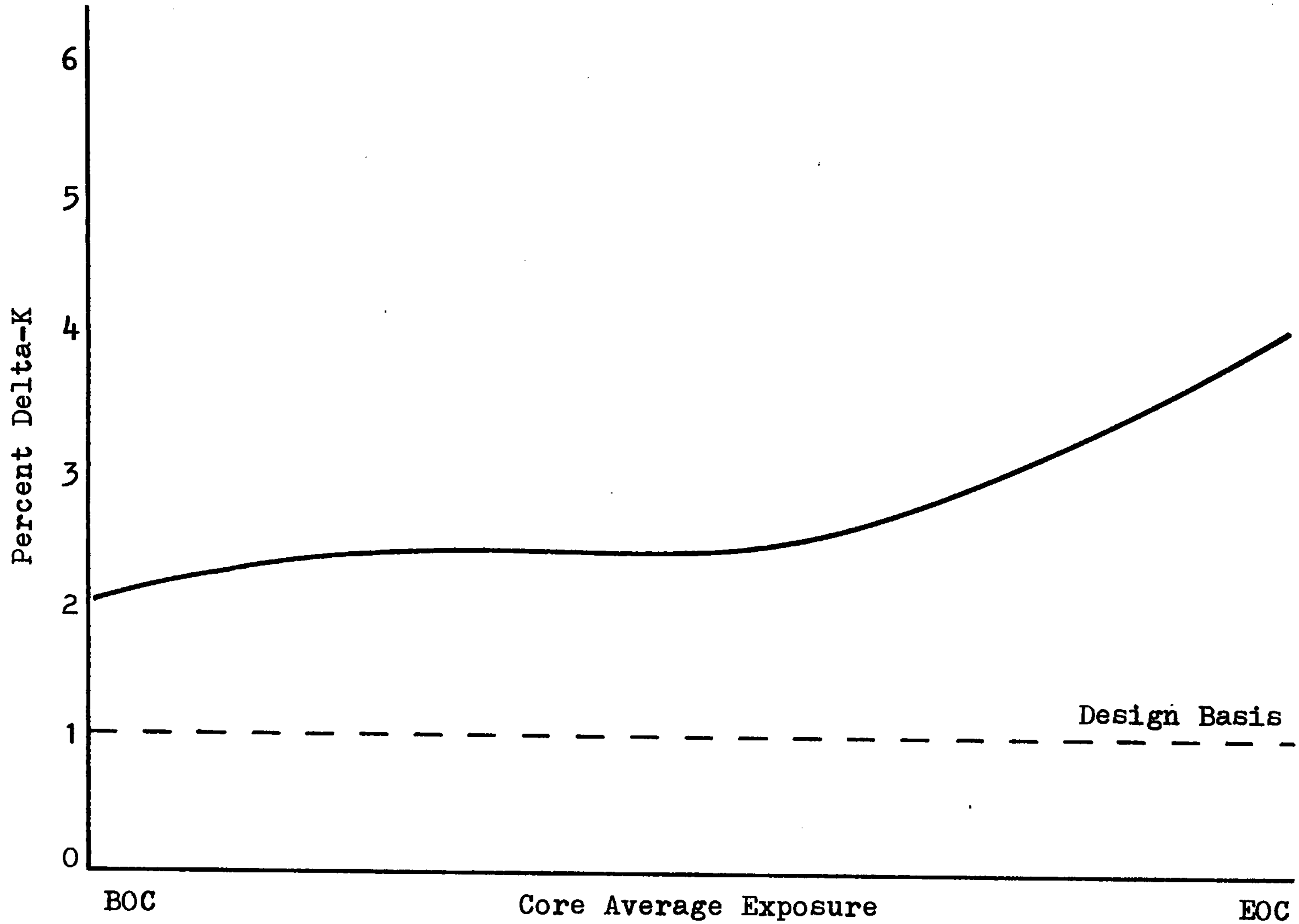

Fig. 12 Typical Equilibrium Cycle Cold Shutdown Margin

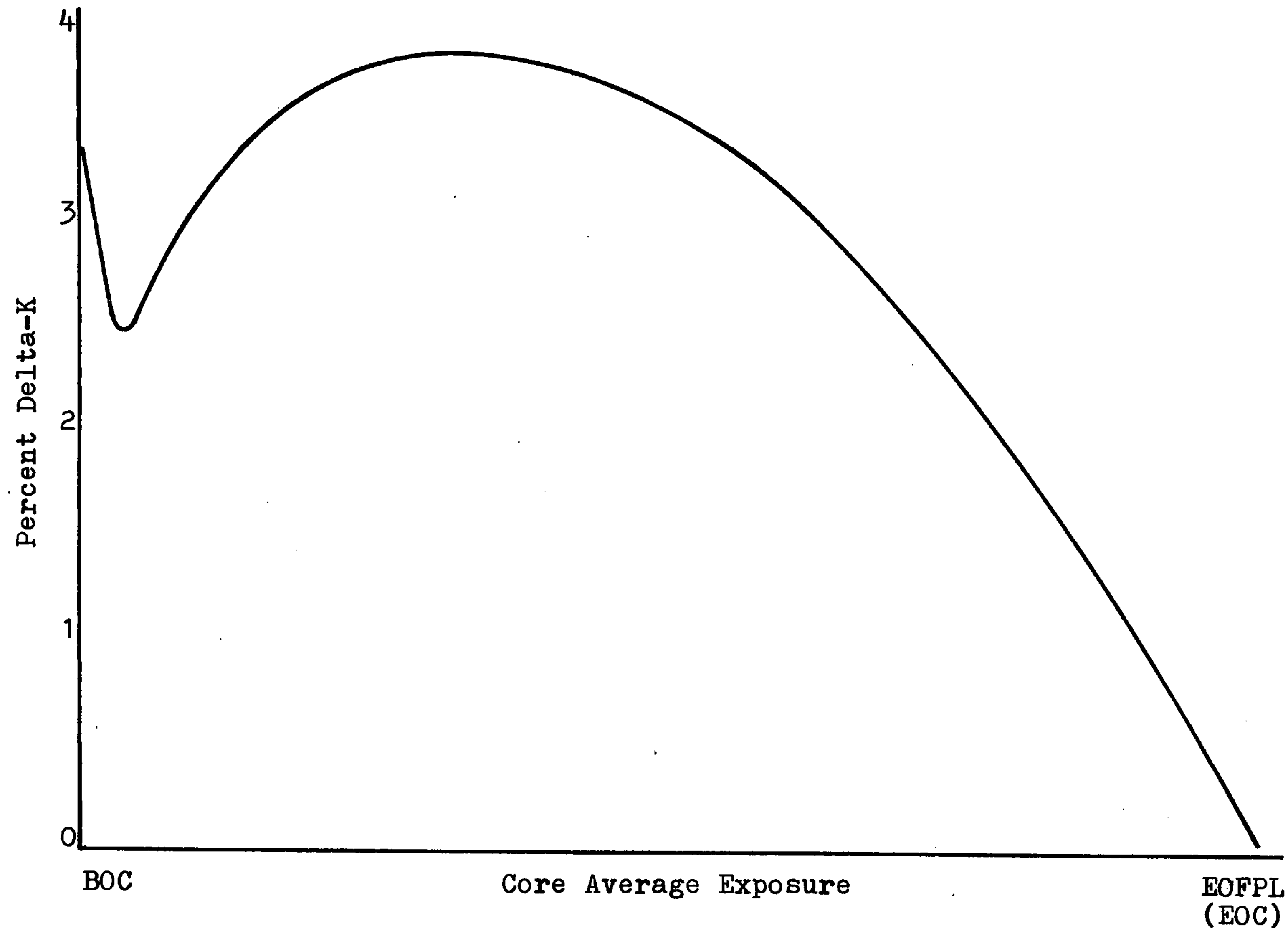

Fig. 13 Typical Hot Excess Reactivity Curve

preliminary design of the next reload core. Batch averages are simply average values of fuel exposure and possibly normalized power. Average values such as these are used to select which batch is to be discharged and give an indication of whether the the radial power distribution was as flat as it should have been. Thermal limits are the core parameters that most limit the operating strategy of the reactor. Table 2 lists a few of the most important thermal limits. Thermal limits are adhered to in order to maintain the integrity of the fuel cladding during normal operation and are set at a level that will insure that the limits are not violated during transient events. Predicted energy generation is never actually calculated but is really just a consequence of the cycle depletion calculation. This is not to say that predicted energy generation is not important; in fact, quite the contrary is true. The predicted energy generation is a measure of how well the fuel is utilized. Utilities of course want to squeeze every bit of energy out of the fuel that they can. Reactor anomalies refers to a family of curves around a curve of total control rod notches, in-core and at criticality, as a function of core average exposure. A control rod notch is a six-inch length of a control blade. The term originates from the fact that a control blade can only be moved in six-inch increments. The family of curves is a curve above and below the "critical notches" curve representing limiting deviations of +1% and -1% in reactivity worth of the control rod notches. If during the course of the cycle the actual control notches in-core deviates more than the 1% limits from the predicted

TABLE 2

IMPORTANT BWR THERMAL LIMIT PARAMETERS

LHGR	Linear Heat Generation Rate. This is the rate of heat generation per unit length in a fuel rod.
MLHGR	Maximum Linear Heat Generation Rate. The purpose of this limit is to prevent fuel rod cladding cracks due to high stresses.
APLHGR	Average Planar Linear Heat Generation Rate. This is the average value of LHGR in a planar slice of the core.
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate. The purpose of this limit is to prevent gross fuel rod cladding failure due to stored heat and decay heat following a Loss of Coolant Accident.
CPR	Critical Power Ratio. This is the ratio of the bundle power to the bundle power that marks the onset of transition boiling.
MCPR	Minimum Critical Power Ratio. The purpose of this limit is to prevent fuel rod cladding cracks due to lack of cooling caused by loss of nucleate boiling.

value, this is considered an anomaly and an investigation of why is immediately undertaken. The investigation encompasses both the core model and the plant itself. Preliminary planning of the next reload core simply makes use of all EOC predictions to begin the design of the next reload core. All fuel cycle scoping calculations are based on these EOC values.

III.E. Reactor Coastdown Analysis

After the completion of the first cycle report, the author was asked to continue the cycle analysis by performing a simulation of reactor coastdown using SIMULATE-E. Coastdown refers to cycle extension techniques used to add flexibility to the length of a cycle or to squeeze a little more energy out of the reactor core. There are basically four cycle extension techniques that may be used separately or together to increase the energy production of a reactor core beyond its normal capacity. The four techniques are known as spectral shift (SS), thermal coastdown (TC), increased core flow (ICF), and final feedwater temperature reduction (FFWTR). The latter three techniques, TC, ICF, and FFWTR, are generally called coastdown and are applied after the ARO EOC condition has been achieved in a reactor core. SS is applied throughout the cycle to produce benefits which may be utilized at EOC.

Extending cycle length through SS involves either reducing core flow or overemphasizing the bottom peak in the axial power shape using control rods or a combination of both. The net result is an increase in core average void fraction, thus, hardening the neutron flux in the upper region of the core. The hardened neutron flux causes an increase in the buildup of Pu-239 which will be used as additional fuel at EOC.

Thermal coastdown is by far the easiest method of extending cycle length. TC is a mode of operation in which the reactor power level is allowed to drift down with exposure after the ARO EOC condition of the cycle. Criticality is maintained through a reduction in negative reactivity coefficient effects with reduced reactor power compensating for the fissionable isotope depletion.

The third method of cycle extension, ICF, is implemented by operating the reactor core at flow rates greater than the reference 100% rated value. The core reactivity is increased by reducing the core average void fraction which results from recirculating more water through the core. Full thermal power can be maintained as well as full efficiency; however, the cycle extension is relatively short.

The final method of cycle extension is FFWTR. This technique had been recommended by General Electric (GE) for River Bend Cycle 1. FFWTR is implemented by reducing the extraction steam to the feedwater heaters or through bypassing the feedwater heaters, thus, reducing feedwater temperature. The reduction in feedwater temperature results in increased core inlet subcooling and, therefore, decreased core average void fraction which increases the core reactivity. A lower limit of 250 F was established due to feedwater nozzle performance and feedwater heater bypass piping requirements. Full thermal power is maintained, but plant efficiency is reduced due to higher irreversibilities in the heat addition portion of the steam cycle. The end result, however, is that net electrical output is still higher than when using TC because the cycle extension lasts longer.

The author modeled FFWTR using SIMULATE-E by simply reducing the feedwater temperature used by the code at full thermal power. The coastdown process was modeled in a manner analogous to the cycle depletion. The core was depleted from end of full power life (EOFPL) in steps where criticality was maintained by step decreases in feedwater temperature. The author developed the following procedure to approximate the coastdown process:

1. Choose a feedwater temperature reduction step resulting in an exposure step of between 50 and 100 MWD/MTU (The linearity of the reactivity as a function of feedwater temperature should govern the temperature step size).

2. Reduce the feedwater temperature by one temperature reduction step from the previous feedwater temperature and deplete the core from the last exposure until criticality is achieved (The user may use the EOC exposure search in SIMULATE-E).

3. When the new EOC exposure is established, repeat the last depletion step using an average feedwater temperature to establish the proper nuclide concentrations.

4. Repeat steps 2 and 3 until the final feedwater temperature is achieved.

The more linear the coastdown process, the more closely will the above procedure approximate the true results, and the larger the feedwater temperature reduction step may be. The author found the process to be very nearly linear and used feedwater temperature reduction steps of 20 F which resulted in exposure steps of approximately 100 MWD/MTU. The above procedure performed well in approximating the coastdown process. This fact was evidenced by the favorable comparison to coastdown data supplied by GE.[15]

III.F. Summary

In the preceding discussion the author presented some specific details about the major steady state core analysis calculations. Although no River Bend specific numbers or figures were used, typical values and figures were presented to aid the reader in understanding the nature of these calculations. Even though core physics data forms the basis for all other calculations in core analysis, the three-dimensional core simulator is the work horse of the analysis package. For this reason, the discussion of how the core physics data, i.e. cross sections, are generated was somewhat brief and generalized and the emphasis of this section was placed on calculations using the nodal core simulator, SIMULATE-E.

