INCREASED RELIABILITY AND REDUCTION IN LONG TERM COST OF OWNERSHIP THROUGH PROPER SPARE ROTOR STORAGE, INSPECTION, DOCUMENTATION, AND TRACKING

by
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ABSTRACT

Recently, a major chemical company put together a project to specifically address the repetitive corrosion problem experienced on the long term storage of critical rotors in a Texas facility. However, as the strategy was being developed to address the corrosion problem, the opportunity to address three other deficient areas presented themselves as well. These areas included the lack of a standardized inspection process, inadequate specific rotor history documentation, and the inability to track individual rotors. The solution was to establish a rotor storage facility and the development of the necessary operating discipline to address each issue. The outcome resulted in increasing the equipment reliability and reducing the long term cost of ownership of the equipment.

INTRODUCTION

For years, there has been a problem with corrosion damage on spare rotors stored for long periods, due to the environment inherent to the Gulf Coast Region. The Dow Chemical Company put together a project to specifically address this problem in Texas Operations. Many different storage methods have been tried in the past to eliminate the corrosion problem. However, none of these methods were very successful and/or cost effective. The ongoing corrosion problem has continued to result in significant cost to repair the damage and reduce the availability of the rotors.

In addition to the corrosion problem, there was also a problem with the lack of a standardized inspection process and maintenance of a detailed history of each individual rotor. This was due to the large number of rotors, long intervals between overhauls, and the continuous change of people involved with the rotors. The insufficient information made it very difficult to determine if all the necessary inspection and repairs had been completed on the rotor to ensure that it was in good operating condition. In addition, it resulted in duplication of inspections and associated costs. Also, the inadequate documentation on the repairs and/or modifications sometimes left potential traps for others that were unaware of the changes that may have required the use of special spare parts or different metallurgy.

Furthermore, there was no means to track which equipment the rotors had operated in and for how many hours. This information is very beneficial when calculating fatigue life and identifying problem rotors and equipment.

Once the above problems were identified, a strategy was developed to address each of these issues. The strategy consisted of three integrated components: first, a climate-controlled vertical rotor storage facility to eliminate the corrosion problem; second, the development of an operating discipline to ensure that all the necessary standardized inspections, repairs, and modifications were completed and properly documented before placing the rotor in the storage facility; lastly, an inventory tracking system that tracks where the specific rotor is, at all times, and how long it has been at a particular location.

STORAGE FACILITY

History

The need for a rotor storage facility was originally identified in 1988. This was because the rotors in the division were stored in various warehouses throughout the division, utilizing a number of different storage methods that included rotor cans, dog houses, wooden boxes, pallets, etc. None of these storage methods proved to be very reliable. As a result of these ineffective storage methods, the corrosion problem was still causing significant damage to the rotors, which resulted in unnecessary costs (Figures 1, 2, and 3).

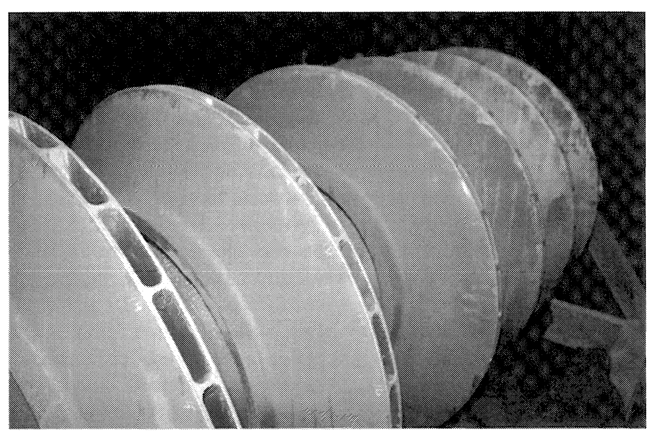

Figure 1. Rotor Stored in a Nitrogen Padded Dog House That Was Supposed to Be in Operating Condition.

Several different storage methods were evaluated to determine if a standard method could be identified that was reliable and cost effective. Part of the analysis included the evaluation of cost factors such as: nitrogen consumption, annual visual inspections,

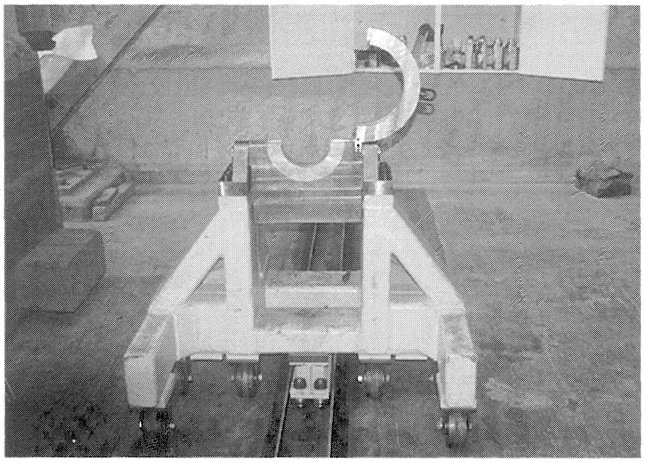

Figure 6. Rolling Support Stand with Pivot Block Assembly Used to Rotate the Rotors from the Horizontal to Vertical Position.

