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Shipping Preparations and Storage of Turbine and Generator Components

Best Practices

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PRODUCT DESCRIPTION

Many utilities are replacing major components in their units and are becoming increasingly concerned with shipping as well as long- and short-term storage of these replacement components, which arrive on site for immediate use or as backup in case of emergency. The choice of storage location depends on space availability, site security, environment, tracking and accessibility of stored equipment, original equipment manufacturer (OEM) requirements, and component inspection or maintenance requirements during storage. This report provides a comprehensive source of information that will enable utilities to identify possible safety hazards, evaluate risks, and select the shipping and storage processes most conducive to increased safety, reliability, and availability.

Results and Findings

This guideline has been designed to help utilities identify and document industry best practices for shipping and storage of spare major turbine and generator components. Components addressed include turbine and generator rotors, stators, turbine stationary components (diaphragms/blade rings), generator retaining rings, stator coils/bars, steam turbine inner and outer shells, generator stators, crossover piping, turning gear, main oil tanks, lubrication system piping, and high-voltage bushings. Following are some important considerations:

- Shipping preparations for major turbine and generator components to a destination should take into consideration the means, methods, packaging, weather conditions, and monitoring of the component during transportation.
- A planned inspection and maintenance program should be developed for each steam turbine and generator component in storage. Planned component inspections should be based at a minimum on the OEM recommendations and adapted to site-specific conditions. A checklist for each component should be developed with specific inspection items and instructions.
- Procedures should be developed that outline site-specific safety requirements for handling, application, and removal of preservatives and coatings that protect equipment during shipping and storage.

Challenges and Objectives

The goal of this project was to publish a comprehensive guide that combines OEM and worldwide utility best practices and procedures for shipping and storage of major turbine and generator components. This goal fits into the broader objectives of EPRI's Steam Turbines-Generators and Auxiliary Systems Program (Program 65), to undertake research and technical support activities that will enable power plant operators to reduce operation and maintenance

costs, maximize plant performance, and more effectively implement plant upgrades and asset management strategies.

Applications, Values, and Use

The main objectives of preparing a component for shipment or storage should be to 1) provide protective means to eliminate or greatly decrease chances of physical damage, 2) reduce or eliminate exposure to moisture and corrosive environments, and 3) address any other adverse conditions that could be encountered during shipping or storage. The OEM of the steam turbine/generator component in question should be contacted for specific shipping and storage instructions and advice if special circumstances are warranted or exist.

EPRI Perspective

Many power producers upgrade steam turbines and generators in order to gain megawatts instead of installing new capacity. This guide provides a single point of reference for plant engineering and maintenance personnel as they face the wide variety of engineering challenges associated with procurement, shipping, and storage of steam turbine and generator replacement components. Through use of this guide, EPRI members should be able to significantly improve the processes associated with upgrading and repairing steam turbines and generators in order to increase plant output.

Approach

This report is organized according to

- Shipping preparations for each component
- Storage practices for each component
- Inspection and maintenance requirements for each component
- Safety considerations

Keywords

Component Storage
Component Shipping
Turbine Components
Generator Components
System Upgrades
System Maintenance
System Inspection

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1
INTRODUCTION

1.1 Background

Many utilities are replacing major components in their units and are becoming increasingly concerned with shipping and the long and short term storage of these replacement components when they arrive on site for replacement or need improved direction on storing the replaced/spare components for future use. Some utilities store the replaced components as a backup in case of emergency. The choice of storage location depends on space availability, site security, and environment, keeping track of stored equipment and accessibility, original equipment manufacturer (OEM) requirements, component inspection or maintenance requirements during storage. Any coatings/coverings on the shipped and stored components must be carefully considered due to chemistry, environmental issues as well as removal techniques prior to installation. OEM's provide shipping preparation and short term storage recommendations and some utilities have developed detailed instructions/procedures. Steam turbine and generator smaller electrical and mechanical components, such as replacement parts, instrumentation, and controls, are not included in the scope of this document and the user should refer to the OEM or supplier for shipping and storage of these items. This report covers industry best practices currently used for shipping and storage of major larger and heavier major steam turbine generator components.

1.2 Approach

This guideline is to identify and document industry best practices for shipping and storage of spare major turbine and generator components. The major components addressed are included in Table 1-1.