The author reviewed the calculations that he performed using SIMULATE-E, how he performed them, and in cases where it might not have been immediately obvious, why the calculations were performed. The author also discussed his task of performing a reactor coastdown analysis on the River Bend initial core. The results of this analysis were comparable to those supplied to GSU by GE. As stated in the previous section, this portion of his internship experience satisfied the author's in-core fuel management objectives.

IV. FUEL CYCLE SCOPING CODE SELECTION

IV.A. Introduction

One of the specific assignments given to the author during his internship was that of investigating the various fuel cycle scoping codes available to GSU and making a recommendation as to which code best fulfilled GSU's requirements. The first order of business in this situation is to define a fuel cycle scoping code. Perhaps the best way to define a scoping code is to define its function. A fuel cycle scoping code, or more commonly, a scoping code is used to make fast multi-cycle, and although not usually detailed, reliable studies of core management strategies. The usefulness of a scoping code varies widely among utilities; however, if a utility is planning to perform its own reload licensing calculations, then a scoping code is indispensable. Scoping codes, as with any computer program, can be used for many purposes, but the most common uses are: economic studies of capacity factor and other reactor operation assumptions, investigations of the feasibility of vendor reload strategies, reload planning, investigations of the future effects of current or planned cycle strategies, and verifying long range vendor cycle data. In this section the author will discuss his investigation of the available scoping codes. The investigation covered such areas as requirements to be applied to the scoping codes, selection of possible candidates, testing of candidates, and finally the recommendation that the author made to GSU.

IV.B. Scoping Code Requirements

The requirements of a scoping code may vary with its intended uses, but there are some basic properties that should apply to all scoping codes. First is speed of execution. Literally hundreds of cases and scenarios will be studied during the investigations listed above; therefore, a fast running code is necessary. This would be especially important to users of outside computing services. A second desirable property is ease of use. This is true of any code but should be especially true of a code that is going to be executed hundreds of times in a short period. Thirdly, a scoping code should have multi-cycle capability. This means either multi-cycle capability in a single execution or a simple way to continue a case after fuel shuffling and reloading. Finally, and perhaps the most important feature of a scoping code, is compatibility. A scoping code must be compatible with the other analysis and economics codes being used. If the scoping code does not provide the type of output data needed as input to the other codes, then it is not much use to the utility. Hand-in-hand with compatibility is the output form. Information from the scoping code must be transferred to economics codes and also to more detailed codes for further and more detailed analysis of promising strategies. If the scoping code cannot do this through computer manipulation of datasets or limited hand transfer, then the code is again of limited use. Using these basic requirements and his knowledge of the codes that GSU already employed, the author began his search through literature and code manuals to select a few promising scoping code candidates.

IV.C. Selection of Possible Scoping Tools

There are many different scoping codes on the market, and after careful review of code descriptions, the author selected three codes for further investigation and testing. The first two of these were HUDDLE, a code developed by Pickard, Lowe, and Garrick (PL&G), and FALC/FCS-II, which was developed by Scandpower. FALC/FCS-II is actually two separate programs meant to be used iteratively, whereas FALC is very coarse, and FCS-II is a fine tuning code. The last code selected for further investigation and testing was not a scoping code but actually the detailed three-dimensional nodal core simulator, SIMULATE-E, that was being used by GSU at the time. The author felt that because of his extensive experience with the code he could suitably alter the code to produce what would in effect be a very detailed scoping code.

IV.D. Scoping Tool Candidate Testing Results

HUDDLE was tested by the author during a trip to PL&G in the first week of March, 1983. Considering the coarseness of the calculation, the results were surprisingly accurate. In addition to being reasonably accurate, it was found that HUDDLE was also extremely fast and extremely easy to use. Standard physics and economics libraries are supplied with the code, and it was these libraries that were used during the testing. Also supplied with HUDDLE were two auxiliary codes that were used to generate one's own plant specific libraries, thus, increasing the accuracy of this code.

The printout was well laid out and very understandable, a major benefit to the user and a feature that did not seem to be common among scoping codes. HUDDLE software is supported by PL&G, who is continuously improving code segments to more accurately model LWRs. HUDDLE has been improved by PL&G since the testing to account for the effects of burnable poison as a separate nuclear property. HUDDLE did not specifically model voids, but this improvement could have been suggested to PL&G as part of their continuing software support. One of the biggest advantages of HUDDLE that the author discovered was the restart option. HUDDLE could read and write a restart file upon demand. This restart file was essentially a punch file that could be used as a means of transferring data to other codes. Additionally, the restart file could be created using actual operating plant data, thus, providing HUDDLE with a means of making more accurate predictions. The author considered HUDDLE a viable alternative as a scoping tool for use at GSU.

The scoping code package FALC/FCS-II, developed by Scandpower, was specifically designed to be used in an iterative manner with FALC being a coarse calculation and FCS-II being a fine tuning calculation. Both codes were more detailed than HUDDLE, accounting for such things as voids and power sharing in a more rigorous manner. FALC was also an optimizing code, using linear programming to optimize loading patterns and cycle lengths based on the overall economics of a multi-cycle strategy. Once FALC had flagged possibilities for the user, FCS-II evaluated the alternatives based on more detailed physics to be sure that the plan was feasible at all. FCS-II would also allow the user to calculate more accurate input parameters for FALC. Consequently, an iterative procedure was developed to improve the accuracy of the results. This process was obviously more complicated than HUDDLE, and required more detailed input, specifically, physics data. FALC and FCS-II both required lattice physics datasets produced by RECORD, Scandpower's equivalent of CASMO. CASMO output could be converted to RECORD format through the use of a program written by Scandpower called CAS2REC. The author was beginning to realize the complexity of the process at this point. The above were minor difficulties of FALC and FCS-II and were a trade-off for more detailed analysis. A more serious disadvantage that the author discovered was that of questionable support. Scandpower had only one full-time representative in the United States, and this meant that software support would be slow if not nonexistent. Training on the proper use of the codes was suggested by Scandpower, and the author would have also recommended training due to the complexity of the required input. The printed output of the codes was not as clear as that of HUDDLE, and the punched output was that which was meant as direct input to FCS-II and was only shuffling information. The user's manuals and documentation of FALC and FCS-II were sketchy at best, contributing to the difficulty in preparing input and executing the codes. As it took several attempts before the author could successfully run a case, the actual testing of FALC was not reassuring. River Bend specific cases were not possible because of the physics requirements of the codes. Finally, except for that performed by Carolina Power and Light, there has been little or no development work performed on FALC or FCS-II by Scandpower since the late seventies. Carolina Power and Light had been modifying FCS-II, but had also purchased the whole Scandpower Fuel Management System (FMS). For these reasons the author did not feel that FALC/FCS-II was a viable alternative as a scoping tool at GSU.

The last code to be tested, SIMULATE-E, was not actually a scoping code. SIMULATE-E was the three-dimensional nodal core simulator that GSU was using as the work horse of its core analysis package. SIMULATE-E was very accurate and very detailed and thus required very accurate and very detailed input, but there was also a great deal of flexibility available. In order to test SIMULATE-E as a scoping tool the author had to reduce the size of the core model that was normally used. The author utilized the symmetry of the River Bend core and reduced the core model to eighth-core from quarter-core and to twelve axial nodes per assembly from twenty-five axial nodes per assembly. This smaller core model ran much faster than the normal SIMULATE-E core model, requiring only about thirty CPU seconds to complete one cycle calculation. The accuracy of the results was expected to suffer; however, the results of the reduced core model were very nearly the same as the normal core model. Even though the reduced core model was fast, the author felt that some slight modification to the code itself would significantly increase the speed of the calculations to a point where the speed might be comparable to other scoping codes.

SIMULATE-E had many advantages over conventional scoping codes. Some of these were: a high degree of accuracy, three-dimensional output, punched as well as printed output, and loading pattern optimization based on CSDM. There were some other advantages specific to GSU. SIMUALTE-E was already in-house; thus, no purchase would be necessary, and In-Core Nuclear Fuels had already had extensive training on the use of SIMULATE-E. SIMULATE-E was already compatible with other codes being used by GSU. Cross section data for the scoping model was the same as for the core analysis model, and slight modification of this data had the potential for further increasing the speed of the scoping model. Finally, SIMULATE-E was supported by the Electric Power Research Institute (EPRI); therefore, improvements and development work was assured. There were, however, some disadvantages to using a modified version of SIMULATE-E as a scoping tool. The first was that SIMULATE-E was not designed as a scoping code, and while multi-cycle analyses were possible, the process was more complicated than with HUDDLE or FALC/FCS-II. Also, multi-cycle SIMULATE-E runs would require multi-cycle lattice physics data; therefore, CASMO analyses of all future lattice types would be necessary. Finally, although these types of analyses could be performed separately, there were no economics calculations or enrichment search options in SIMULATE-E. Nevertheless, the author felt that the advantages of using a modified version of SIMULATE-E outweighed the disadvantages.

IV.E. Summary of Results and Recommendation

The author concluded that the FALC/FCS-II scoping package was not acceptable for use at GSU due to major disadvantages stemming from the fact that GSU was not a user of Scandpower's FMS. These disadvantages were:

1. input requirements were comparable in complexity to those of SIMULATE-E, yet the accuracy and detail of the output was far below that of SIMULATE-E. In the case of physics data, even more work would be required to convert CASMO data to a usable form;

2. software development and improvement support seemed to be lacking, and as GSU was not a major user of Scandpower's FMS, special attention was doubtful; and

3. training in the proper use of FALC and FCS-II as well as supporting codes such as CAS2REC and POLGEN would have been necessary, thus, incurring additional expenses.

The author felt that if in the future GSU were to purchase Scandpower's FMS, then FALC and FCS-II would become the logical alternatives for scoping tools because of their compatibility with the system. This was an extremely remote possibility; therefore, the author recommended that the FALC/FCS-II package not be chosen.

HUDDLE had some attractive features which qualified it as a viable alternative in the search for a fuel cycle scoping code. These features were:

1. HUDDLE was very easy to use. Input was simple, yet results were accurate enough to allow reliable fuel management strategy decisions;

2. a restart file could be written by HUDDLE which was essentially a punch file, and therefore the use of data generated by HUDDLE could be automated;

3. the restart file could be created using actual plant operating data, thus, allowing HUDDLE to make more accurate predictions for future cycles; and

4. software support and development activities were offered by the code vendor: Pickard, Lowe, and Garrick.

At the time, computing time was not as important a factor as compatibility or support since GSU did not use any outside computing services. However, should that situation change, the author felt that HUDDLE could easily become the logical alternative as a fuel cycle scoping tool.

SIMULATE-E, the three-dimensional nodal core simulator, could be modified and the core model reduced to produce a slow running but highly accurate scoping tool. Although SIMULATE-E required more CPU time than HUDDLE or FALC/FCS-II, its advantages far outweighed this disadvantage or any of the disadvantages previously listed. The strong points in the case for using SIMULATE-E as a scoping tool were:

1. SIMULATE-E was already in-house, and expertise had already been developed in its use;

2. SIMULATE-E was compatible with all codes being used by GSU and would be compatible with future codes being developed such as a spent fuel isotopics code;

3. SIMULATE-E had punched, three-dimensional output options which greatly simplified the transfer of data between codes; and

4. SIMULATE-E was supported by EPRI, and future development work was assured.

In light of the advantages offered by SIMULATE-E, the author recommended that this code be chosen as the scoping tool for use at

GSU. It was further recommended that future efforts in the area of fuel cycle scoping be spent developing a modified version of SIMULATE-E and a sufficiently reduced core model such that the code would run quickly but accurately.

IV.F. Conclusions

The author feels that this task more than any other during his internship helped him obtain an understanding of the philosophy behind successful management of company resources and assets. The author learned to take into account as many aspects of a problem as possible in making a decision. Another lesson learned here was that the specific statement of a problem may inadvertently obscure some possible solutions; as in this case where the task was to investigate "scoping" codes and to recommend a choice. If the author had not thought of modifying SIMULATE-E to produce a "scoping" code the best solution might have been missed because of a narrow interpretation of what constituted a scoping tool. The author feels that the experience described in the last three sections fully satisfied the in-core fuel management objectives of his internship.

V. BUSINESS MANAGEMENT RELATED ACTIVITIES

V.A. Introduction

Engineers have traditionally been leaders both in industry and society. To provide leadership, engineers must be more than technically competent. Engineers must understand social, political, environmental and other influences which shape modern society. This is one of the objectives of the Doctor of Engineering degree program: to educate engineers who can bridge the gap between society and technology and make technological alternatives clear to non-engineers. Engineering problems frequently have a societal impact which is non-technological in nature, and technological advances are implemented through business and industry. The Doctor of Engineering program seeks to couple understanding of the characteristics of social and business institutions with high competence in solving engineering problems. The author recognized this portion of the degree program as essential and tried to incorporate this ideal into his internship objectives. Specifically, the non-technical objectives of his internship were the contract management objectives and the civic and professional objectives. The author's experience in this area included contract administration, contract negotiation, budgeting, and many other subjects to be discussed later. In this section the author discusses his experience in the area of contract administration which includes such subjects as interpretation, clarification, and economic evaluations. The author also discusses contract negotiation with attention to the economics of the proposals and the author's experience in this area. The author also discusses his experience with the budgeting activity. Finally, the author lists the specific internship objectives that were satisfied by this portion of his internship.

V.B The Fuel Fabrication Contract

The In-Core Nuclear Fuels Group had the responsibility for management of the fuel fabrication contract. At the time the author began his internship, the supervisor of that group, Lynn A. Leatherwood, performed all administrative functions; however, when the author arrived Mr. Leatherwood began to shift some of the responsibility to the author. One of the biggest jobs involved with the contract administration function of contract management is interpretation of the meaning and intent of the contract wording. Although the authors of the contract strove for clarity at the time of its writing, there remained sections that were difficult to interpret or whose intent may been have lost over the years. The fuel fabrication contract which GSU had with GE was about ten years old; therefore, those originally involved at GE were no longer participating in its administration. For this reason, interpretation was a major effort. Whenever differences of interpretation occurred between GSU and GE there would be action to try and settle this difference. This action usually involved negotiations.