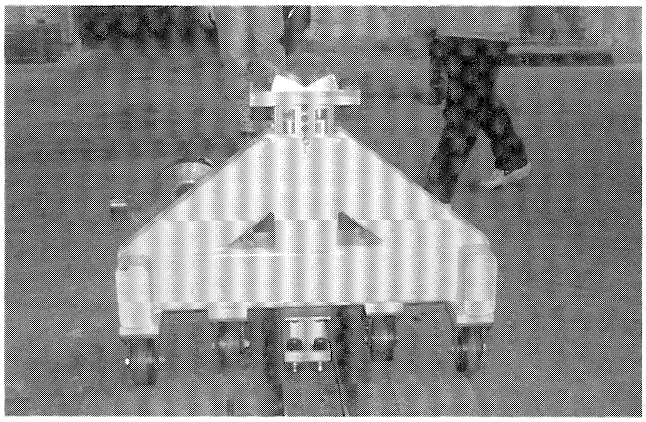

Figure 7. Rolling V-Block Stand Used to Support the Rotor in the Horizontal Position.

geometry to fit the specific shaft end. This allowed for multiple shaft ends to utilize the same pivot block assembly (Figure 8). The main purpose of the pivot bushing was to support the weight of the rotor and to react the axial load of the rotor against one of the shoulders on the shaft end, as it was lifted in the vertical position. This allowed the crane to be attached to the other end of the rotor and lift it straight up as the stand rolled forward, while the crane continued to lift the rotor. Once the rotor is in the vertical position, the rotor could then be lifted through the pivot block or, if it had an integral flange, the pivot block could be removed (Figures 9 and 10).

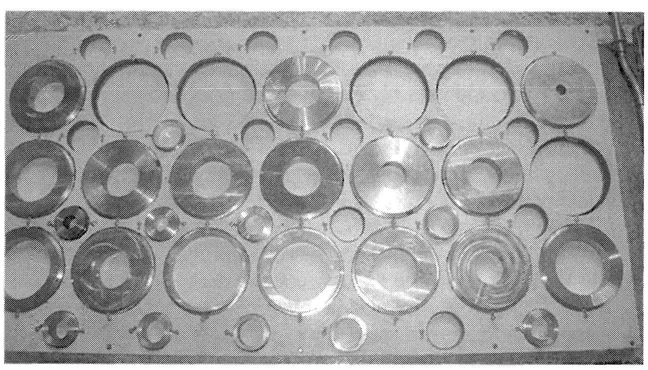

Figure 8. Assortment of Pivot Block Bushings Utilized to Adapt the Various Rotor to the Pivot Block Assembly.

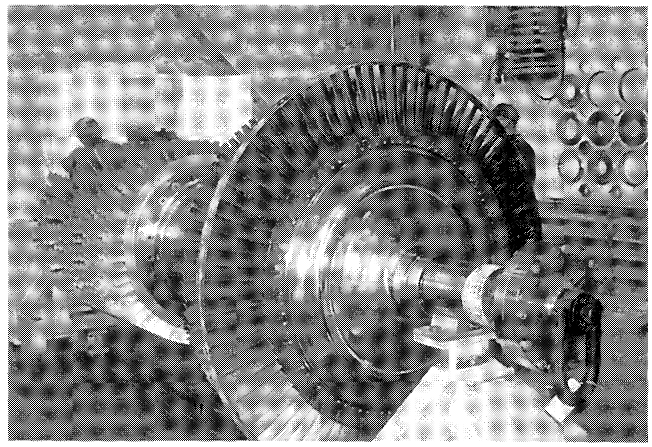

Figure 9. Gas Turbine Rotor Positioned in the Horizontal Position in the Rolling Pivot Block System, Ready to Be Lifted into the Vertical Position.

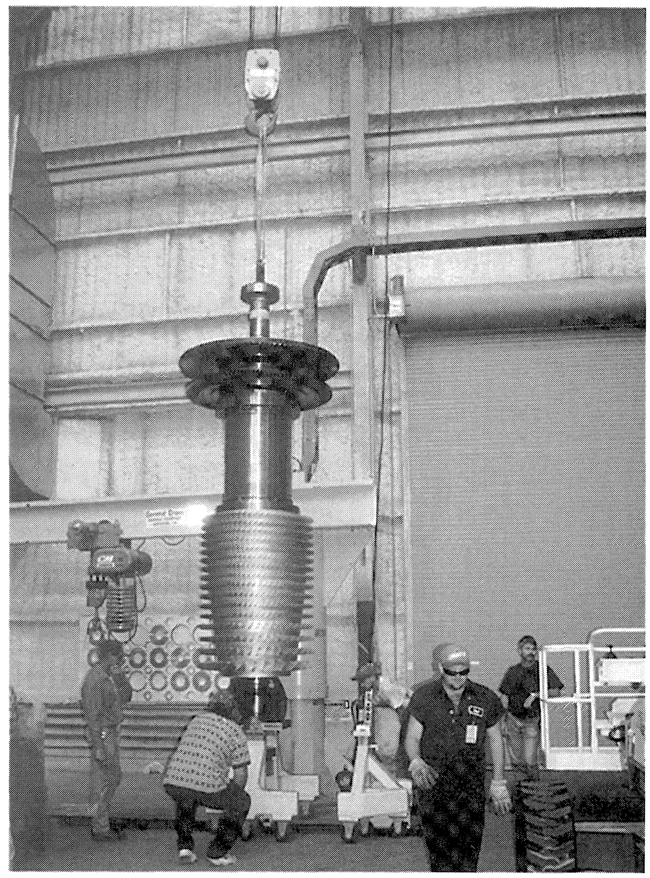

Figure 10. Gas Turbine Rotor Rotated to the Vertical Position and Ready to Be Removed from the Pivot Block Assembly.

To address the second and third step of the process, it was recognized that with the large number of rotors of varying weight and shaft end configurations, that a modular type design would be best suited. This approach would minimize the cost and time required to engineer and acquire the necessary fixturing to hang the rotor in the rotor storage facility. Thus, a standard fixturing package was developed that consisted of a hanger, a hoist ring, and possibly an adapter plate, depending on the shaft end configuration. This fixturing package interfaced with the pivot block system so that the rotor could be moved from the horizontal to the vertical position and allowed it to be attached to the standard storage rack. The description of each device is described as follows:

- *Adapter plate*—A flat metal plate that is attached to the end of the rotor that allows the hoist ring to be threaded into it. Adapter plates are utilized on tapered shaft ends with coupling nuts, and on shaft ends with integral coupling flanges when it is not feasible to drill and tap the shaft end. The rotor adapter plate must be verified for each rotor to ensure it has sufficient capacity to withstand the applied loads.