Table 1-1
Scope of Equipment Discussed in This Report

Component	Shipping	Storage	Inspection/Maintenance
Turbine Components			
Rotor	See Section 2.2.1	See Section 3.2.1	See Section 4.1
Shells and Cylinders	See Section 2.2.2	See Section 3.2.2	See Section 4.2
Stationary Components	See Section 2.2.3	See Section 3.2.3	See Section 4.3
Assembled/Packaged Turbine	See Section 2.2.4	See Section 3.2.4	See Section 4.4
Generator Components			
Rotor	See Section 2.3.1	See Section 3.3.1	See Section 4.5
Stator	See Section 2.3.2	See Section 3.3.2	See Section 4.6
Retaining Rings	See Section 2.3.3	See Section 3.3.3	See Section 4.7
Stator Coils/Bars	See Section 2.3.4	See Section 3.3.4	See Section 4.8
Miscellaneous Components			
Crossover Piping	See Section 2.4.1	See Section 3.4.1	See Section 4.9
Turning Gear Assembly	See Section 2.4.2	See Section 3.4.2	See Section 4.10
Mail Oil Tank Assembly	See Section 2.4.3.1	See Section 3.4.3.1	See Section 4.11
Lubrication Piping	See Section 2.4.3.2	See Section 3.4.3.2	See Section 4.12
High Voltage Bushing	See Section 2.4.4	See Section 3.4.4	See Section 4.13
Rotating and Brushless Exciter	See Section 2.4.5	See Section 3.4.5	See Section 4.14

This project had a Technical Advisory Group (TAG) formed consisting of plant representatives from EPRI member utilities. The TAG provided input and review of the guide.

A survey was sent to selected members of the EPRI Program 65 Steam Turbine Generator and Auxiliary Systems for input on current best practices for shipping and storage of major turbine and generator components. Follow-up discussions were held with survey participants.

A discussion was held with a railway corporation for information and requirements for shipping large and heavier items by rail.

A search of current EPRI literature, manufacturers, vendors, and industry was conducted to include the latest information available.

1.3 Organization

The information in this report can be found in the following sections:

- Shipping Preparations for each component
- Storage Practices for each component
- Inspection and Maintenance Requirements for each component
- Safety Considerations

1.4 Acronyms

OEM - original equipment manufacturer

TAG - Technical Advisory Group

MSDS - Material Safety Data Sheet

NSTI - Nuclear Steam Turbine Initiative

ASME - American Society of Mechanical Engineers

ANSI - American National Standards Institute

VCI - vapor corrosion inhibitor

GPS - Global Positioning System

2
SHIPPING PREPARATIONS

Shipping preparations for major turbine and generator components to a destination should take into consideration the means, methods, packaging, weather conditions, and monitoring the component during transportation. This guide will focus on the preparation of the component for shipment. Two excellent resources for the means, methods, and monitoring of turbine generator components is ASME/ANSI N45.2.2 *Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants* and Section 7 of EPRI report 1014717 *Project Management Guidance when Upgrading Steam Turbines at Nuclear and Fossil Power Plants*. Two EPRI references for lifting and rigging requirements are report 1007914, *Lifting, Rigging, and Small Hoist Usage Program Guide*, and report 1009706 *Rigger's Handbook*.

The recommendations given in this guide should be used as general instructions for shipping of major components and should not be considered complete for all situations as there are many variables required to be taken into consideration for each location and circumstances. Application of this report should be implemented at the discretion of each end user. The main objectives of the shipper when preparing a component for shipment should be to prepare the component with protective means to eliminate or greatly reduce chances of physical damage, reduce or eliminate exposure to moisture, reduce or eliminate exposure to corrosive environments, and address any other adverse conditions during shipping. The OEM of the turbine components should be contacted for specific shipping instructions and advice for any major steam turbine/generator component if special circumstances are warranted or exist.

Common items that need to be considered before preparing a major turbine or generator component for shipping are included the following table:

Table 2-1
General Shipping Considerations

1	Configuration of the component including length, width, and height
2	Weight of the component
3	Susceptibility to damage of the component during shipment
4	Susceptibility to movement of the component during shipment (tilt and roll)
5	Lifting drawings of the component, especially for rotors, shells, and stator, for rigging points and center of gravity information
6	Means of attachment of the component to the shipping device
7	Expected routing information, including planned travel time and planned transportation route
8	Expected weather information along the planned transportation route

9	Expected other environmental conditions along the planned transportation route
10	Need for monitoring the shipment for shock or impacts with instrumentation requirements
11	Applicable site rigging and safety requirements
12	Obtain any local, state, or federal permit requirements

Configuration and weight of a component often determine the means of shipping that will be required.