Another function the author performed as a part of his administrative duties was that of determining cash flows involved with the purchase of the fuel. The price of the fuel in the contract was stated in December 1971 dollars and was to be escalated using a weighted average of two indices published by the Bureau of Labor Statistics. These labor indices dealt with the cost of materials and the cost of a certain type of labor. Based on the trend these indices had established, the author predicted the future cash flows for payments related to the fuel purchase. This type of work was also used to evaluate possible proposals for changing payment schedules during the major renegotiation mentioned earlier.

The second aspect of contract management that the author experienced was that of contract negotiation. During his internship the author had the opportunity to become involved in a major renegotiation of the fuel fabrication contract. The author's part in these negotiotions was mainly support: performing economic analyses and evaluations and providing technical support on demand. During the actual negotiating sessions which were held at GSU corporate headquarters in Beaumont, Texas, the author was present but not as a participant in the true sense of the word. The author used this opportunity to take notes on proposals to be used later in evaluations and to make notes on possible counter proposals.

Another experience the author had in the area of contract administration dealt with actually trying to have a contract put in place. The In-Core Nuclear Fuels Group had arranged for a training session to be given by a consulting firm on the use of some special pressure drop routines added to SIMULATE-E. As the time for the training approached, the contract had not been signed by the necessary people at GSU and the consulting firm. The author contacted both parties to find out what was causing the problems in putting the contract in place. The problem turned out to be an indemnity clause which GSU put in all of their contracts but which the consulting firm claimed did not apply in this situation. GSU would not sign without it, and the consulting firm would not sign with it. Up to the point where the author began working on the problem all correspondence had been by letter, and no oral communication had taken place between GSU and the consulting firm. After contacting both responsible parties, the author explained both sides to both parties and then suggested they speak to each other directly. The problem was solved shortly afterward when the consulting firm agreed to sign the contract with the indemnity clause intact, and the contract was put in place.[16] In this case the author acted more as a mediator than an administrator. It would also seem to be a small problem to solve, but these types of problems hold up a great deal of work in many companies. Since returning to Texas A&M University, the author has completed a course in Labor Relations in which mediation techniques were a major portion of the course. The author believes that these mediation skills will be useful in the future.

V.C. Budgeting Activities

Preparing budget requests may be considered more an art than a science by some. It is true that it takes some insight and a great deal of experience in order to prepare a truly accurate budget request. The author had the opportunity to assist in preparing a budget request for the In-Core Nuclear Fuels Group. This particular budget request encompassed only three years. Even then, predicting expenses and needs three years in the future is very difficult, especially in the River Bend Nuclear Group where organizational changes are expected to occur when River Bend goes on-line. Even though budget requests span more than one year, they are submitted every year. This allows for long range planning by upper management and for revisions to requests for future years when needs are more accurately known. In preparing a budget request everything must be considered. The preparer must forecast salaries, including salaries for new employees added to the group and for future Doctoral Interns. The budget request must also account for the portions of salaries for employees of support groups that may be dedicated to your group, such as a programmer from Computer Applications. Office equipment and supplies must also be considered. This includes office furniture, workstation furniture, and any supplies that the group uses down to the last details like pens and pencils or printer and typewriter ribbons. The budget request must include provisions for the addition of any special equipment such as computer terminals, printers, microfiche viewers, and other such equipment. Any books and publications that are needed or anticipated must also be included in the budget request.

There are some common problems that occur in conjunction with budget requests. Many managers will pad their budget requests in anticipation of cuts. In this manner the manager will get what he believes he really needs. As a result of this type of budget request strategy, cuts to budget requests are common because the firm's budget manager expects padded budget requests. Another problem occurs at the end of the fiscal period. If there is any money left in the budget at the end of the period, managers fear that the excess will result in a smaller budget allowance for the next period and to avoid this will spend the excess budget allowance at the end of the period on equipment or supplies that are not needed. These two types of problems are common at many companies; however, at GSU in the In-Core Nuclear Fuels Group the budget request that the author assisted on was not intentionally padded. It was also the author's experience that the surplus budget allowance was not needlessly spent at the end of the fiscal period. The author therefore feels that he assisted in preparing a proper budget request for the In-Core Nuclear Fuels Group at GSU.

V.D. Summary

Engineers must be more than just technically competent, they must be able to understand the world of business and be able to communicate with non-engineers. Since technological advances are usually implemented through business and industry, education of engineers in subjects relating to these worlds is necessary; indeed, education in these subjects is critical if engineers are to become successful leaders in industry and society. In recognition of this, the author devised the business related internship objectives listed as contract management objectives on his internship proposal. In the preceding section the author discussed his experience in the area of contract management. The experience included both economic and technical support of the fuel fabrication contract as well as participation in the negotiation function of the management of this contract. This experience specifically satisfied the author's contract management objectives. In addition to experiencing contract administration and negotiation in connection with the fuel fabrication contract, the author performed a mediating function in connection with a computer code training contract. Although this experience was not specifically contract management, the author considers the experience a valuable asset.

In addition to discussing his contract management experience, the author discussed his experience in assisting in the preparation of the In-Core Nuclear Fuels Group budget request. Preparing budget requests is a major function of any management position, and although this was not a part of the author's internship objectives, the author considers this experience valuable. Experience of the type discussed in this section is a critical part of the author's professional development and will help him further his career in the future.

VI. GENERAL EXPERIENCE

VI.A. Introduction

The following section is a discussion of what one might call miscellaneous experience. This is experience that the author feels is worthy of mention because something of value was gained, yet the experience itself was not a major portion of the internship. Much of what the author learned through this miscellaneous experience can be discussed in the classroom, but the true meaning does not sink in until the student has actually experienced the idea or the situation. In the following section the author will discuss his experience concerning quality assurance, a meeting with a safety review committee, the generation of economic data, a training course on the use of a computer program, various business trips, the making of presentations, and the Louisiana Nuclear Society. As mentioned earlier, the author considers this experience an important part of his internship.

VI.B. Quality Assurance Support

Quality assurance (QA) is a relatively new addition to the general public's vocabulary of "buzz words", and many people do not really know what QA is. In fact, for many the only reason they have heard of QA is that it was the reason company X had so many problems with the NRC in building their nuclear power plant. Many people may not realize that QA is not exclusive to the nuclear industry. There are also those who think that QA is the same thing as quality control (QC). Briefly, QC is the act of making sure quality is maintained or controlled, and QA is the program that assures that QC is carried out. Granted this may be an abstract difference, but it is an important difference. The requirements of the QA program necessary for nuclear utilities are laid out in Appendix B of Title 10 of the Code of Federal Regulations Part 50 (10 CFR 50).

Gulf States Utilities has an extensive QA program that has been praised by the NRC. This is one of the reasons that River Bend has had very few problems during construction and will have very few problems during operation. One of the functions of GSU's QA department is performing QA audits of vendors in which GSU travels to the vendor, inspects the vendor's QA program, and makes sure the program is being followed by reviewing documentation of QC activities. While the author was employed at GSU, the QA department requested support in performing a QA audit of GE's Nuclear Fuel Engineering Department (NFED). Logically, a member of the Nuclear Fuels Group was chosen to help the QA department; the author was given this opportunity to broaden his experience. As it turned out, the audit team was short-handed and the author became an auditor instead of just support for the audit team. The author then began an immediate and intense training period in preparation for the QA audit. The author was given the specific tack of auditing the Design Control function of GE's QA program in their Nuclear Fuels Engineering Department. Design Control encompasses such areas as design reviews, engineering change control, independent design verification, and engineering computer programs. Other areas that the author reviewed in connection with the Design Control function were reload licensing and licensing documentation because these areas are a part of the design process. Before embarking on the audit trip the author had to prepare an audit check list. The check list is a list of specific procedures from the vendor QA procedures that will actually be checked and verified by the auditor. The check lists that the author prepared for this audit may be seen in Appendix B. These check lists serve as the auditor's method of documenting compliance or violation of specific procedures. In preparing his check lists the author studied criterion III of Appendix B of 10 CFR 50, GE's Engineering Operating Procedures (EOPs) which are GE's QA procedures in the NFED, and previous check lists prepared by other GSU auditors of the Design Control function at various vendor departments. One point the author had to pay particular attention to was violations documented in previous audits. Procedures that were violated are generally checked at all subsequent audits.

The QA audit is a very important function to both GSU and GE and is treated as such. This is one time when all of the author's questions were answered without hesitation, unlike when the author was trying to gather data for core analysis. The importance of a proper QA program cannot be overemphasized. Most of the electric utility industry's problems with the construction of nuclear power plants seem to stem from QA program deficiencies. In reading newspapers and news magazines, the author noticed that it is the QA program that is most often attacked by anti-nuclear groups and interveners. The QA program is also an area of special interest to the NRC. A specific example of what effect a below standard QA program can have is that of the Zimmer nuclear power plant. This power plant was ninety-seven percent complete when it was converted to a coal-fired power plant. It was said that the biggest reason for the conversion was that the owner of the plant felt it would not be able to obtain an operating license without a lot of additional requalification work because of its poor QA program. A study for the owner stated it would be less expensive to convert the plant to coal than to perform all the reinspections and requalification work that would be necessary to obtain an operating license for the nuclear plant.[17] It is interesting to note that the plant was still "safe" enough to use as a coal-fired power plant.[17] The result of the conversion was a very expensive coal-fired power plant. The utility customers will now have to pay for the nuclear plant without having the benefits in terms of reliability and lower fuel costs. This example is an excellent illustration of the importance of the QA program.

VI.C. Other Experiences Worth Mention

VI.C.1. Safety Review Committee

Gulf States Utilities Company has instituted the use of a Safety Review Committee as an independent review of the technical abilities of the River Bend Nuclear Group engineers. This committee is comprised of professors from several universities who have expertise in all areas of concern. The Safety Review Committee periodically reviews the River Bend Nuclear Group's technical competence by having the various departments make presentations to them and by asking questions during these presentations. The In-Core Nuclear Fuels Group made a presentation to the Safety Review Committee on January 25, 1984 concerning the fuel design and the group's core analysis capabilities. The fuel design portion of the presentation included both mechanical and nuclear considerations. The author participated in the presentation as technical support; when questions were asked dealing with the area of core analysis, these questions were referred to the author. The author answered questions ranging from general information about GSU's core model to specific details about the results of GSU's analyses as of that date. The author was also called upon to explain why some of the results of GSU's analyses differed from those of GE. This experience served to partially fulfill the author's professional objectives of his internship and also helped the author to learn to work under direct pressure.

VI.C.2 FUELCOSTIV Input Data Generation

As stated in an earlier section, the author performed economic analyses of various scenarios using a computer code called FUELCOSTIV. The main input affecting the results of this code is the fuel cost set. This is a data set containing predicted costs of fabricated fuel as a function of the year the fuel is put into service. In performing his economic evaluations of GE proposals during the fuel fabrication contract negotiations the author generated several different cost sets to use in FUELCOSTIV. These cost sets were based on different assumptions about fabrication cost, capacity factor, cash flow times, interest rates, and other factors affecting the final cost of the fuel to GSU's customers. The calculation of cost sets required the author to make assumptions about future interest rates and to evaluate the trend of certain labor statistics used to escalate fuel components costs. As a result of this task, the author became increasingly aware of the time value of money and the real difference it can make in the real world. This task also helped the author to fulfill one of his internship objectives: to learn the philosophy behind the successful management of company resources and assets.

VI.C.3. Training in the Use of SIMULATE-2

During his internship the author attended two week-long training sessions on the use of SIMULATE-2. This training has proven to be of great value to the author for two reasons. First, the author learned a great deal about SIMULATE-2 in a short period. This knowledge was also applied to the use of SIMULATE-E when GSU obtained that version of SIMULATE. The training also gave the author insight into how the code was developed, what assumptions were made, and how they affected the input the code required. The knowledge made the author more aware of input needs of all codes and how these needs are influenced by assumptions used in developing the code. Secondly, since the training was given by major a consultant who had a great deal of contact with other utilities, the training gave the author insight into how other utilities were performing their calculations: what assumptions were being made, what was considered important and what was considered negligible. This type of information coupled with the author's educational background gave the author the ability to build a good core model for GSU to use in core analysis. This experience helped the author to satisfy his in-core fuel management internship objectives.

VI.C.4. Business Trips

The author had the opportunity to make several business trips for various purposes. Of these, three are worthy of mention here. The first was a trip to Washington D.C. to visit Pickard, Lowe, and Garrick to test their scoping code, HUDDLE. During this trip the author learned how to work with others under unusual circumstances. The author also had to maintain an objective point of view in evaluating HUDDLE, even though he was surrounded by people trying to sell this code to him. The second trip worthy of mention was a trip to San Jose, California to an EPRI computer code user's group conference. This trip was by far the most productive and helped the author to fulfill one of his professional objectives: to participate in professional activities. At the conference, utilities gave presentations about how they did their analyses, and during breaks and after hours individuals exchanged information. These types of meetings give analysts and engineers a chance to ask each other questions and get answers to questions concerning particular problems they had with their codes. Since this meeting was at EPRI, the author also had a chance to speak with the code developers and get answers to questions about certain code peculiarities. The third trip worthy of mention was the QA audit trip. This trip was important because the author was performing a vital support function and was a representative of the In-Core Nuclear Fuels Group. The author learned two things that apply to all business trips. The first is that while on a business trip, the engineer is a representative of his company at all times; this includes after hours. The second is that important professional contacts are made during business trips, and these contacts can be good sources of information.

VI.C.5. Presentations

Communication skills are of major importance for any professional, and engineers are no different. During his internship the author made a few small presentations to the members of In-Core Nuclear Fuels, and, even then, the author felt he was not as effective at communicating as he should have been. The author's lack of effectiveness in making presentations was not due to a lack of knowledge of the subject; it was due to lack of knowledge of effective communication techniques. Since returning to Texas A&M University, the author has completed a speech communication course in technical speaking and has found this course to be among his most interesting and valuable non-technical courses. The author learned about the importance of factors other than knowledge of one's subject in presenting material. As a result of this course the author now feels he can effectively make presentations and communicate the necessary information. The reason this subject was worthy of mention here is that communication skills is an area where engineers in general seem to be deficient. The author recommends that all engineers complete a course in effective communication before beginning their careers.