- *Hoist ring*—A commercially available device that consists of a ring allowed to swivel 360 degrees and pivot 180 degrees, and is threaded into a drilled and tapped hole in the end of the shaft or adapter plate. A hoist ring is required on all rotors and is purchased directly from the approved manufacturer. One of seven different standard hoist ring sizes must be used in order to connect to the rotor hanger. The hoist ring has to be properly selected to ensure that it has sufficient capacity to withstand the applied loads. Also, the threads in the rotor adapter fixture or the shaft end itself have to be evaluated for the applied load as well.

- *Rotor hanger*—The device that attaches to the hoist ring and hooks over the main support I-beam in the storage rack. There are two different sizes of rotor hangers available, dependent upon the weight of the rotor. The correct rotor hanger size is determined by the hoist ring selected for the particular rotor. Standard rotor hangers are required on all rotors and can be acquired from the approved manufacturer.

Three basic shaft end configurations were identified. They were the drilled and tapped shaft end, the integral coupling flange shaft end, and the tapered shaft end with the coupling nut (Figures 11 and 12). Standard design procedures with drawing details were developed for each. The preferred arrangement is the drilled and tapped shaft end, which does not utilize any type of adapter fixture and requires the drilled and tapped hole to be placed in the nondrive end of the rotor, if possible.

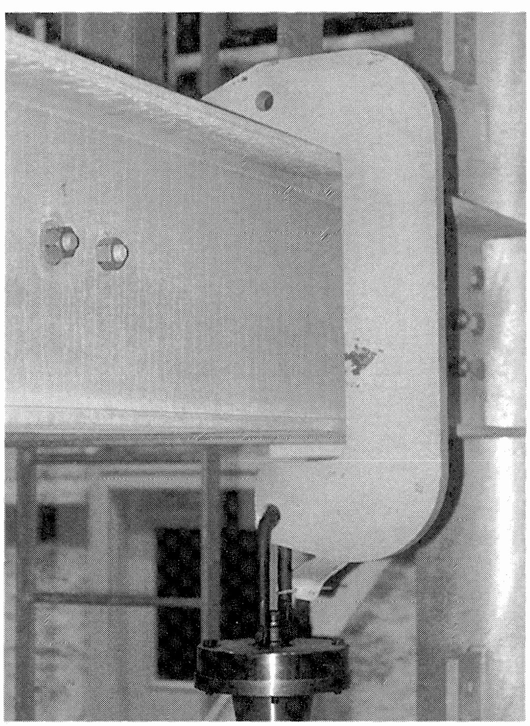

Figure 11. Standardized Fixturing Package for a Rotor That Has an Integral Flange (which includes a rotor hanger, hoist ring, and an adapter plate bolted onto the flange on the rotor).

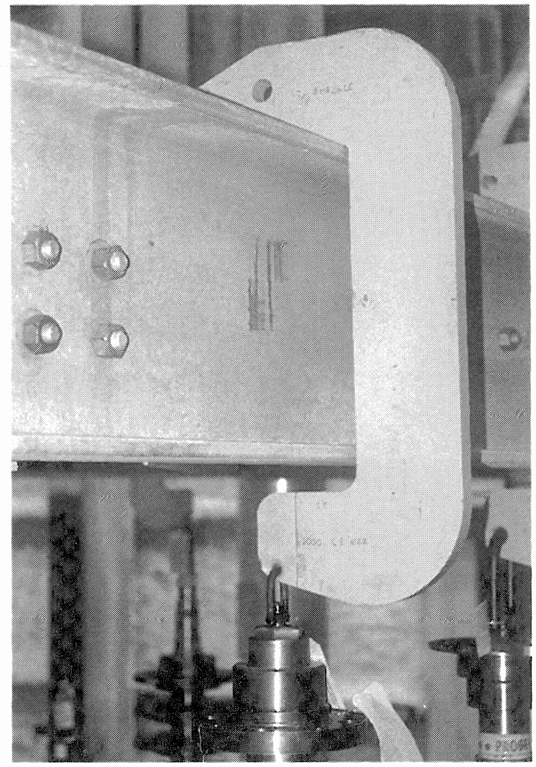

Figure 12. Standardized Fixturing Package for a Rotor That Utilizes the Coupling Nut Threads (which includes a rotor hanger, hoist ring, and an adapter plate threaded onto the coupling nut threads).

Standard design spreadsheets were developed to evaluate the stresses for all three configurations. The design spreadsheet evaluates all the bolted joints utilized, along with the stresses in the rotor due to the lifting arrangement (Figure 13).