Typically larger and heavier components are routinely shipped via rail car, barge or another special or unique vehicle. Specialized Schnabel and larger flatbed rail cars are located at worldwide rail systems for moving heavy and large components.

There are also air freight vendors with capability of transporting a wide range of large and heavy cargo. There are also specialized freight aircraft transports available. An example of a specialized air transport super heavy aircraft that has been utilized for intercontinental transportation of turbine equipment is the AN-225 Mriya (website: http://www.antonov.com/). The AN-225 has transported single pieces of cargo up to 200 Tons (203 Metric Tonne).

The shipping destination often will determine the transportation routing and the necessary permit requirements.

A drawing showing the lifting instructions, dimensions, weights, and center of gravity of the component to be shipped is important to supply to the transportation vendor. Weight and center of gravity will be especially important if a large component is to be shipped via barge or rail car. Proper positioning of the component on the vendor truck, barge, or rail car can help ensure the load does not become “top heavy” and have a tendency to flip over during transportation.

Expected weather and environmental conditions along the planned transportation route determine the amount of corrosion protection that will be required during the transportation. Care should be taken to ensure the component is protected from moisture and corrosive environments if the transportation time or routing is changed or delayed.

New, repaired and refurbished components shipped from the OEM or third party vendors should have specifications in the purchase contract for the expected environmental conditions during the transportation phases plus up to a minimum three months of storage.

2.1 General Shipping Preparations

The component should be prepared to be adequately protected to prevent physical damage or exposure to moisture or corrosion environments during transportation. Some items where considerations should be made for protection are shown in the following table:

Table 2-2
Shipping Environments Requiring Protection for Shipped Components

1	Environmental elements, such as rain, snow, salt water
2	Airborne materials such as rocks, dirt, general debris
3	Corrosive atmospheres along the transportation route
4	Physical damage from handling during loading and unloading
5	Physical damage during transport (due to unexpected movement of the component or impact with road obstacles like overhanging branches or bridges over the road)
6	Damage from shock or vibration

In cases of shipments with short durations (less than a week), environmental protection for shipment via commercial and vendor truck or rail may only need covering of the component with waterproof tarpaulins for general environmental protection and short time storage at the plant or vendor is anticipated. In all cases machined areas of turbine generator components should always be protected with coatings and/or wrapped in vapor corrosion inhibitor (VCI) treated paper for protection. Tarpaulins or VCI paper should not remained tightly wrapped around components for an extended length of time as moisture and mildew can become trapped or formed in pocket areas to create corrosive environments and damage the component metal surfaces. For longer shipment durations or if shipping is via barge or ship, the turbine generator component will require a sufficient enclosure structure for protection from water and corrosive mist exposure. Upfront shipment planning will help identify known areas with corrosive atmospheres in the transportation routes plus expected and potential weather conditions that may require additional protection measures.

Shrink film packaging systems are currently being used within the industry for protecting components while being shipped. The shrink wrap is typically made of polyethylene film and can be used for all types of irregular shaped components. Shrink wrap is frequently used for shipping protection in other industries when transporting items such as large boats, aircraft, vehicles, tanks, or helicopters and is readily adaptable for steam turbine generator components. There are vendors that specialize in shrink wrap systems that can be utilized for most steam turbine generator components.

Shipping of steam turbine generator major components often occurs during emergency and outage situations and the utility needs to know the real time safety and delivery status of the shipments for planning and execution activities. Global Positioning System (GPS) (website http://www.gps.gov) is a widely used and useful tool for tracking and providing reliable world-wide location at all times for a shipment with an attached GPS receiver. GPS can provide accurate location and time information to an unlimited number of people in all weather, day and night, anywhere in the world. It uses a space-based global navigation satellite system maintained by the United States government and is generally freely available to anyone domestically. Many international countries have access to the system through coordination with the United States government GPS International Working Group.