VI.C.6. Louisiana Nuclear Society

Membership in professional societies is encouraged by most companies and is of real value to the engineer. Attending professional society meetings is one way the engineer can stay up with current developments. The author became a member of the Louisiana Nuclear Society (LNS) and attended all meetings while in Louisiana. The LNS met once every two months and always had a speaker. The meetings were usually very interesting, and the author made several professional contacts at these meetings. The author joined a group of volunteers who took a day off from work to speak to high school students about commercial nuclear power. This was to satisfy the author's civic internship objective, but unfortunately the author had not been asked to give a talk before the end of his internship. Although on a smaller scale, professional society meetings also perform a similar function to computer code user's group meetings.

VI.D. Summary

In this section the author discussed experience that was worthy of mention because something of value was gained, yet the experience itself was not a major portion of the author's internship. The greater portion of the preceding discussion was concerned with the importance of a QA program and the author's QA experience. This was an indication of the importance of QA programs in the nuclear industry. The author also discussed his experience with the Safety Review Committee at GSU and his role in In-Core Nuclear Fuels' presentation to the committee. The author noted that this experience served to partially satisfy the professional objective of his internship. The use of a nuclear fuel accounting code called FUELCOSTIV was another experience the author felt worthy of mention. This experience made the author more aware of the time value of money, and also helped the author to learn more about the philosophy behind successful management of company resources and assets by forcing the author to evaluate proposals from a strictly economic point of view before assessing the technical merits. The next experience mentioned was that of training in the use of SIMULATE-2. The importance of this experience lay in the amount and type of information that was obtained other than that information explicitly presented during the training. The training also helped the author obtain his in-core fuel management objectives. The author's experience with business trips taught him the importance of communication between engineers belonging to different organizations and at the same time helped to fulfill one of the author's professional objectives. The experience also taught the author that he was a representative of his organization at all times while on a business trip. Finally, business trips create professional contacts for the engineer to make use of in solving problems. The importance of effective communication techniques was instilled in the author during his experience with presentations. This experience also partially fulfilled the author's professional objectives of his internship. Last, the author discussed the importance of professional societies in terms of keeping up with new developments and making professional contacts.

While it might be argued that any one of the experiences discussed in this section is not of great importance, the knowledge that the author gained from the combined experience is of great value. This knowledge will enable the author to more effectively use his expertise in the technical areas of his career by giving him an understanding of how to communicate effectively and how to solve problems in the real world.

VII. CONCLUSION

VII.A. The Doctor of Engineering Program

The Doctor of Engineering Program is designed to prepare individuals for professional engineering activities in industry and the public sector. The program emphasizes engineering practice instead of research, and the internship is one of the ways that engineering practice is emphasized. The internship has two general objectives:

1. to enable the student to demonstrate and enhance his or her abilities to apply both knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization or industry in which the internship is served, and

2. to enable the student to function in a non-academic environment in a position in which he or she will become aware of the employer's approach to problems, in addition to those approaches of traditional engineering design or analysis.

In order to fulfill these objectives, the author in cooperation with his internship supervisor developed a set of specific internship objectives. These specific internship objectives were designed to satisfy the requirements of the Doctor of Engineering Program and to provide professional experience that was of value to both the author and GSU. The objectives were divided into four categories: internship objectives (the general objectives stated above), in-core fuel management objectives, contract management objectives, and civic and professional objectives. GSU also provided a synopsis of the proposed work plan for the author. The remainder of this section is devoted to explaining how each of the internship objectives were met by the author's experience. The author also discusses the proposed work plan and makes some concluding remarks and recommendations about his internship and the Doctor of Engineering Program.

VII.B. Achievement of Internship Objectives

VII.B.1 In-Core Fuel Management Objectives

There were three in-core fuel management objectives, the first of which was to learn to use and understand industry fuel management computer codes. The author's experience concerning this objective is discussed in sections II and III of this report. These sections detail the author's work in steady state core analysis and his use of several industry codes in performing such analyses. The author also completed an investigation of industry fuel cycle scoping codes and made a recommendation to GSU concerning the choice of such a code. Details of this investigation may be found in section IV of this report. The author's experience in these areas certainly fulfill the first in-core fuel management objective.

The second in-core fuel management objective was to learn to evaluate the need for, operation of, and costs of using a computer code for analyses. Again, the author's experience as discussed in sections II, III, and IV completely fulfilled this objective. The evaluation of computer codes was learned during the fuel cycle scoping code investigation, and the other parts of the objective were learned during all aspects of steady state core analysis.

Finally, the third in-core management objective was to learn the philosophy behind successful management of company resources and assets; specifically management of nuclear fuel for the River Bend nuclear reactor. This particular objective was very broad and required the whole of the author's internship experience to satisfy. The largest contributions to the fulfillment of this objective came from the author's contract management experience with other economic evaluations and the fuel cycle scoping code investigation coming second and third, respectively. Overall, the in-core fuel management objectives were the most thoroughly satisfied internship objectives; however, this was expected because of the author's assignment to the In-Core Nuclear Fuels Group.

VII.B.2 Contract Management Objectives

There were two contract management objectives included on the author's internship proposal. The first of these was to learn to perform the necessary economic and technical analyses required to support contract administration and negotiation. The second objective in this area was to learn to perform contract administration and evaluation through participation in this function of the In-Core Nuclear Fuels Group. These two objectives were actually two parts of one activity. In satisfying one of them the author also satisfied the other. Learning to perform contract administration and evaluation by participation required the author to perform the necessary economic and technical evaluations. In performing these evaluations the author learned how and thus fulfilled the first objective while working to satisfy the second objective. The author's experience concerning contract management is discussed in section V of this report.

VII.B.3 Civic and Professional Objectives

Again there were two objectives in this area. The first was to address civic or professional organizations on subjects which would illustrate the author's expertise, and which would increase the appreciation of the engineering profession. The author made presentations to the In-Core Nuclear Fuels Group. The author also addressed the Safety Review Committee when specific questions about core analysis were raised; between these two activities the author partially fulfilled the objective of addressing professional organizations. The author says partially because the organization addressed was the same organization of which he was a part. While the objective specifically stated "civic or professional", the author tried to do both. As mentioned in section VI, the author volunteered to speak to high school students; however, the opportunity to do so did not arise before the author returned to Texas A&M University to complete his degree program.

The second objective in this area was to participate in professional activities such as state and national engineering societies. The author was a member of the Louisiana Nuclear Society while he was in Louisiana and attended all LNS meetings. In addition, the author's trip to an EPRI sponsored computer code user's conference was also in agreement with this objective. The author therefore concludes that these internship objective were fulfilled.

VII.B.4 Synopsis of Proposed Work Plan

The synopsis of the proposed work plan that was attached to the author's internship proposal was only proposed and thus subject to change according to the needs of GSU. As submitted, the work plan had five tasks for the author. Briefly these were: develop and test a computer program for fuel cycle scoping analysis; use a fuel cycle scoping program to perform studies on River Bend cycle length, coastdown and variation in capacity factor; generate input and run the CASMO computer program for River Bend 1 Cycle 1 Control Cell Core fuel lattice types; benchmark CASMO and GSU lattice physics methods against Quad Cities gamma scans; and perform technical and economic analyses as required in support of fuel fabrication contract administration.

Addressing these tasks one at a time, the first task evolved from the development of a program to the fuel cycle scoping code investigation that was discussed in section IV. The second task was never performed as GSU did not yet have a fuel cycle scoping code by the end of the author's internship. Third, the calculation of lattice physics for the new Control Cell Core was performed, although the results report was not completed before the author finished his internship. The fourth task was not done and as the author understands, is yet to be done. This task has been postponed until after River Bend is operating. The last task, that of performing economic and technical analyses in support of fuel fabrication contract administration was performed on a continuous basis by the author throughout his internship.

VII.B.5 Concluding Remarks

In this report the author has discussed in detail his experience during his internship in the In-Core Nuclear Fuels Group at GSU. Aside from simply recounting his experience, the author has also remarked on the knowledge he gained from each of his experiences and discussed the value of this knowledge. In-Core Nuclear Fuels afforded the author the opportunity to experience a broad mixture of tasks requiring the use of both technical and non-technical skills to complete. The author's internship supervisor, James E. Booker, and immediate supervisor, Lynn A. Leatherwood, worked closely with the author to be sure that all requirements of the Doctor of Engineering Program were satisfied and that the type of experience that the author was obtaining was indeed the type of experience the author both needed and wanted. Based on this review of his experience, the author now concludes that his internship objectives were satisfactorily achieved and the requirements of the Doctor of Engineering Program were satisfied.

VII.C. The Doctor of Engineering Program in Review

At this point the author would like to make some recommendations concerning the Doctor of Engineering Program. First, obtaining an internship is not an easy task; many companies are reluctant to hire an engineer whom they know is only going to stay one year. However, the author has found that once exposed to the program, most companies wish to continue providing internships. The difficulty of obtaining an internship may be one of the reasons that the program has not gained wider acceptance among engineering graduate students. The author feels that the university should provide some assistance to the student in his search for an internship. Maintaining contact with those companies that have been exposed to the program and want to continue providing internships is an obvious way to assist the student. Secondly, the author feels that the internship should be taken earlier in the student's degree program. Currently, the student is urged to begin his internship only after completing ninety percent of his course work; however, this precludes taking advantage of what the author believes is one of the major benefits of the internship. During the internship the student can find out areas where more course work is needed or areas of new interest. Upon returning to the university the student can then change his degree program to meet these new needs and interests. If the student is nearly finished with his course work, this advantage is lost unless the student extends the time he must stay at the university. The author feels that if these changes are made, the Doctor of Engineering Program will be improved.

REFERENCES

1. "Doctor of Engineering Program Manual," College of Engineering, Texas A&M University, p.5. (1985).

2. "Gulf States Utilities Company 1983 Annual Report," Gulf States Utilities Company, Beaumont, Texas, p.i. (Feb. 1984).

3. M. Edenius and A. Ahlin, "MICBURN: Microscopic Burnup in Gadolinia Fuel Pins," Computer Code User's Manual, Electric Power Research Institute, San Jose, California, p.7-3-3 (Sept. 1975).

4. A. Ahlin, M. Edenius, and H. Haggblom, "CASMO: A Fuel Assembly Burnup Program," Computer Code User's Manual, Studsvik Energiteknik AB, Studsvik, Sweden, p.3-6 (June 1978).

5. L. A. Leatherwood, T. W. Laub, T. W. Oliphant, C. C. Roberts Jr., and D. C. Albright, "River Bend Unit 1 Cycle 1 Core Model: MICBURN Input Preparation and Results Report," Gulf States Utilities Company, St. Francisville, Louisiana, pp.30-39 (June 1984).

6. ibid. p.3.

7. D. M. Ver Planck, W. R. Cobb, R. S. Borland, and P. L. Versteegen, "SIMULATE-E: A Nodal Core Analysis Program for Light Water Reactors," Computer Code User's Manual, Electric Power Research Institute, San Jose, California, p.1-1 (March 1983).

8. A. Ancona, M. Becker, M.D. Beg, D.R. Harris, A. Dac. Menzes, D.M. Ver Planck and E. Pilat, "Nodal Coupling by Response Matrix Principles," Nuclear Science and Engineering, **64**, pp.405-417 (1977).

9. op. cit. "MICBURN: Microscopic Burnup in Gadolinia Fuel Pins." p.7-2-1

10. C. C. Roberts Jr.,Gulf States Utlitites Company, Private Communication (1983).

11. R. M. Johnson, Pacific Gas and Electric Company, Private Communication (1983).

12. R.K. Haling (GE Company, Atomic Power Equipment Department), "Operating Strategy For Maintaining An Optimum Power Distribution Throughout Life," American Nuclear Society Topical Meeting on Nuclear Performance in Reactor Cores, San Francisco, CA (Sept. 1963).

13. L. A. Leatherwood, Gulf States Utilities Company , Private Communication (1985).

14. L. A. Leatherwood, R. M. Johnson, T. W. Laub, and C. C. Roberts Jr., "River Bend Station Unit 1 Cycle 1 Core Model Standard Core Design Preliminary Results Report," Gulf States Utilities Company, St. Francisville, Louisiana, p.92 (1983).

15. ibid. p.156.

16. L. A. Leatherwood, Gulf States Utilities Company, Private Communication (1985).

17. G. Brooks, "Utilities' Plan to Switch Zimmer Plant From Nuclear to Coal Raises Questions," Wall Street Journal, CCIII, p.3 (Jan. 23, 1984).

APPENDIX A

INTERNSHIP OBJECTIVES

GULF STATES UTILITIES COMPANY

June 10, 1983

Dr. R. R. Hart
Department of Nuclear Engineering
Texas A & M University
College Station, TX 77843

Dear Dr. Hart:

As per your request, please find attached a copy of my resume and the signed proposal for the Doctor of Engineering Internship for Thomas W. Laub.

I would be pleased to serve as Mr. Laub's Internship Supervisor and will certainly support any of the activities that are required of me at Texas A & M University. If I can be of any assistance, please do not hesitate to call.

Very truly yours,

J. E. Booker

J. E. Booker
Manager-Engineering,
Nuclear Fuels & Licensing
River Bend Nuclear Group

Attachment

PROPOSAL FOR THE DOCTOR OF ENGINEERING INTERNSHIP FOR THOMAS W. LAUB

INTRODUCTION

The internship will be fulfilled as Doctoral Intern, Incore Fuels for the River Bend Nuclear Group of Gulf States Utilities Company, St. Francisville, Louisiana. A list of proposed projects is attached. Mr. Laub will report directly to Mr. Lynn A. Leatherwood for organizational purposes, however, his Internship Supervisor will be Mr. James E. Booker, Manager, Engineering, Licensing, and Nuclear Fuels. Mr. Booker's resume is also attached.