Hoist Ring Bolt/Threaded Shaft End - Joint Analysis

Engineer			Date	6/2/98	
Rotor I.D. Number	50991954		Plant	CMP	
Rotor Weight	4,050	Lbs	Tag Number	NC-141	
Hoist Ring Bolt Properties			**Areas**		
Nominal Bolt Diameter	0.63	In	Tensile Stress Area Of Bolt Body	0.31	In^2
Nut Factor	0.12		Tensile Stress Area Of Bolt Threads	0.22	In^2
Bushing Diameter	0.99		Shear Stress Area Of Shaft Threads	0.43	In^2
Grip Length	1.23	In	Compression Stress Area Of Joint	0.47	In^2
Effective Bolt Body Length	0.25	In			
Effective Bolt Length Of Threads	1.50	In	**Stiffnesses**		
Number Of Threads Per Inch	13	TPI	Bolt Stiffness	3.87	MLbs/In
Minimum Outside Diameter Of Threads	0.4876	In	Joint Stiffness	9.24	MLbs/In
Bolt Torque	28	Ft-Lbs	Stiffness Ratio	2.39	
Material Properties			**Loads**		
			Bolt Preload	4,480	Lbs
Yield Tensile Strength	165,570	Psi	Applied Load	1,196	Lbs
Ultimate Tensile Strength	180,000	Psi	Total Bolt Load	5,676	Lbs
Yield Shear Strength	95,500	Psi	Critical Applied Bolt Load	6,358	Lbs
Modulus of Elasticity	30	MPsi			
			Thread Engagement		
			Minimum Required Thread Length	0.38	In
Internal Shaft Thread Properties			Available Thread Length	1.03	In
Maximum Pitch Diameter Of Threads	0.4565	In			
			Bolt Safety Factors		
Material Properties			Bolt Tensile Stress Safety Factor - (3)	6.31	
			Bolt Shear Stress Safety Factor - (3)	7.65	
Yield Tensile Strength	113,850	Psi	Bolt Bearing Stress Safety Factor - (3)	48.84	
Ultimate Tensile Strength	137,000	Psi			
Yield Shear Strength	65,691	Psi	**Bolted Joint Safety Factors**		
Ultimate Shear Strength	112,340	Psi	Shaft Thread Shear Stress Safety Factor - (5)	5	
Modulus of Elasticity	30	MPsi	Shaft Thread Engagement Safety Factor - (1)	2.68	
			Joint Tensile Separation Safety Factor - (1.5)	1.57	

Shaft End - Stress Analysis

Shaft Details			**Shaft End Section Properties**		
Shaft Diameter On Hanging End (D)	5.5	In	Shaft Cross-Sectional Area	23.45	In^2
			Shaft Cross-Sectional Inertia	44.91	In^4
Distances					
End Of Shaft To Location Of Shaft Section (L1)	25	In	**Shaft End Stresses**		
End Of Shaft To Lifting Location (L)	104.9	In	Tensile	173	Psi
			Bending	2865	Psi
			Shear	89	Psi
			Shaft End Safety Factor		
			Shaft Tensile Stress Safety Factor	659.25	
			Shaft Bending Stress Safety Factor	39.74	
			Shaft Shear Stress Safety Factor	738.32	

Figure 13. Standard Spreadsheet for Calculating Stresses and Safety Factors Resulting from the Hanging Process.

Storage Racks

To maximize the rotor storage space, two standard types of storage racks were designed and constructed. The first storage rack design was a two level rack that had an adjustable bottom rack and a fixed top rack. This rack design could support multiple rotor weights up to a maximum total weight of 40,000 lb per I-beam, and lengths up to 13 ft on top and 7 ft on bottom (Figure 14). The other rack design was a single level rack that could support multiple rotor weights up to a maximum total weight of 60,000 lb per I-beam and a length of 21 ft (Figure 15). In addition to being able to support the weight of the rotor, they were also designed to withstand a wind load rating of 150 mph.

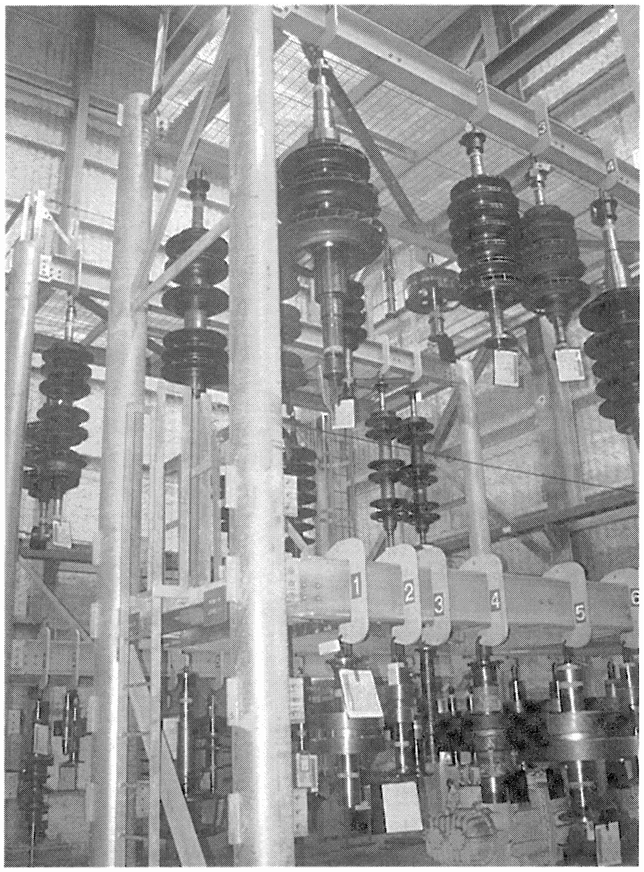

Figure 14. Two Level Storage Rack.

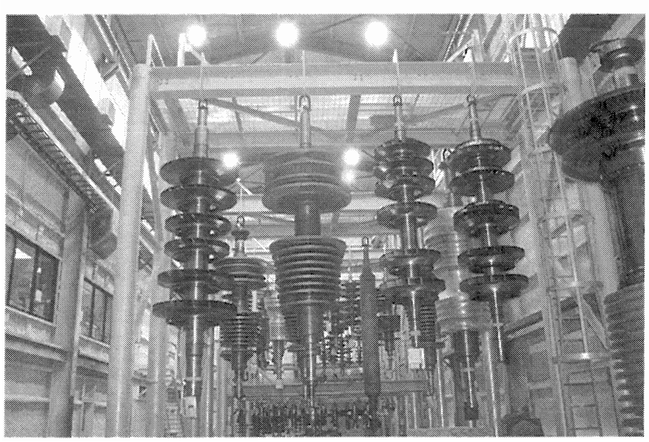

Figure 15. Single Level Storage Rack.