Components that need to be protected from shock and vibration require a cushioning material to be used between the component and the support structure. The cushioning material should have sufficient strength to protect the component, have no corrosive effect when in contact with the component, have low moisture absorption properties, and not readily combustible. Often wood is used for the cushioning material for turbine components. A rubber or plastic spacer should be placed between wood and component to act as a moisture barrier.

Receiving site security inspection requirements for receiving shipments should be considered when preparing a component for shipment. Many utilities, especially those with nuclear units, may also require site security internal inspections of all shipments received due to safety or regulatory requirements. One United States utility saved considerable expense by allowing their nuclear plant site security personnel visit a manufacturing facility to conduct a security search while a component was being packaged prior to shipment. This allowed the site security personnel to conduct an internal physical search of the component and packaging internals at the factory, witness the closure of the component and packaging, and application of their own security identification seals at all openings and covers. Once the component was received on site an internal inspection was not required and the inert gas protection was not breeched. This process allowed the component to stay protected in an inert gas environment, not require an internal inspection when received at the nuclear plant site, not require expense of repackaging and sealing, and helped preserve the manufacturer's warranty on the component.

2.1.1 International Shipping Considerations

International overseas shipments via ship or barge often require an extended period of time and typically require the component to be enclosed in a structure, often wooden or metal, that has been lined and sealed with waterproof paper or plastics for protection from salt water and mist. Enclosures can be engineered and built to enclose the component in an inert dry gas blanket during shipment. There are domestic and international vendors who specialize in this service. Components located in structure enclosures should also contain desiccant bags to absorb any water or water vapor that may get into the structure. Desiccant bags help maintain the relative humidity inside the enclosures. For international sea shipments, components are typically stored below the main deck of a cargo ship for added protection from the environments.

Many steam turbine generator components are routinely shipped between various countries as many OEM's and manufacturers have repair, supply, and fabrication facilities worldwide. Some steam turbine generator components require shipment in sealed containers and/or under an inert dry gas blanket as a means of protection and integrity. Breaking the seal or dry gas blanket can expose the component to potential loss of manufacturer's warranty, potential damage or exposure to corrosive environments if security import searches or inspections are required by the receiving country. Importing and custom requirements between countries can vary widely and can change frequently as worldwide political environments and relationships change. Part of the planning process for utility international shipments should include identification of the custom requirements between the exporting and importing countries, potential impacts of customs inspections to the shipped component, and potential means to eliminate or mitigate the inspection.

2.2. Turbine Components

2.2.1 Turbine Rotors

Preparation of turbine rotors for shipment to an OEM or vendor site for repairs is typically performed by site or contract personnel. Site procedures for shipping each rotor should be developed prior to shipment. Extreme care must be used in handling turbine rotors to protect it from physical damage and excessive shock or vibration during handling and shipment. Shipping methods for turbine rotors can vary from commercial or vendor truck for smaller rotors to a rail car, barge, or special vehicle for larger, heavier rotors. Size and weight characteristics often determine the shipping method required. The site's rigging and handling procedures must be followed in handling and movement of the rotor at all times.

Rotors should be set in suitable cradles or frames when being transported to eliminate or minimize the risk for physical damage, thrust, shock, and vibration. Cradles and frames should be constructed of metal and/or wood with sufficient strength to fully support and securely hold the rotor for the entire transportation period. An engineered frame or cradle may be required by the shipper, OEM, or the site engineering support group to ensure the frame's strength capacity. There are vendors that specialize in design and construction of rotor cradles, frames, and enclosures. The rotor must be positioned and supported in the cradle or frame to not allow the rotor to thrust in any direction. Cradles for rotor shipping should be designed and built to be able to be securely attached to the shipping truck, rail car, or barge via bolting and/or strapping. Rotor cradles also should take into consideration the points of support and rigging connections specified in the OEM's lifting drawings to adequately support the rotor at the correct contact point locations. The cradle support points should not be the journal areas but the support areas designated on the OEM drawings. Rotor lift rigging points from the lifting drawings must also be accessible for installing or removing the rotor from the cradle. Figure 2-1 shows a picture of a turbine rotor prepared for shipment. If a wooden frame, blocking, or cushioning is used for shipments, a metal spacer and a rubber or plastic shim should be placed between the metal spacer and rotor to limit vapor exposure of the metal rotor to any wood contact points. The rubber or plastic spacer may consist of polyethylene or non-hydroscopic Teflon, neoprene, or Textolite material.