INTERNSHIP OBJECTIVES

The overall objectives of the internship are as outlined in the Doctor of Engineering manual. These are:

1. to enable Mr. Laub to demonstrate his ability to apply his knowledge and technical training by making an identifiable engineering contribution in an area of practical concern to Gulf States Utilities Company, and

2. to enable Mr. Laub to function in a non-academic environment in a position where he will become aware of the organizational approach to a problem.

INCORE FUEL MANAGEMENT OBJECTIVES

Some of the incore fuel management objectives to be accomplished are:

1. Learn to use and understand industry fuel management computer codes.

2. Learn to evaluate the need for, operation of, and costs of using a computer code for analyses.

3. Learn the philosophy behind successful management of company resources and assets; specifically, management of nuclear fuel for the River Bend Unit 1 nuclear reactor.

CONTRACT MANAGEMENT OBJECTIVES

Some of the contract management objectives to be accomplished are:

1. Learn to perform necessary economic and technical analyses required to support contract administration and negotiation.

2. Learn to perform contract administration and evaluation through participation in this function of the incore fuels group.

CIVIC AND PROFESSIONAL OBJECTIVES

Personal, professional, civic and community objectives as a means to develop his total professional growth during the internship include but will not be limited to:

1. Address to civic or professional organizations on subjects which will illustrate his expertise, and which will increase the appreciation of the engineering profession.

2. Participate in professional activities such as state and national engineering societies.

REPORT OF THE INTERNSHIP

The final objective of the internship is to prepare a Professional Internship Report which will summarize Mr. Laub's experience and document the work performed. The report will establish that the objectives of the internship have been fulfilled. The report will also satisfy the requirements of the College of Engineering with regard to format, mechanics, and submission of file copies.

The duration of the internship will be a twelve month period beginning in June 1983 and ending in June 1984.

Respectfully Submitted,

T. W. Laub

THOMAS W. LAUB

APPROVED BY:

R. R. Hart
Dr. R. R. Hart, Co-chairman
Student's Advisory Committee

Robert S. Wick
Dr. R. S. Wick, Co-chairman
Student's Advisory Committee

Carl A. Erdman
Dr. C. A. Edman, NE
Department Head

David Dubofsky
Dr. D. A. Dubofsky, FIN
Committee Member

RR ~~Dr. J. D. Randall, NE~~
~~Committee Member~~

Gerald A. Schlapper
Dr. G. A. Schlapper, NE
Committee Member

G. C. Useltan
Dr. G. C. Useiton, FIN

D. T. Phillips
Dr. D. T. Phillips, I. Engr. (GCR)

L. A. Leatherwood
Mr. L. A. Leatherwood,
Supervisor, Incore Fuels

J. E. Booker
Mr. J. E. Booker, Manager,
Engineering, Licensing, and
Nuclear Fuels; Internship
Supervisor

Doctorial Internship

Synopsis of Work Plan

Depending on available resources, the following type of assignments will be given. Concentration is expected in either or both of the first 2 Projects.

1. Develop and test a computer program for fuel cycle scoping analysis based on linear reactivity model. Product - software, a user's manual and sample cases.

2. Use a fuel cycle scoping program to perform studies on River Bend cycle length, coastdown and variation in capacity factor. Results would be used in a fuelcost program by Mr. Laub or a permanent employee for evaluation and recommendation. Product - reports of results; GSU Planning would use fuelcost numbers for various capacity factor assumptions.

3. Generate input and run CASMO computer program for River Bend 1 Cycle 1 Control Cell Core fuel lattice types. Product - input preparation report, output results report, and data for use in modeling the core.

4. Gather data, generate input and run CASMO computer program for benchmarking GSU lattice physics methods against Quad Cities gamma scans. Product - input preparation report, output results report, and data for subsequent use in SIMULATE computer program for GSU methods verification.

5. Perform technical and economic analyses as required in support of fuel fabrication contract administration. Product - reports of results.

HJG/gj

JAMES E. BOOKER
GULF STATES UTILITIES COMPANY
BEAUMONT, TEXAS 77704
409/839-2181

EDUCATION

Lamar University- Beaumont, Texas Bachelor of Science Degrees, May, 1956	Industrial Engineering and Mechanical Engineering

EXPERIENCE

Employed by Gulf States Utilities Company in Beaumont, Texas, in June, 1956.

June, 1956 - August, 1962	Six years' experience in the System Engineering Department involved in design and construction of transmission lines and substations, major electrical equipment and requirements, specifications and construction budgeting.
August, 1962 - January, 1971	System Power Plant Production Department- various positions such as result engineer conducting performance tests on gas-oil fired power plants, maintenance planning and scheduling, and staff engineer to production manager coordinating operations, maintenance and personnel requirements for six operating fossil power plants.
January, 1971 - March, 1972	Supervisor of Administrative Services in charge of corporate Records Department, duplicating, microfilming, telephone services, stenographic services, library and mailroom facilities.
March, 1972 - Present	Various involvements in GSU nuclear program as outlined below:
March, 1972 - September, 1972	Six months in the Quality Assurance (QA) Department as QA coordinator.
September, 1972 - November, 1977	In charge of licensing activities of two nuclear power plants--River Bend Project and Blue Hills.
November, 1977 - December, 1978	In charge of licensing for River Bend Project and environmental licensing of fossil power plants.
December, 1978 - December, 1979	Project Manager for River Bend Project in charge of Project Engineering, Nuclear Licensing, and Administrative Services.

December, 1979 - May, 1980	Manager of Technical Programs in charge of Nuclear Licensing, Emergency Planning, Out-of-Core Fuels, and Project Engineering.
May, 1980 - October, 1982	Manager of Technical Programs in charge of Nuclear Licensing, Emergency Planning, and Out-of-Core Fuels.
October, 1982 - Present	Manager in charge of Engineering, Nuclear Fuels, Nuclear Licensing, and Emergency Planning.

MEMBERSHIPS

Registered Professional Engineer - Texas
American Nuclear Society
The American Society of Mechanical Engineers
Atomic Industrial Forum, Inc.
  Committee on Reactor Licensing & Safety
  Committee on Environmental Projects
Edison Electric Institute (EEI)
  Prime Movers Committee on Nuclear Power

6-07-83

APPENDIX B

QA AUDIT CHECK LISTS

PAGE 1 OF 4 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 40-3.00 DATE ____ AUDITORS T. W. Laub

SUBJECT Engineering Computer Programs

NO.	REQUIREMENTS	SAT	UNSAT	OBJECTIVE EVIDENCE/COMMENTS
1.	The Control Component maintains a file of all computer programs classified as ECPs. View this list and select several ECPs for further investigation. The ECPs selected should include: (1) a lattice physics code, (2) a 3-D core simulator, (3) a fuel scoping code, and (4) a transient analysis code. (Control Components are: (1) Core and Fuel Technology, NFED J. E. Wood, and (2) Advanced Electronic Engineering, NC&ID G. G. Obrien)			

PAGE 2 OF 4 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 40-3.00 DATE AUDITORS T. W. Laub

SUBJECT Engineering Computer Program

NO.	REQUIREMENTS	SAT	UNSAT	OBJECTIVE EVIDENCE/COMMENTS
2.	Engineering Computer Program documentation contained within the Design Record File shall include or shall reference at least the following items: A. Software Management Plan, B. Hardware/Software System Specification, C. Software Design Specification, D. Software Requirements Specification, E. Software Test Report, F. Independent Design Verification Packet, G. Code listing, and H. User's Manual. If any of items C through F are only referenced in the DRF, request to see them for each of the ECPs selected above. Be sure to check that materials properties encoded into the program or identified as critical input values have been classified as either: a) Compliant with the BWR Fuel or Plant Materials Properties Handbook, or b) Authorized as noncompliant, or c) not applicable to the BWR Fuel or Plant Materials Properties Handbook.			

PAGE 3 OF 4 AUDIT NO. GSU CRS-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EGP 40-3.00 DATE AUDITORS T. W. Laub

SUBJECT Engineering Computer Programs

NO.	REQUIREMENTS	SAT	UNSAT	OBJECTIVE EVIDENCE/COMMENTS
3.	The Responsible Engineer will document ECP changes authorized by the Control Component and assure that any change to a level 2, 2R, or 3 ECP that results in new values of calculated output, which have been used as part of the technical basis for product design, licensing, or operation, is programmed and identified as a new version of the ECP.			
4.	The Responsible Engineer will specify, for all ECPs not executed on computing systems administered by NEBO Computations Section, the method to be used to confirm that no changes occur in the ECP after level 2 is assigned. This should be part of the Level 2 Design Review. (The method may be administrative control of the ECP software or execution and comparison of output from previously defined test cases.)			

PAGE 4 OF 4 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 40-3.00 DATE AUDITORS T. W. Laub

SUBJECT Engineering Computer Programs

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
5.	The Responsible Engineer will identify to the applicable Control Component, errors and proposed corrective action within 30 days after identification of the error.			
6.	For each application of an ECP executed through an external computational service bureau, it will be confirmed that the ECP has not changed since it was originally qualified, verified, and assigned Level 2 status.			

PAGE 1 OF 2 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
1.	The responsible Engineer in performing verification will: a. Determine and document the scope and method of verification to be used to confirm that the design meets its specified requirements or the requirements of its application. For an application of a design in which design requirements are less stringent than a previously verified application of the design, it is necessary to verify only that the previous requirements apply. (Review examples of these.) b. Select a Verifier who qualifies by knowledge and experience to verify the design or design change. (Review evidence of this.)			

PAGE 2 OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE ______ AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
	c. Select a Verifier who is not the responsible engineer's technical supervisor unless the supervisor is the only technically qualified person available. Document and sign justification for selecting the supervisor as Verifier, obtain approval signature of the supervisor's manager, and file the justification in the appropriate DRF before verification is performed. (Review examples of these.)			
	d. Select a Verifier who is not the responsible engineer's subordinate when the responsible engineer is a manager or technical leader directly responsible for the design or design change, unless the subordinate is the only qualified person available and if so justification must be given as above. (Review examples of these.)			

PAGE 3 OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
	e. Provide a design verification packet to the Verifier which is to include: (1) the documented scope and method of verification including specification of necessary additional checking of documents, and (2) identification of the design requirements including a list of input documents. (Review examples of these packets.)			
2.	When verification is deferred until after design document issue, the Responsible Engineer will state on the ERM/ECN issuing or applying the document or on the Design Verification Status Change Notice: a. That verification is deferred. b. The reason for deferral. c. A schedule for performing verification. d. The DRF reference if applicable. e. The signature of the Responsible Engineer's section manager authorizing deferral. (Review examples of these ERM/ECNs.)			

PAGE 4 OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	UNSAT	OBJECTIVE EVIDENCE/COMMENTS
3.	When deferred verification is completed, the Responsible Engineer will notify Engineering Services 1 by processing a DVSCN form that identifies the verified documents, DRF containing verification, completion date, and distribution identical to that of the issued document. (Review examples of these DVSCNs.)			
4.	When additional verification is required after document issue or application, the Responsible Engineer will advise Engineering Services 1 to revise the verification status of the document to "unverified" by processing a DVSCN as above. (Review examples of these DVSCNs.)			

PAGE ______ OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE ______ AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	UNSAT	OBJECTIVE EVIDENCE/COMMENTS
5.	When verification is by testing, the Responsible Engineer will: a. Ensure that the test program includes requirements for testing under specified design conditions. When testing overall design, all pertinent operating modes will be considered. When testing a specific design feature, other features may be verified by other means. (Review examples of testing program.) b. Document modifications required by testing to obtain acceptable performance and retest the design or otherwise verify satisfactory performance. (Review examples of modification documentation.)			

PAGE 6 OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
6.	The Responsible Engineer will verify differences in design between new parts and original parts when new parts are of a modified or different design. (Review examples of verifications.)			
7.	The Responsible Engineer will ensure that the document authorizing a disposition of deviation contains the verification statement required for the deviation or references the DRF that contains the verification statement. (Review examples of documents and verification statements.)			

PAGE 7 OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE ______ AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	UNSAT	OBJECTIVE EVIDENCE/COMMENTS
8.	When design data is sent to others in a noncontrolled transmittal, the Responsible Engineer will ensure that the verification status of the transmittal is indicated. (Review examples of transmittals.)			
9.	The Verifier will: a. Upon receipt of the verification package, perform the indicated verification in scope a method specified and assure that the design satisfies its requirements or the proposed application of the design is correct. If the Verifier judges the scope and method of verification inadequate, the Verifier will renegotiate them with the Responsible Engineer. (Review examples of renegotiation.)			

PAGE 8 OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA 111 REFERENCE EOP 42-6.00 DATE ______ AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
	b. When the design is verified, sign a verification statement that includes: 1. Identification of the design or design application verified or both. 2. Description of the verification performed, including scope and method. 3. Statement of design adequacy made by the Verifier from results of the verification. 4. The name of the verifier and date of verification. (Review example verification statements.)			
10.	Engineering Services 1 will notify Engineering Services 2 to track completion of deferred verifications and additional verification requirements. . . (Review notices.) . . . and forward DVSCNs to Engineering Services 3. (Review proof of forwarding if possible.)			

PAGE 9 OF 9 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 42-6.00 DATE AUDITORS T. W. Laub

SUBJECT Independent Design Verification

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
11.	Engineering Services 2 will provide periodic reports on overdue additional verifications and overdue deferred verifications to the Responsible Engineer's section manager. (Review examples of reports.)			

PAGE 1 OF 5 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 55-2.00 DATE ______ AUDITORS T. W. Laub

SUBJECT Engineering Change Control

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
1.	The originator requests a change to an engineering controlled document by initiating an Engineering Change Authorization (ECA) or a Engineering Change Notice (ECN). (Review examples of ECAs and ECNs.)			
2.	The Responsible Engineer: a. Evaluates the economic and technical impact of the proposed change and develops appropriate change documentation. (Review examples of change documentation.)			

PAGE 2 OF 5 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 55-2.00 DATE AUDITORS T. W. Laub

SUBJECT Engineering Change Control

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
	b. Identifies the reason for the type, category, and priority of the proposed change. (Review examples of these documents.)			
	c. Identifies each requisition project affected by the change. (Review examples of lists.)			
	d. Resolves comments received or escalates the problem to management for resolution. (Review examples of resolution or escalation.)			