Another factor that had to be taken into account when designing the racks was safe access to the rotor for the personnel that were installing and removing the rotors. Safety was a concern because a person has to physically remove or install the shackle that is attached to the top of the hanger. To safely accomplish the task, racks were designed with permanent ladders for easy access, and tie-off lines to allow personnel to tie-off while working in the racks. Also a catwalk was utilized to provide easy access to the top platforms and connect them together (Figure 16).

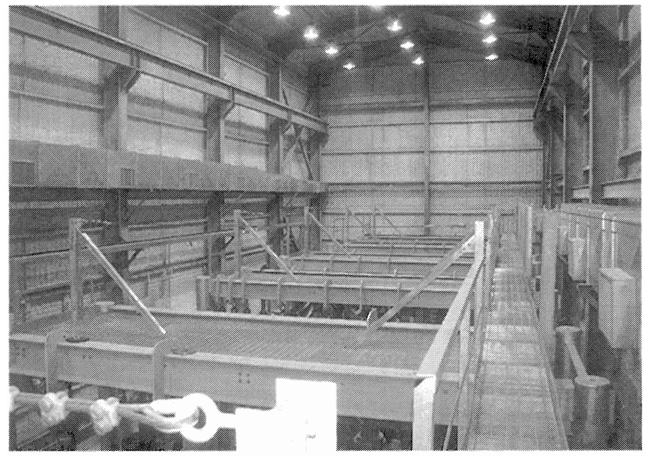

Figure 16. Catwalk with Safety Lines Providing Access to All Top Levels of Storage Racks.

The rotor storage racks were used to store all rotors except the gas turbines. The decision was made not to hang the gas turbine rotors due to the through bolting in the compressor section. Individual support stands were designed and fabricated on which those rotors would stand (Figure 17).

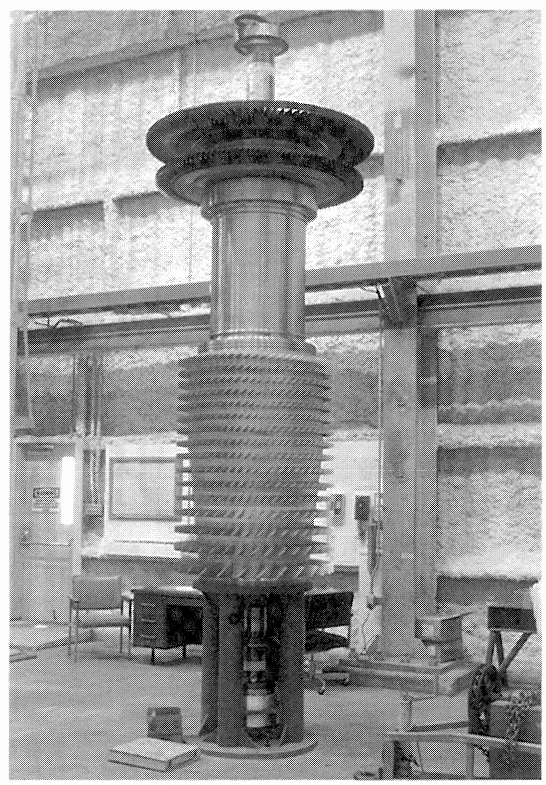

Figure 17. Gas Turbine on Support Stand.

Climatization System

At the heart of the facility is the climatization system, which maintains the environment inside the building at a relative humidity below 40 percent and at a temperature of 10ºF above the outside dewpoint. These parameters eliminate the potential for corrosion and ensure that the equipment does not sweat once it is removed from the facility. The conditions inside the facility are maintained by a system that first dehumidifies the air to reach the desired humidity level, and then uses steam coils to reheat the air to the desired temperature. The air circulates in a closed system and also serves to provide a positive pressure in the building to minimize infiltration.

The major components of the system consist of a chiller, two air-handlers, storage tank, and two centrifugal pumps. All these components are integrated together and are controlled by a control system. The main brain of the control system is a programmable logic controller that controls all the equipment. The programmable logic controller monitors the conditions in the facility via temperature and humidity sensors mounted at different locations and elevations throughout the storage area. When the conditions in the facility are not being met or there is a failure with one of the main pieces of equipment, a warning or alarm light is indicated, depending on the severity of the problem.

STANDARD INSPECTION AND DOCUMENTATION

History

Historically, there has been a problem with the rotors receiving all the necessary inspections in some cases and inadequate inspections in others. In addition, when some inspections were completed, there was insufficient documentation completed that resulted in incomplete equipment history. Further adding to the problem, when many modifications and repairs were made to the rotors, they were not properly documented and left potential traps for others. The end result was excessive costs, consumption of valuable manpower, and rotors that were not in good operating condition.

Process

One major cause of these problems was the lack of a formal operating discipline that defined which inspections were required, what was necessary to complete repairs and modifications, and what documentation was needed. A process was developed to address these problems.

Inspections

A list of all the inspections, from the time the rotor was removed from a piece of equipment until it was ready to be placed in the storage facility, was developed. For each standard inspection required, a detailed procedure was developed that defined each inspection step and the documentation required. A standard procedure checklist was developed to ensure that all the required inspections were completed (refer to APPENDIX A, Figure A-1, for actual checklist).

Modification

A management of change policy process was developed that specifically addressed repairs and modification to rotating equipment. The process defined which modifications required a management of change and which ones did not. In addition, the process defined what steps needed to be completed and what approvals were required. This process would be utilized to ensure that all modifications were completed and properly documented.