PAGE 3 OF 5 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 55-2.00 DATE ______ AUDITORS T. W. Laub

SUBJECT Engineering Change Control

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
	e. When change is Category I, obtains a copy of the approved project initiated work authorization and submits it to Engineering Services 1 for CCB review. (Category I changes require CCB approval - see appendix B of EOP.) (Review examples of CCB approval.)			
3.	Engineering Services 1 will: a. Issue ECA following receipt of appropriate approvals by imprinting the change control issue stamp and issue date. (Review examples of issued ECAs.)			

PAGE 4 OF 5 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 55-2.00 DATE AUDITORS T. W. Laub

SUBJECT Engineering Change Control

NO.	REQUIREMENTS	SAT	UNSAT	OBJECTIVE EVIDENCE/COMMENTS
	b. In the event of the cancellation of an ECA or Category I ECN approved by one or more project managers, obtain a reason for cancellation from the Responsible Engineer and forward it and the first sheet of the cancelled ECA or ECN to each project manager who approved the change. (Review examples of these notices.)			
	c. Prepare technical internal sheet corrections to ECNs by obtaining the ECN from Engineering Services 5 and requesting a correcting ECN from Engineering Services 2, document traceability of the correcting ECN, and submit ECNs to Engineering Services 5 for microfilming. (Review examples of process.)			

PAGE 5 OF 5 AUDIT NO. GSU GES-11/83 GULF STATES UTILITIES - AUDIT CHECKLIST

CRITERIA III REFERENCE EOP 55-2.00 DATE AUDITORS T. W. Laub

SUBJECT Engineering Change Control

NO.	REQUIREMENTS	SAT	INSAT	OBJECTIVE EVIDENCE/COMMENTS
4.	Procurement will provide complete and timely estimates of costs for proposed changes, including engineering, hardware, tooling, field costs, operation, maintenance, logistics, and schedule changes. (Review examples of these documents.)			

APPENDIX C

INTERNSHIP ACTIVITY REPORTS

MEMORANDUM

TO L. A. Leatherwood — February 23, 1983

FROM T. W. Laub — ICF-M-83-14

Monthly Activities Report
Doctoral Intern
February, 1983
River Bend Station Unit 1

Summary

A general orientation and familiarization of myself with the GSU River Bend Station buildings, personnel, and procedures comprised much of the first week and periodically throughout the month of February. This is expected to continue on a limited basis for the near future.

The major portion of February was spent becoming familiar with the fuel fabrication contract and reviewing fuel scoping theory as well as available fuel scoping codes. In connection with the study of available fuel scoping codes, a trip to meet with Mike Schwartz of Pickard, Lowe, and Garrick, Inc., in Washington D. C. was arranged for Thursday and Friday, March third and fourth. Some trips down to the site and into the Unit 1 buildings were made to view the various components and buildings.

Description of Activities in Support of Project

General

1. Reported for work on February 1, 1983 and began the check-in and orientation procedures.

2. Attended a half-day indoctrination program on February 8, 1983.

Fabrication

1. Read article III.B. of the fuel fabrication contract and all articles, sections, and appendices referred to concerning contract work control procedures.

2. Went over response from GE on establishing contract work control procedures with Supervisor Lynn Leatherwood.

Core Analysis

1. Reviewed and studied fuel scoping theory contained in materials provided by Randy Johnson and Lynn Leatherwood.

2. Reviewed information on available fuel scoping codes and their alternative uses.

3. Arranged trip to meet with Mike Schwartz of Pickard, Lowe, and Garrick, Inc., in Washington D. C. to spend two days becoming familiar with the HUDDLE fuel scoping code, its use and usefulness.

Forecast of Activities for Next Reporting Period

1. Continue to review fuel scoping theory.

2. Continue to review available fuel scoping codes.

3. Travel to Washington D. C. to meet with Mike Schwartz of Pickard, Lowe, and Garrick, Inc.

4. Analyze usefulness of HUDDLE and compare its accuracy against GE CASSANDRA results.

T. W. Laub

Thomas W. Laub
Doctoral Intern, Incore Nuclear Fuels

TWL/gf

cc: J. E. Barry

MEMORANDUM

TO L. A. Leatherwood — March 28, 1983

FROM T. W. Laub — ICF-M-83-25

Monthly Activities Report
Doctoral Intern
March, 1983
River Bend Station Unit 1

Summary

The activities of the month of March dealt almost entirely with the review of fuel scoping codes available to GSU and further exercises using the linear reactivity method (LRM) in an attempt to develop some useful hand calculation procedures. I attended several meetings during the month dealing with general employee information, document control, and interfaces and responsibilities of incore fuels and plant staff. In connection with fuel scoping codes, I made a trip to Washington, D. C. to meet with Mike Schwartz of Pickard, Lowe, and Garrick to receive a short training session on the HUDDLE fuel scoping code. Actual River Bend Unit One cases were used as input during this HUDDLE demonstration and later a comparison of HUDDLE results against those of GE was performed.

Description of Activities in Support of Project

General

1. Attended employee information meetings on March 7, 10, and 14.

2. Attended a document control seminar on March 10.

3. Attended interface and responsibilities meeting with plant staff on March 25.

4. Gave a short oral report to John Barry about the Washington, D. C. trip and the HUDDLE fuel scoping code on March 17.

Core Analysis

1. Spoke with Erin Heinlein of GE about additional information on River Bend Unit 1 Case 818.15 to be used as HUDDLE input.

Core Analysis - Continued

2. Traveled to Washington, D. C. on March 2, 3, and 4 and met with Mike Schwartz of Pickard, Lowe, and Garrick to discuss the HUDDLE fuel scoping code.

3. Compared HUDDLE results with those received from GE as part of the fuel contract.

4. Reviewed the EPRI fuel scoping code REFUEL manual.

5. Received and reviewed the Scanpower fuel management code manuals for FALC and FCS-II.

6. Continued to work on the LRM to try and develop useful hand calculation procedures.

7. Reviewed the FLACM fuel scoping code report and manual.

Trips Taken

1. Traveled to Washington, D. C. and met with Mike Schwartz of Pickard, Lowe, and Garrick on March 2, 3, and 4.

2. Traveled to the Grand Gulf Nuclear Station and met with Charles Tyrone of Mississippi Power and Light for a tour of the plant on March 15.

T. W. Laub
Thomas W. Laub
Doctoral Intern, Incore
Nuclear Fuels

TWL/gf

cc: J. E. Barry

MEMORANDUM

TO L. A. Leatherwood April 26, 1983

FROM T. W. Laub ICF-M-83-33

Monthly Activities Report
Doctoral Intern
April 1983
River Bend Station Unit 1

Summary

Most of April was spent learning about the Scanpower fuel scoping codes FALC and FCS-II. As anticipated, input preparation has proved to be the major portion of this work. H. K. Naess, the author of the codes, was contacted about some confusing problems with the code manuals and has agreed to come to River Bend to answer questions and clarify the language of the code manuals. H. K. Naess will do this on April 28 and GSU will not be charged for his visit. Along these same lines, UCC came to River Bend on April 8 and gave a one day seminar on how to run codes on the UCC system and how to use the UCC system editor.

I traveled to Texas A&M University on two occasions, April 11-12 and April 20, and successfully completed the qualifying examinations required to continue with my internship. Incore fuels traveled to Beaumont on April 18 and 19 and L. A. Leatherwood gave a presentation to Engineering on the mechanical and nuclear design of the fuel as well as the nuclear fuel cycle.

Description of Activities in Support of Project

General

1. Traveled to Texas A&M University on April 11-12 and 20 and successfully completed the Doctor of Engineering qualifying examinations.

2. Supported L. A. Leatherwood in the preparation of a presentation on the mechanical and nuclear design of the fuel and the nuclear fuel cycle.

3. Studied IBM system 370 JCL as well as CICS and SPF. This is necessary to be able to use the GSU computer.

Core Analysis

1. Worked on the preparation of input for the FALC and FCS-II fuel scoping codes.

2. Contacted H. K. Naess about the use of FALC and FCS-II and set up a meeting with him at River Bend to discuss the two codes.

3. Attended seminar by UCC at River Bend to learn how to run codes on their system and how to use their editor.

4. Met with CAD while in Beaumont on April 19 to discuss present and future support needs.

Trips Taken

1. Traveled to Beaumont to attend a presentation given by L. A. Leatherwood to Engineering about the mechanical and nuclear design of the fuel and the nuclear fuel cycle.

Forecast of Activities for the Next Reporting Period

1. Continue working on the FALC and FCS-II fuel scoping codes.

2. Continue working on the linear reactivity method to develop some useful hand calculations.

3. Continue JCL, SPF, and other computing necessities.

4. Contact other utilities to find out what is being done about fuel scoping including which codes are being used and in what way.

T. W. Laub
Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Barry

MEMORANDUM

TO L. A. Leatherwood   May 25, 1983

FROM T. W. Laub   ICF-M-83-41

Monthly Activities Report
Doctoral Intern
May, 1983
River Bend Station Unit 1

Summary

Hans K. Naess of SCANDPOWER came to River Bend Station on April 28,1983 and gave a one day familiarization/training seminar on the fuel scoping codes FACL and FCS-II as well as the whole FMS system. Preparation of input for FALC began immediately following the seminar. Results of the SIMULATE and FUELCOSTIV computer codes is being used to derive some of the FALC input parameters for correlations and cost calculations.

T. Laub attended two meetings with GE in Beaumont during this month. The first meeting was held on May 13 and was a presentation of the new GE fuel designs. These include GE7 (extended burnup), Barrier fuel, and GE8 (high energy cycles). The second meeting took place on May 24 and concerned the fuel fabrication contract. Negotiations on several issues began at this meeting. These issues were delay of unit one initial core delivery, unit one initial core and reload upgrades (Control Cell Core, Barrier fuel, GE7), delay of unit two cash flows until the final decision on unit two is made, and regulatory changes charges.

Description of Activities in Support of Project

General

1. Studied new GE fuel designs in preparation for GE presentation on May 13.

2. Reviewed STS markup 1.0-1 and made comments to L. Leatherwood.

3. Began to develop a region of applicability as presented by GE on May 13 for River Bend Unit 1.

Fabrication

1. Performed economic analyses for River Bend Units 1 and 2 in preparation for GE fabrication contract negotiations.

Core Analysis

1. Investigated the enrichment/discharge burnup parameter of the LRM.

2. Gave a brief presentation on FALC and FCS-II to R. Johnson and L. Leatherwood on April 27, 1983.

3. Ran FUELCOSTIV to determine some FALC cost input data.

4. Used SIMULATE results to determine region-wise power/void correlation parameters for FALC input.

5. Began deriving power sharing coefficients from SIMULATE results for input to FALC.

6. Began collapsing the 5 region model input data for FALC into 3 region model data.

7. Began to read the SIMULATE-2 code manual in preparation for the upcoming training.

Meetings and Trips Taken in Support of Project

1. April 28, 1983, Incore Fuels attended a one day seminar by Hans K. Naess of SCANDPOWER concerning FALC and FCS-II familiarization.

2. May 13, Incore Fuels attended a presentation by GE in Beaumont on new GE fuel designs.

3. May 24, T. Laub attended a meeting with GE in Beaumont concerning fuel fabrication contract negotiations.

Forecast of Activities for the Next Reporting Period

1. Continue FALC and FCS-II investigation.
2. Continue working on LRM.
3. Contact other utilities with regard to scoping.
4. Perform economic and technical analyses as required in support of the fabrication contract negotiations.
5. Attend SIMULATE training scheduled for the week June 20-24.
6. Begin formal internship by enrolling at Texas A&M in the engineering 684 course.

T. W. Laub
Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Barry
R. M. Johnson

MEMORANDUM

TO L. A. Leatherwood — June 27, 1983

FROM T. W. Laub — ICF-M-83-55

Monthly Activities Report
Doctoral Intern
June, 1983
River Bend Station Unit 1

Summary

During the first half of the month of June the major activity was economic evaluation of GE6B (barrier fuel) and the various payment deferral options offered by GE during the fuel fabrication contract negotiations held on May 24, 1983. The FUELCOST IV computer code was used extensively in performing the necessary calculations. Through the use of the FUELCOST IV it was discovered that a recent modification to the code still had a small problem. The problem has been identified and a solution devised.

Dr. Antonio Ancona came to River Bend Station to give a one week training session on the use of SIMULATE, a 3-D nodal core simulator code. The training and preparation for the training comprised the remainder of the June activities. During the training, experience was also gained in the use of the CASMO and NORGE codes. These codes are necessary to prepare input for SIMULATE.

Description of Activities in Support of Project

General

1. Completed internship proposal and it has been submitted for approval.

2. Discovered a problem with a recent modification to FUELCOST IV having to do with edit options. A temporary solution has been devised pending a permanent change to the code by CAD.

Fabrication

1. Performed economic evaluations of GE6B using several different assumptions about discount rate and worth of the fuel in terms of capacity factor savings.

2. Performed economic evaluation of deferring Unit 2 payments until December 31, 1985.

3. Developed a fuel fabrication cost set for the 18 month cycle physics data GE818I24 to be used in FUELCOST IV.

Core Analysis

1. Worked with CASMO output to determine cross section dependencies needed in NORGE. This was in preparation for the SIMULATE training.

2. Studied the SIMULATE, SIMULATE-2, and SIMULATE-E user manuals in preparation for the SIMULATE training.

Meetings and Trips Taken in Support of Project

1. Attended a one week training session at River Bend Station on the use of the SIMULATE code. The training was given by Dr. Antonio Ancona during the week of June 20-24 and also included use of CASMO and NORGE.

Forecast of Activities for the Next Reporting Period

1. Perform CASMO runs required to develop a cold core model in SIMULATE.

2. Attend continued SIMULATE training scheduled for the week July 25-29.

3. Continue economic evaluations of GE proposals as necessary in support of the fuel fabrication contract negotiations.

4. Continue work on LRM.

T. W. Laub

Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Barry
J. E. Booker
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood — July 28, 1983

FROM T. W. Laub — ICF-M-83-61

Monthly Activities Report
Doctoral Intern
July, 1983
River Bend Station Unit 1

Summary

The activities of the month of July were split between SIMULATE model development of fuel fabrication contract negotiation support. Fuel fabrication contract negotiation support centered on analysis of GE's regulatory change proposal and cash flows associated with barrier fuel and extended burnup fuel (GE7). These analyses were used in developing GSU counter proposals to GE for the contract negotiation meetings held July 26 and 27.