Documentation

To assist in the documentation process, the concept of a standard "critical information drawing" (CID) was developed. The standard CID provides an effective means for documenting and combining the vast amount of information that is critical to the repair and overhaul of the rotor into a standard documentation format (refer to APPENDIX B, Figure B-1).

The design dimensions and tolerances, along with the actual measured dimensions, are contained in the drawing. The majority of the design information is obtained from the manufacturer. When this information is not available, it is acquired by reverse engineering. When new equipment is purchased, the manufacturers are asked to complete a CID as part of the supplier required documentation. This helps reduce the amount of time and cost required to develop the CID, and ensures all the design information is received at the time of purchase.

Once the design information is obtained, it is made a permanent part of the drawing, which is then stored electronically. Each equipment type has a standard drawing format that is then adapted to each individual rotor. The actual dimensions for the rotor are recorded on the drawing as part of the inspection process and the operational clearances are recorded when the rotor is installed in the actual piece of equipment. The various information contained in a standard CID is detailed as follows:

- *General description*—The drawing consists of an outline of the specific rotor with labels identifying all the critical areas. Each of the major components is listed with the required information. Also, there is a section to provide general background information and describe visual observations.

- *General information*—This section includes several fields that pertain to the general background information of the rotor.

- *Component visual observation comments*—This section is utilized to document the visual observation (i.e., foreign object damage, corrosion, erosion, excessive wear, rubs, cracks, discoloration, scratches, dents, etc.) for each of the major components listed that makes up the rotor.

- *Shaft end detail*—This section documents the contact between the coupling and the shaft end, the desired draw, and the cold and installed standoff. In addition, the section also identifies if a ring and plug set is available to check the tapers fit, if it were in need of repair.

- *Stacking dimensions*—The drawing includes all the necessary dimensions to unstack and stack the rotor if necessary. All the dimensions are referenced to the shoulder of the thrust runner.

- *Burnish probe areas*—The drawing indicates the location and width of all the radial vibration probe areas. This information is often useful when checking the electrical runout as part of the inspection process.

- *Critical diameters*—All the critical design diameters, with their associated tolerance, are included to allow the actual diameter to be compared with the design diameter, to determine if the diameter is within tolerance. Special attention is given to the radial bearing journals in that they are checked at three different locations to check for a tapered journal.

- *Critical runouts*—All critical radial runouts are included and compared with the design tolerance to determine if the runouts are within tolerance. Axial runouts are taken on the critical areas as well (i.e., thrust runner shoulders, seal face shoulders, coupling hub boss fits, and turbine buckets), which are all critical to the operation of the rotor. The phase of the maximum runout that is usually referenced to a key way is also recorded. This information can be important when installing the rotor, particularly with steam turbines.

- *Interference/clearance fits*—Interference/clearance fits for impellers, sleeves, balance pistons, and thrust runners are included to ensure all fits are correct when the rotor is disassembled and reassembled.

- *Operating clearances*—The actual clearances are documented along with the design clearances, so that they can be compared.

Process Integration

To integrate the inspection, modification, and documentation process all together with the storage facility, a checklist was developed to ensure that all these items have been addressed and properly completed. This checklist serves as an admission ticket for placing the rotor into the rotor storage facility (a copy of the checklist has been included in the APPENDIX A, Figure A-2). If this checklist is not completed in its entirety and approved by the facilitator, the rotor is not placed in the facility.

When the checklist is properly completed, it results in an information packet for that specific rotor. Two copies of the information packet are required. One packet is attached to the rotor itself and is not to be removed or opened until the rotor is installed in the field. The other packet is placed in the "Active File" at the facility, indicating that the information contained in the file is the most current information available on the rotor. The information packets are organized in the files by the specific rotor identification numbers stamped on each end of the rotor. Once the rotor is removed from the facility and installed in the machine, the information packet is removed from the "Active File" and placed in the "Inactive File." Each information packet in the "Inactive File" serves as a record for the specific rotor repair history.

INVENTORY MANAGEMENT/ ROTOR TRACKING SYSTEM

Overview

Another opportunity identified in the development stages of the project was an inventory management/rotor tracking system that had two primary purposes. First, to manage the rotors in the facility and, second, to keep track of the rotor as it moves through the various locations, once it leaves the facility.

Inventory Management

The existing division spare parts inventory system was adapted to assist in the management of the rotor inventory in the storage facility. This provided the advantage of allowing the system to interface with other important computer programs in the division. For the system to function properly and meet the desired requirements, each rotor was actually treated as an individual piece of equipment and assigned a specific rotor identification number. The number was then stamped onto the end of each rotor, which allows the history of each individual rotor to be tracked throughout its life. As the rotors were brought into the facility, the pertinent background information such as manufacturer, model, serial number, weight, length, etc., were entered into the system. A coordinate system was defined within the facility that consisted of a row, level, and position that defines the exact location of the rotor. As the rotors are moved in and out of the facility, the inventory is updated, which is essential, so that the exact location of the rotor can be known at all times.

Rotor Tracking

Again, the existing division inventory system was adapted to assist in tracking the movement of each individual rotor. To accomplish the task, specific location identities were assigned to each location that the rotor could possibly be placed. Thus, equipment with more than one spare, and identical equipment that utilizes a common spare rotor, will each have a different location identity so that the exact path that each rotor passes through can be traced. Also, there are location identities for repair facilities so that the complete history of the rotor can be traced and documented. For rotors that do not operate 100 percent of the time, runtime counters are utilized to account for actual hours of operation.

This historical operating information is very beneficial when calculating fatigue life, identifying problem rotors and equipment, and defining "age to failure" data for use in Weibull probability plots, Duane-AMSAA reliability growth plots, etc.