SIMULATE model development activities included CASMO cold branch cases, CASMO zero exposure hot branch cases, and NORGE cases for all of these. A general review of all SIMULATE input was performed and improvements were made when possible. One such improvement was the development of a power/flow correlation for the hydraulic regions of SIMULATE. Near the end of the month of July several SIMULATE test cases were run and additional input improvements were being developed from the results of these runs.

Description of Activities in Support of Project

General

1. Reviewed the first revision of section 1.0 of the Technical Specifications.

2. Reviewed some new information sent to Incore Fuels by Scandpower.

Fabrication

1. Performed analyses of the GE regulatory change proposal. Emphasis was placed on comparisons with past proposals with respect to consistency and cost basis breakdowns.

2. Developed a set of incremental cash flows associated with the acceptance of the regulatory changes proposal, barrier fuel, and extended burnup fuel (GE7).

Core Analysis

1. Developed input for and performed CASMO cold branch cases to obtain the necessary cross sections for a SIMULATE cold model.

2. Performed CASMO zero exposure hot branch cases and added these to existing hot branch cases.

3. Performed all necessary NORGE runs to prepare CASMO results for use in SIMULATE.

4. Worked on the linear reactivity model in connection with GE's region of applicability to try and develop regions of applicability for River Bend Unit 1.

5. Reviewed past work of FALC/FCS-II input in light of present work on SIMULATE input.

6. Developed and improved SIMULATE input and began running several test cases. From these cases some reactivity coefficient estimates were developed and input to SIMULATE for future criticality searches.

Forecast of Activities for the Next Reporting Period

1. Continue support of fuel fabrication contract negotiations.

2. Continue development of hot SIMULATE core model and further development of cold SIMULATE core model.

3. Continue work on LRM.

4. Document procedures and methods used with CASMO, NORGE, and SIMULATE cold and hot model development.

T. W. Laub

Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood — August 26, 1983

FROM T. W. Laub — ICF-M-83-70

Monthly Activities Report
Doctoral Intern
August, 1983
River Bend Station Unit 1

Summary

The activities of the month of August dealt almost entirely with development of the SIMULATE core models, both hot and cold. Emphasis was on documenting the assumptions and methods employed to generate the input data being used on the hot SIMULATE core model. The documentation began with thermal hydraulic inputs and fuel characteristics and will continue into the month of September. Documentation of CASMO and NORGE input and output manipulation necessary to produce cold model cross sections is also planned.

Fuel fabrication contract negotiation continued in August and support of these negotiations continued with cash flow analyses performed on a tentative compromise. Negotiations are continuing with a final resolution expected soon.

Description of Activities in Support of Project

Fabrication

1. Predicted cash flows associated with the tentative compromise reached with GE during fuel fabrication contract negotiations.

Core Analysis

1. Documented methods and assumptions employed in generating SIMULATE hot model input data. Specifically these were thermal hydraulic and fuel characteristic data.

2. Several SIMULATE cases were run using the various options and results of these cases were used to determine areas of needed input data improvement.

Meetings and Trips Taken

1. Tim Howe and Greg Dischler of Engineering Analysis came to River Bend and met with Incore Fuels to discuss the SIMULATE/RETRAN interface.

Forecast of Activities for the Next Reporting Period

1. Continue documentation of SIMULATE input data generation.

2. Continue development of SIMULATE cold core model.

3. Continue support of fuel fabrication contract negotiations.

4. Attend second SIMULATE training seminar scheduled for the week of September 19-23.

T. W. Laub

Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood — September 26, 1983

FROM T. W. Laub — ICF-M-83-94

Monthly Activities Report
Doctoral Intern
September, 1983
River Bend Station Unit 1

Summary

Documentation of methods and data employed in generating SIMULATE hot model input was completed this month and a cold model was developed. Documentation of cold model input data is planned for the future along with documentation of the necessary CASMO and NORGE input and output manipulation necessary to produce the cold model cross sections.

On September 19, 1983, Dr. Antonio Ancona of UAI came to River Bend to give a one week SIMULATE training seminar. This was a continuation of the SIMULATE training received the week of June 20, 1983. The training included instruction in methods for Control Cell Core reload design as well as standard core designs.

Description of Activities in Support of Project

Fabrication

1. Investigated the documentation of required regulatory changes sent by GE as part of the fuel fabrication contract proposal.

Core Analysis

1. Documented methods and assumptions employed in generating SIMULATE hot model input data.

2. Attended a one week SIMULATE training seminar at River Bend given by Dr. Antonio Ancona the week of September 19, 1983.

3. Developed a SIMULATE cold model and used this model during the SIMULATE training mentioned above.

Meetings and Trips Taken

1. On September 8, 1983, Randy Johnson, Claude Roberts, Tom Oliphant, and Tom Laub met to discuss SIMULATE input and the use of the computer codes MICBURN, CASMO, NORGE, and SIMULATE.

Forecast of Activities for the Next Reporting Period

1. Begin documentation of SIMULATE cold model input preparation.

2. Continue documentation of SIMULATE hot model and update present documentation as per improvements.

3. Continue investigation of GE regulatory changes proposal.

4. Attend WUFMG meeting October 25, 1983, and the ARMP conference October 26 and 27, 1983, in Palo Alto, California.

5. Continue work on fuel scoping with investigation of FALC and FCS-II and/or begin development of Control Cell Core MICBURN, CASMO, NORGE, and SIMULATE input.

T. W. Laub
Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood November 7, 1983

FROM T. W. Laub ICF-M-83-100

Monthly Activities Report
Doctoral Intern
October, 1983
River Bend Station Unit 1

Summary

Documentation of methods and data employed in generating the SIMULATE hot and cold models continued through the month of October. This work is expected to continue through November also. Work began on a River Bend 1 Cycle 1 results report for the standard core design. This work is expected to continue through the month of November and into December.

T. Laub represented Incore Fuels at a Western Utilities Fuel Management Group meeting and also an ARMP Users Group meeting. These meetings were both in Palo Alto, California.

Description of Activities in Support of Project

Core Analysis

1. Input preparation and documentation of both hot and cold SIMULATE models continued through the month of October. This included model improvements and updates resulting from the last SIMULATE training session in September.

2. Work began on a River Bend 1 Cycle 1 results report for the standard core design with cold model calculations of temperature coefficients and strongest rod search.

Meetings and Trips Taken in Support of Project

1. October 25, T. Laub attended Western Utilities Fuel Management Group meeting in Palo Alto, California.

2. October 26-28, T. Laub attended ARMP Users Group meeting in Palo Alto, California.

Forecast of Activities for the Next Reporting Period

1. SIMULATE hot and cold modelling will continue.

2. Work will continue toward a River Bend 1 Cycle 1 results report for the standard core design.

3. T. Laub will represent Incore Fuels in a QA audit of GE San Jose nuclear engineering group October 31 through November 4. T. Laub will be responsible for criterion III of 10CFR50, Appendix B, Design Control.

T. W. Laub

Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood November 23, 1983

FROM T. W. Laub ICF-M-83-110

Monthly Activities Report
Doctoral Intern
November, 1983
River Bend Station Unit 1

Summary

The month of November was almost totally devoted to work on the River Bend 1 Cycle 1 results report. Work on the report included development of calculational procedures for such items as cold shutdown margin, cycle depletions, and hot excess reactivity. This work will continue into December culminating in the River Bend 1 Cycle 1 results report for the standard core design tentatively scheduled to be completed by December 20, 1983.

The first week of November was spent performing a QA audit of the GE Nuclear Fuels Engineering Department at San Jose, California. T. Laub was responsible for auditing procedures specifically intended to meet the requirements of criterion III of 10CFR Part 50, Appendix B, Design Control. The results of the audit are contained in ICF-M-83-101, Trip Report, QA Audit of GE San Jose.

Description of Activities in Support of Project

Core Analysis

1. A River Bend 1 Cycle 1 depletion was performed using the SIMULATE hot model and GE preliminary target rod patterns.

2. Determination of the strongest control rod at several cycle exposures is being performed and will form the basis of the cold shutdown margin calculation upon completion.

Meetings and Trips Taken in Support of Project

1. October 31 - November 4, T. Laub participated in a QA audit of the Nuclear Fuels Engineering Department of GE at San Jose, California.

Forecast of Activities for the Next Reporting Period

1. Work will continue toward a River Bend 1 Cycle 1 results report for the standard core design.

2. Documentation of SIMULATE hot and cold models will continue through the month of December.

T. W. Laub

Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/df

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood December 28, 1983

FROM T. W. Laub ICF-M-83-114

Monthly Activities Report
Doctoral Intern
December, 1983
River Bend Station Unit 1

Summary

The first three weeks of December were totally devoted to work on the River Bend 1 Cycle 1 standard core results report. The report was completed by December 21, 1983 and work began on a proposed addendum to the report. The addendum will concern operation of the reactor after full power life is completed; that is, coastdown using feedwater temperature reductions. The group as a whole also began preparing for the late January 1984 meeting with the GSU technical review committee.

Description of Activities in Support of Project

Core Analysis

1. The River Bend 1 Cycle 1 standard core results report was completed. The report results included strongest rod determination, shutdown margin, hot excess reactivity, Haling depletion, cycle depletion, predicted energy generation, batch average exposures, and thermal limits.

2. Work began on an addendum to the above report to cover the coastdown period following full power operation. This analysis will include the reduction of feedwater temperature to insert positive reactivity. The minimum feedwater temperature will be 250°F.

General

1. The group as a whole began preparing for the late January 1984 meeting with the GSU technical review committee. The preparation will include study and review of fuel design and core modelling code theory and application.

Forecast of Activities for the Next Reporting Period

1. Complete coastdown analysis of River Bend 1 Cycle 1 standard core.

2. Continue preparing for technical review committee meeting.

T. W. Laub

Thomas W. Laub
Doctoral Intern, Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood — January 26, 1984

FROM T. W. Laub — ICF-M-84-13

Monthly Activities Report
Doctoral Intern
January, 1984
River Bend Station Unit 1

The month of January was spent on preparing for the Safety Review Committee meeting on January 25, 1984 and on producing an addendum to the Preliminary Results Report concerning the coastdown operation of River Bend Station Unit 1. Completion of the addendum to the Preliminary Results Report is expected by the week of January 31, 1984. A phone survey of utilities that have been or are being qualified by the NRC to perform reload analyses licensing is in progress. The purpose of this survey is to collect information regarding the process of qualification and any helpful suggestions the utilities may have for Incore Fuels at this stage of our development.

Description of Activities in Support of the Project

Core Analysis

1. Analysis of the coastdown operation of River Bend Station Unit 1 has been performed and results are being compiled. The completed report is expected by the week of January 31, 1984.

2. SIMULATE-E is expected to be operational very soon. Acquisition and collection of data to be used as input to the new FIBWR portion of SIMULATE-E has begun.

General

1. The group as a whole prepared for the January 25, 1984, meeting with the Safety Review Board. The preparation included study and review of fuel design and core modelling code theory and application. The group also gave short presentations on each of the codes used to the rest of the members of Incore Fuels.

Meetings and Trips Taken

1. January 13, 1984, L. Leatherwood, C. Roberts Jr., J. Barry, and T. Laub attended a meeting to discuss the special nuclear materials license application.

2. January 24 and 25, 1984, Incore Fuels travelled to Beaumont, Texas to attend the Safety Review Board meeting. A presentation to the Board was made and questions of the Board were answered.

Forecast of Activities for the Next Reporting Period

1. Complete the addendum to the Preliminary Results Report on the analysis of River Bend Station Unit 1 coastdown.

2. Investigate the purposes of a fuel cycle scoping code and develop requirements of the scoping code to be obtained by GSU.

3. Aid in the preparation of input to MICBURN to begin the development of the Control Cell Core model for River Bend Station Unit 1 Cycle 1.

4. Study the CAROLE code development and obtain an understanding of the requirements and abilities of the code.

T.W. Laub
Thomas W. Laub, Doctoral Intern
Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood February 28, 1984

FROM T. W. Laub ICF-M-84-40

Monthly Activities Report
Doctoral Intern
February, 1984
River Bend Station Unit 1

Summary

Several documents were reviewed including Special Nuclear Materials (SNM) license applications for incore detectors and for onsite fuel storage, and Technical Specifications for River Bend Station Unit 1 Sections 3/4.0, 3/4.1, and 3/4.2. An estimate of Incore Fuels computer requirements for 1984 was delivered to Computer Applications to aid them in their planning and support functions; also Information System Function Evaluations were completed for Computer Applications.

In the area of core analysis, several activities were completed this month. These included the completion and distribution of the River Bend Unit 1 Cycle 1 coastdown analysis. This was an addendum to the River Bend Unit 1 Cycle 1 Preliminary Results Report released earlier. Two other analyses were also performed to produce region averaged control rod worths for use by operations and a new cold shutdown margin (CSDM) curve based and the assumption that all rods were held at notch position 02 (ARN2) instead of all rods in (ARI).

Finally, MICBURN input preparation methodology was developed. The actual preparation of MICBURN input for the new River Bend Unit 1 initial core has begun.

Description of Activities in Support of the Project

General

1. An estimate of Incore Fuels computer requirements for 1984 was prepared for C. R. Whitman of Computer Applications to aid them in their planning and support functions. The estimate encompassed all of the codes and computer services that Incore Fuels would be using in 1984.

General - Continued

2. An Information System Function Evaluation form was completed for each of the code packages and computer applications used by Incore Fuels and returned to the Business Information Plan Team.

3. The SNM license application for incore detectors was reviewed in support of licensing.

4. The SNM license application for onsite fuel storage only was reviewed in support of licensing.

5. The River Bend Unit 1 Cycle 1 Technical Specifications Sections 3/4.0, 3/4.1, and 3/4.2 were reviewed in support of licensing.

6. The administration of several tapes formerly used by R. M. Johnson was taken over. Currently, the data on these tapes is being reviewed to determine which of the tapes need to be retained in permanent records.

Core Analysis

1. The River Bend Unit 1 Cycle 1 coastdown analysis report was completed and distributed as an addendum to the River Bend Unit 1 Cycle 1 Preliminary Results Report. Both of these reports concerned the former standard core design of the River Bend initial core.

2. CASMC thermal expansion methodology was documented as part of the MICBURN input preparation methodology development.

3. T. Laub and C. Roberts Jr. developed MICBURN input preparation methodology and T. Laub assisted C. Roberts Jr. with the development of a computer program to perform MICBURN input preparation and punch MICBURN input files.

4. SIMULATE-2 and SIMULATE-E were run using identical SIMULATE-2 input decks and SIMULATE-2 restart files produced earlier to verify that SIMULATE-E reproduces SIMULATE-2 results. This was verified.

Core Analysis - Continued

5. A CSDM reanalysis was performed using the assumption that all control rods except the strongest control rod were held at notch position 02 instead of at ARI. The same analysis has been requested of GE and results will be compared.

6. In support of operations, an analysis was performed to produce region averaged control rod worths.

7. The requirements of a fuel scoping code were investigated.

Forecast of Activities for the Next Reporting Period

1. Continue investigation of fuel scoping code requirements and current abilities.

2. Continue MICBURN input preparation and aid C. Roberts Jr. in performing necessary MICBURN calculations for the River Bend Unit 1-Cycle 1 initial core.

3. Prepare for the scheduled SIMULATE-E training in late April by gathering the necessary FIBWR input and obtaining the ability to run FIBWR in UCC.

4. Begin CASMO input methodology development.

5. Investigate SIMULATE as a fuel scoping code.

6. Continue reviewing Technical Specifications and SNM License Applications in support of licensing.

T. W. Laub

Thomas W. Laub, Doctoral Intern
Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood — March 26, 1984

FROM T. W. Laub — ICF-M-84-77

Monthly Activities Report
Doctoral Intern
March, 1984
River Bend Station Unit 1

Summary

Technical Specification sections 3/4.3 and 3/4.4 were reviewed and comments returned for consideration. Other documents reviewed included the startup and test LPRM calibration procedure, the startup and test TIP uncertainty calculation procedure, and the final review of the Special Nuclear Materials license application for fuel storage only. Incore Fuels again aided Computer Applications by preparing the necessary input needed to install and test the computer program SIMTRAN-E. SIMTRAN-E is to be used by Engineering Analysis.

In the area of core analysis, MICBURN input methodology development was completed and final River Bend Unit 1 Cycle 1 MICBURN analysis is expected to be completed during the month of April. Work on CASMC input methodology began and will be completed shortly. Scoping analysis continued with the cutting down of SIMULATE and some testing of this new cut-down input deck.

Description of Activities in Support of the Project

General

1. Reviewed Technical Specification sections 3/4.3 and 3/4.4 and submitted comments for consideration.

2. Reviewed startup and test procedures for LPRM calibration and TIP uncertainty calculation and submitted comments for consideration.

3. Reviewed Special Nuclear Materials license application for fuel storage and submitted comments for consideration.

4. Worked in support of Computer Applications and Engineering Analysis by providing necessary input data for the computer program SIMTRAN-E. The data was needed for installation and testing of the code.

Core Analysis

1. Worked with C. C. Roberts Jr. in developing and documenting MICBURN input methodology and data. MICBURN analysis of River Bend Unit 1 Cycle 1 will be completed in early April.

2. Began arrangements with EPRI and UCC to obtain approval to execute the computer program FIBWR on the UCC system. The necessary license agreement has been submitted and all arrangements are expected to be complete in time to run FIBWR during the May SIMULATE-E training session.

3. Continued gathering FIBWR input data and spoke with Ron Cobb of SAI to clarify some FIBWR terminology.

4. Prepared and began testing a cut-down version of a SIMULATE-E input deck in order to investigate the possible use of SIMULATE-E as a fuel scoping code. Preliminary tests are promising.

5. Gathered data and references to complete and revise the River Bend Data Work Sheets (RBDWS). The RBDWS will become the main source of design and analysis information for Incore Fuels.

6. Reviewed the first draft of CASMO input methodology and data and developed execution JCL for CASMO.

Forecast of Activities for the Next Reporting Period

1. Continue investigation of fuel scoping codes and the possible use of SIMULATE-E for this purpose.

2. Complete MICBURN analysis and prepare MICBURN input preparation and results report.

3. Complete CASMO input methodology development and begin CASMO analysis.

4. Continue review of Technical Specifications and Startup Test procedures in support of project.

T. W. Laub

Thomas W. Laub, Doctoral Intern
Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood — April 26, 1984

FROM T. W. Laub — ICF-M-84-103

Monthly Activities Report
Doctoral Intern
April, 1984
River Bend Station Unit 1

Summary

The first part of April was devoted to investigating scoping tools. Testing of the cut-down version of SIMULATE-E continued with emphasis placed on the REFUEL option of the MAGIC subroutine. This option performs fuel shuffling and shuffling pattern optimization with respect to cold shutdown margin. Testing of the Scandpower scoping code FALC also began this month. Some minor difficulties were overcome which in turn gave some insight to the needs of FALC.

Completion of the Control Cell Core MICBURN model was the major activity in April. The execution of all required MICBURN cases is complete. Copies of input, output, and punch files have been made and a request for archiving these data sets has been made. Copies of the same data sets have been submitted for microfiching and Incore Fuels is awaiting the results. Computer graphics of results have been produced and by the end of April the MICBURN Input Preparation and Results Report should be complete.

Description of Activities in Support of the Project

General

1. Spoke with Randy Armentrout of UCC about computing and analysis services which are offered by UCC. Also spoke with Randy about obtaining the JCL necessary ro run FIBWR.

Core Analysis

1. Worked on CASMO input preparation methodology and data acquisition.

2. Continued testing SIMULATE-E as a scoping tool with emphasis on the REFUEL option of MAGIC. The use of this option requires additional input about k-infinity for the fuel types. With this information a shuffling pattern optimization based on maximizing cold shutdown margin can be performed.

Core Analysis - Continued

3. The Scandpower scoping code FALC was tested and testing will continue. Some initial problems were overcome with the help of Tony Wallace of Scandpower. The problems dealt with cross section information required by FALC. This resulted in new insight into the requirements of FALC.

4. The necessary agreement with EPRI to allow the use of FIBWR was completed, a user's manual has been obtained, and Randy Armentrout of UCC is working on getting Incore Fuels the necessary JCL and information to run FIBWR. All information necessary will be obtained before the May SIMULATE-E/FIBWR training session.

5. MICBURN input preparation, execution, and results graphics have been completed. The final report will be completed by the end of April.

6. Updates to the CASMO program have been submitted to CAD and installation is expected soon. These updates have been given top priority.

7. Some errors in the SIMULATE-E FIBWR modifications were identified by EPRI and CAD has already corrected the errors in the version on the GSU system.

Forecast of Activities for the Next Reporting Period

1. Complete investigation of possible fuel cycle scoping codes and prepare a recommendation as to which path Incore Fuels should follow in the fuel cycle scoping area.

2. Complete CASMO input methodology and begin execution of necessary case to produce both a hot and cold model.

3. Attend SIMULATE-E training session the week of May 21.

4. Begin and complete transfer of information regarding core modelling and the use of SIMULATE to perform cycle analyses to Claude Roberts and Dennis Albright.

5. Complete internship with Incore Fuels and return to Texas A&M University to complete Doctor of Engineering Degree.

T. W. Laub

Thomas W. Laub, Doctoral Intern
Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

MEMORANDUM

TO L. A. Leatherwood May 24, 1984

FROM T. W. Laub ICF-M-84-128

Monthly Activities Report
Doctoral Intern
May, 1984
River Bend Station Unit 1

Summary

The month of May has been a very busy month. Major emphasis was placed on CASMO input preparation, FIBWR input preparation, and the completion of fuel cycle scoping code recommendations. It is expected that CASMO input preparation will be complete by May 31, 1984 or shortly thereafter. The preparation of a FIBWR input deck has been completed but has not yet been tested as the necessary JCL to execute FIBWR on UCC is unavailable. Efforts to obtain the proper JCL continue. The investigation of available fuel cycle scoping codes has been completed and recommendations are given in ICF-M-84-118. The end result of the investigation was the recommendation that a sufficiently reduced SIMULATE-E core model be used as a scoping tool for Incore Fuels.

Other activities during May included the testing of the newly updated CASMO code and the newly installed NORGE-B. The NORGE-B code still has some problems with plotting options but as these are unnecessary the code is essentially ready to use. There was also time spent trying to track down problems with the SAI SIMULATE-E training contract. Due to these problems the training session originally scheduled for the week of May 21, 1984 was postponed until details could be worked out.

This will be the final Doctoral Intern Monthly Activities Report.

Description of Activities in Support of the Project

General

1. Transfer of information and files from T. Laub to C. C. Roberts Jr. will be completed by May 31, 1984.

General - Continued

2. Tracked and attempted to speed the resolution of problems concerning the SAI SIMULATE-E training contract. Due to these problems the training session originally scheduled for the week of May 21, 1984 has been postponed until details can be worked out.

3. Prepared the 1984-1986 Incore Fuels budget for review and approval by L. A. Leatherwood.

Core Analysis

1. Completed preparation of one FIBWR stand alone input deck to be used during the SAI SIMULATE-E training session.

2. Worked on obtaining the necessary CDC JCL to execute FIBWR on UCC. Efforts included conversations with Joe Naser of EPRI and several UCC employees in both Houston and Dallas.

3. Completed investigation of fuel cycle scoping codes and recommended the use of a cut down version of SIMULATE-E (see ICF-M-84-118).

4. Put finishing touches on the MICBURN Input Preparation and Results Report early in May.

5. Tested the newly updated CASMO code.

6. Tested the newly installed NORGE-B code. Some problems with plotting options remain but do not affect code performance and NORGE-B is therefore ready for use.

7. Work continued on CASMO input preparation and is expected to be complete by May 31, 1984 or shortly thereafter.

Meetings and Trips Taken in Support of the Project

1. Attended Power Ascension Task Force formation meeting in the Special Services building on May 9, 1984.

Forecast of Activities for the Next Reporting Period

1. This is the final Doctoral Intern Monthly Activities Report for T. W. Laub. The Internship is complete and T. W. Laub will be returning to Texas A&M University June 1, 1984.

T. W. Laub

Thomas W. Laub, Doctoral Intern
Incore Fuels

TWL/gf

cc: J. E. Booker
J. E. Barry
Dr. R. R. Hart

APPENDIX D

INTERNSHIP SUPERVISOR'S REPORT

GULF STATES UTILITIES COMPANY

POST OFFICE BOX 2951 • BEAUMONT TEXAS 77704

AREA CODE 409 838 6631

March 15, 1985

Dr. R. R. Hart
Co-Chairman, Student's
Advisory Committee
Department of Nuclear Engineering
Texas A&M University
College Station, Texas 77843-3133

Subject: Doctor of Engineering Internship
of Mr. Thomas W. Laub

Dear Dr. Hart:

This letter is hereby submitted as a final report on the performance of Mr. Thomas W. Laub during his practicum at Gulf States Utilities Company. Mr. Laub served as Doctoral Intern in the Incore Nuclear Fuels section of the River Bend Nuclear Group from February 1, 1983 to May 31, 1984. His formal internship began June 1, 1983 and ended May 31, 1984. He reported directly to Mr. Lynn A. Leatherwood, Supervisor Incore Fuels, for organizational purposes. However, I served as his Internship Supervisor.

Mr. Laub's performance as a practicing engineer has been excellent. With respect to his major internship objectives, he has definitely made identifiable engineering contributions in an area of practical concern to Gulf States Utilities Company. He has also been exposed to the organizational approach to problems and traditional engineering design and analysis. Mr. Laub has successfully completed every assigned task - short term and long term. He has used good engineering practices and documentation in his work. In our assessment Mr. Laub has suitably accomplished each of the incore fuel management objectives and each of the contract management objectives. He also participated in meetings of the Louisiana section of the American Nuclear Society.

Among his accomplishments, Mr. Laub has performed detailed core analysis of the River Bend reactor using CASMO and SIMULATE-E computer codes. He is a major contributor and co-author of three results reports in this area. He investigated and made recommendations on software to select for use in multi-cycle scoping analysis. He has performed nuclear fuel economic, regulatory and contractual analysis for a major amendment to our nuclear fuel fabrication contract. He has investigated new fuel designs and has participated in an engineering design audit of our fuel vendor. Mr. Laub has developed expertise on our inhouse computer and has participated in the procurement and implementation of new computer codes. Mr. Laub has also performed various administrative duties such as budget preparation and procurement of training services for Incore Fuels group.

In conclusion, we feel that Mr. Laub's internship with Gulf States Utilities Company has been very successful. We appreciate the opportunity of participating, and we hope to participate in this program in the future. Our gratitude goes to Mr. Laub and Texas A&M University.

Very truly yours,

J. E. Booker

J. E. Booker
Manager-Engineering,
Nuclear Fuels & Licensing

Internship Supervisor

JEB/LAL/gf

VITA

Thomas William Laub

1135 Shadeland Drive

Houston, Texas 77043

Birthplace:	Woodbury, New Jersey
Birth date:	March 3, 1958
Parents:	William H. and Josephine S. Laub
Family:	Wife, Julie A. Laub, no children
Education:	Bachelor of Science, Nuclear Engineering (1980) Texas A&M University
	Master of Engineering, Nuclear Engineering (1982) Texas A&M University
Experience:	January 1985 - May 1985 Graduate Teaching Assistant Department of Nuclear Engineering Texas A&M University College Station, Texas 77843
	February 1983 - May 1984 Gulf States Utilities Company Doctoral Intern In-Core Nuclear Fuels Group PO Box 220 St. Francisville, Louisiana 70775
	August 1981 - December 1982 Graduate Assistant Department of Mathematics Texas A&M University College Station, Texas 77843
	August 1980 - May 1981 Graduate Assistant Department of Nuclear Engineering Texas A&M University College Station, Texas 77843