SUMMARY AND CONCLUSION

The rotor storage facility was completed in 1995, and the majority of the rotors were installed in 1996. Since the rotors were placed in the facility, there have been no corrosion problems whatsoever on any of the rotors. In fact, there have been machined surfaces exposed to the environment inside the facility without any type of rustproof for more than two years and show no sign of corrosion. Thus, preliminary indications are that corrosion is no longer a problem associated with long term storage of rotors as it has been in the past. In addition, no person has been injured nor has a single rotor incurred any type of damage due to being installed in the facility. Thus, the primary objective of the project was successfully completed.

With regard to the secondary objectives, all the necessary operating discipline has been developed to ensure the rotors are properly inspected and modified, and that all the necessary documentation has been completed. This operating discipline was implemented and utilized when the majority of the rotors were placed in the facility. During the inspection process, many rotors perceived to be in good operating condition were found deficient in areas that required additional repairs. Also, several new rotors received from the manufacturers were found with defects that required additional work.

Please see appendices on the following page.

APPENDIX A

Scope

This procedure is used to outline the necessary tasks that need to be completed prior to requesting a rotor be installed into the Critical Rotating Equipment Storage Facility. The purpose of this document is not to describe how each of the tasks is to be completed. Refer to pertinent ETS accepted practices and procedure for exact details on completion of the necessary tasks.

☐ Potentially Hazardous ☐ Critical Checklist ☐ Emergency Procedure

Tools and equipment

The tools and equipment listed below are needed to do this job.

Balance Machine	NDT	Vibration Services
RPQA	Machinist	Measuring Devices

Consequences of deviation from this procedure

Deviation from this procedure will result in a rotor that is not in the proper operating condition which could result in unnecessary extended plant outages, excessive repair costs, and/or equipment damage if the rotor was actually installed. Also the rotor will not be accepted in the Critical Rotating Equipment Storage Facility unless all tasks outlined in this procedure have been properly completed.

Procedure

These steps will be followed in order unless stated otherwise:

Step	Action
1	Blast and clean the rotor.
2	Request RPQA to generate a standard Critical Information Drawing for the particular rotor if it does not already exist.
3	Visually inspect the rotor and document all observation (i.e., F.O.D., corrosion, erosion, excessive wear, rubs, cracks, discoloration, etc.) on the Critical Information Drawing General Comments section.
4	NDT the rotor, check shaft end hardness, and document (ETS T5M-0530-20).
5	Repair all problem areas utilizing Mechanical Department Repair/Modification Procedure.
6	Modify the shaft ends as required to install the necessary rotor hanging fixtures/adapters (See Rotor Hanging/Adapter Fixture Procedure for additional details).
7	Verify that rotor has the proper Rotor ID Number scribed on each end of the rotor. If the Rotor ID Number is not present, obtain a Rotor ID Number from the facilitator. Note: The facilitator will have had to approve the request for the rotor to be stored in the facility and received a completed Rotor Information Form before the Rotor ID Number can actually be issued.
8	Complete all sections of the standard Critical Information Drawing, except the clearance information section. Compare the actual to the design parameter to ensure they are within the design tolerance. If the numbers are not in tolerance, correct the problem or document the problem on the critical information drawing and the facilitator will approve or disapprove the exception. Note: If all sections are not complete the facilitator will not accept it as completed.
9	Check and document electrical/mechanical runout in vibration probe areas.
10	Permanently install the coupling and thrust runner(s) on the rotor if it is not necessary that they be removed prior to installation (i.e., steam turbines). Document actual cold stand-off, draw, and installed stand-off on the Critical Information Drawing. Rotors requiring removal of the coupling hub prior to installation (i.e., compressors, pumps) are required to have a coupling temporarily (zero draw) installed with the coupling nut used to hold it in place. Document actual cold stand-off, desired draw, and desired installed stand-off on the Critical Information Drawing. Place a green tag on the coupling hub to indicate that it has not been permanently installed.
11	Balance the rotor with all rotating components in place to a 4W/N tolerance and document.
12	Wrap all vibration probe areas to protect them from accidental damage and wrap them with the type of tape that indicates that it is a probe area.
13	Prepare rotor for storage by applying a light rust proof compound per the standard procedure (See Standard Rust Proofing Procedure For Storing Equipment in the facility).
14	Install bearing protectors on radial bearing journal areas to protect them from accidental damage. Note: Some bearing protectors are located in the cabinet on the second floor at B-1054.
15	Place the rotor in a stand that has sufficient capacity to support the rotor.
16	Complete the necessary rotor repair report documenting all observations and repairs/modifications that were made to the rotor assembly. Note: Included in the repair report should be material certifications, heat treatment furnace charts, stress relieve furnace charts, NDT Reports, hardness reports, over-speed reports, weld repair procedures, or any other types of reports that were generated during the fabrication or repair of any of the components that make up the rotor assembly.
17	Review Rotor Documentation Checklist to ensure that all the necessary documentation has been completed.

Resources and references

The following background information is available.

Revision history

Below are at least the last three revisions of this document but includes all revisions within the last 6 months.

Date	By	Description
11/02/95	Rod Mitchell	Document Created

Figure A-1. Rotor Preinstallation Requirements.

Checklist

These steps will be followed in order unless stated otherwise.
Note: Steps with asterisk are to be complete when rotor actually arrives at the facility.

CRESF Location:		**Plant:**	
Equipment Plant Location:		**Date:**	

Step	Action	Initial
1.	Repaired Rotor Yes ☐ No ☐ Rotor Repair Report ☐ Were any of the components repaired, replaced, or modified on the rotor assembly? Yes ☐ No ☐ If yes, was the Mechanical Department Modification/Repair Policy utilized and copy of the form attached? Yes ☐ No ☐ If yes, ☐ ☐ N/A Material certifications ☐ ☐ N/A Furnace charts ☐ ☐ N/A Hardness checks ☐ ☐ N/A Over speed reports ☐ ☐ N/A Weld procedures	
2.	New Rotor Yes ☐ No ☐ If yes, ☐ Material certifications ☐ Hardness checks ☐ ☐ N/A Impeller over speed reports	
3.	Balance Report ☐	
4.	Electrical Runouts Report ☐	
5.	Completed standard Critical Information Drawing ☐ Note: All sections must be completed except clearance sections.	
6.	Completed Rotor NDT Reports ☐ Shaft Ultrasonic ☐ Shaft Mag-Particle/Dye-Penetrate ☐ Impeller/Wheel/Gear Mag-Particle/Dye-Penetrate ☐ ☐ N/A Blade Mag-Particle/Dye-Penetrate ☐ ☐ N/A Blade Tennion Ultrasonic ☐ Shaft End Hardness	
7.	Rotor Weight Documentation ☐ Note: Two different sources are required (i.e., OEM drawing, scale weight ticket, balance report if actually weighed, etc.).	
8.	Approved rotor hanging fixture/adapter ☐ Adapter Drawing ☐ Engineering Calculations ☐ Form 1/MOC	
9.*	Rotor has been properly rust proofed per procedure	
10.*	Vibration probe areas have been properly protected and identified	
11.*	Rotor hanging fixture/adapter has been installed and properly torqued.	
12.*	Rotor has been stamped with I.D. number on each end.	
13.*	Coupling hub installed or in place with green tag attached.	
14.*	Thrust runner installed or in place with green tag attached.	
15.*	Coupling nut adapter/coupling flange adapter stamped with proper equipment identification and plant.	
16.*	Rotor hanger stamped with proper equipment identification and plant.	

Records control requirements

File the completed record of this critical checklist with the rotor documentation packet in the "active" file.
Date: ______________ Facilitator Signature: ______________________

Figure A-2. Rotor Documentation Checklist.

APPENDIX B

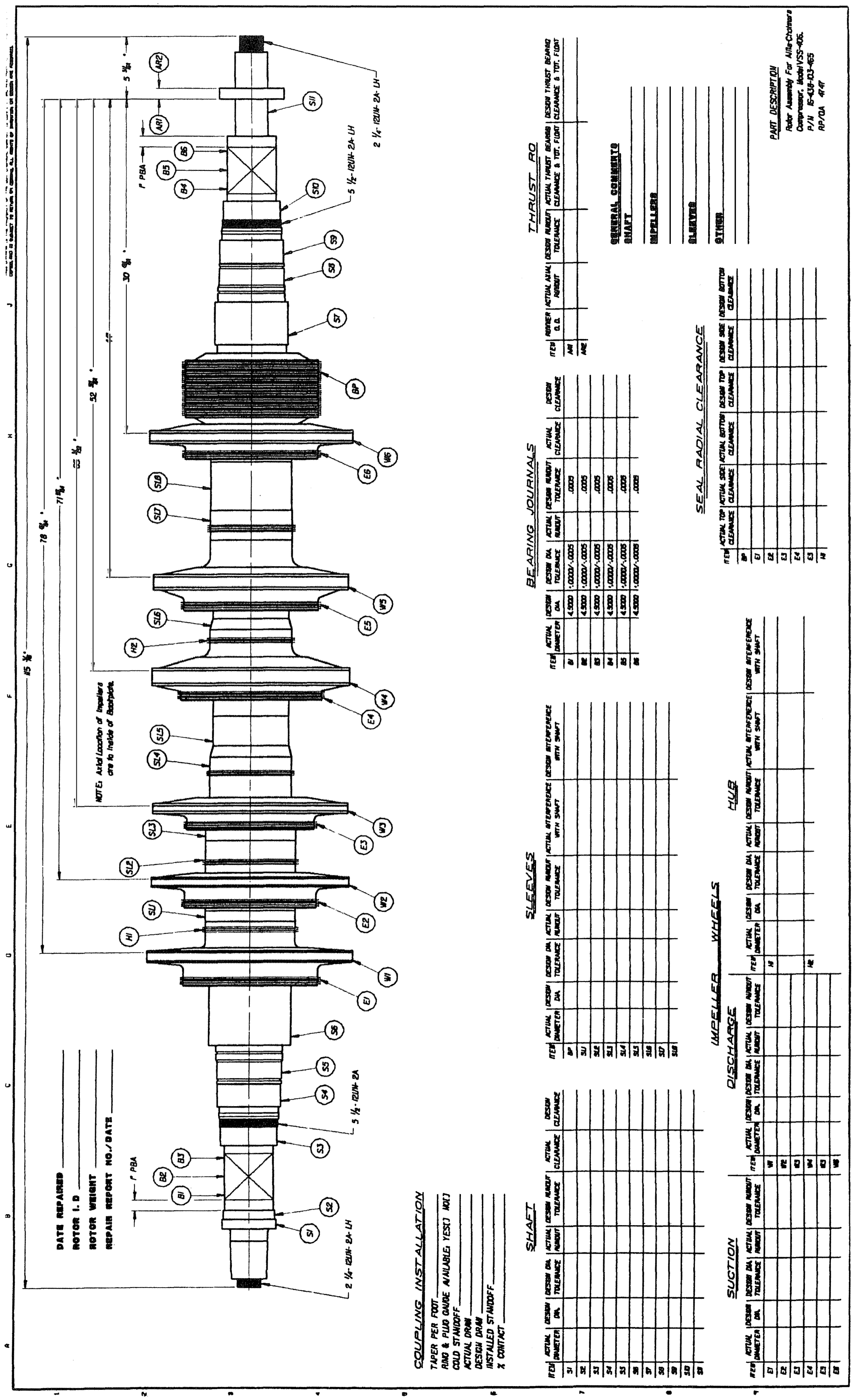

Figure B-1. Typical Critical Information Drawing for a Centrifugal Compressor Rotor.