Caution: Teflon should never be used on any rotor journal bearing surfaces, as the Teflon can become impregnated into the micro porosity of the journal finish. If the Teflon "coats" the journal, the capacity of the journal for "pumping" lube oil will be diminished and bearing failures can occur.

For most domestic shipping requiring only a couple of days, rotors should have a coating of light oil applied to the journal areas and the entire rotor covered with a tarpaulin.

For protection during shipments requiring more than a week, non-bearing turbine rotor journal areas should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E and/or wrapped in vapor corrosion inhibitor (VCI) paper. The wax based compound can be brushed or sprayed onto the rotor as required with attention to full coverage of areas suspect for collecting and

containing moisture. Turbine rotor bearing journal surfaces should be coated with an asphalt or petroleum type or petroleum type corrosion preventive compound that also meets Military Specification MIL-PRF-16173E and then wrapped with vapor corrosion inhibitor paper. During shipment, the entire rotor should be covered with a waterproof tarpaulin for general environmental protection once mounted on the truck, rail car, or barge.

OEM's or shipping vendors can provide a metal or fabricated enclosure for shipping a new or refurbished rotor with provisions for an inert dry gas blanket or dehumidified air system to be used. This method is recommended when shipping to an area near a sea coast, near industrial areas with corrosive atmospheres, areas with high humidity, or to sites where the rotor will not be installed for a period of time greater than three months. Rotors can be wrapped in an airtight vapor barrier packaging enclosure. There are vendors who specialize in this system. The vapor barrier packaging is placed over the rotor in the shipping stands and a vacuum is established to shrink wrap the enclosure over the rotor. Desiccant bags should also be placed inside all of the types of enclosures for absorption of any residual water or vapor that may develop or if the inert dry gas blanket, dehumidified air system, or shrink wrap vacuum system should fail.

Figure 2-1
Turbine Rotor on Trailer
(Picture from P3 files)

2.2.1.1 Turbine Rotor Shipping via Truck

When shipping a rotor via truck the following items should be addressed by the shipper:

Table 2-3
Turbine Rotor Shipped by Truck Items to Address

1	Contact trucking service provider for clearance and weight information to determine routing to destination and permitting requirements
2	Coordinate with trucking service provider for appropriate duty flat trailer for transportation. Ideally, turbine rotors should be shipped on a low boy trailer or rail car.
3	Construct significant, engineered rotor shipping stands to securely hold rotor
4	Ensure stands are well secured to trailer both axially and to the trailer bed
5	Ensure the rotor is secured axially within the stands to prevent thrusting
6	Determine if the transportation route will be over salted roads and level of protection required
7	Determine if needed and obtain a shock / vibration recorder to be used during the shipment
8	Determine if needed and obtain a Global Positioning System (GPS) indicator
9	Determine if someone should accompany the rotor during transportation

2.2.1.2 Turbine Rotor Shipping via Rail

The loading guidelines for dimensional loads for your local rail carrier service provider can be found on their website. If any questions arise, please contact your service provider for clarifications. When shipping a rotor via rail car the following items should be addressed by the shipper:

Table 2-4
Turbine Rotor Shipped by Rail Items to Address

1	Contact rail service provider for clearance and weight information to determine clearance and routing to destination
2	Coordinate with rail service provider for appropriate duty flat car for transportation and loading date
3	Construct significant, engineered rotor shipping stands to securely hold rotor
4	Ensure stands are well secured to rail car both axially and to the rail car bed
5	Ensure the rotor is secured axially within the stands to prevent thrusting
6	Obtain a shock / vibration recorder to be used during the shipment
7	Obtain a Global Positioning System (GPS) indicator, if needed
8	Determine if someone should accompany the rotor during transportation
9	Coordinate the final mechanical inspection of the rotor on the rail car by the rail service company inspector

2.2.1.3 Turbine Rotor Shipping via Barge or Ship

When shipping a rotor via barge or ship the following issues should be addressed by the shipper:

Table 2-5
Turbine Rotor Shipped by Barge Items to Address

1	Contact barge or ship service provider for clearance and weight information to determine port for shipping and destination
2	Contact turbine rotor OEM supplier for recommendations and requirements
3	Coordinate with barge or ship service provider for appropriate support structure required for handling all movements expected during water transportation.
4	Determine if needed and obtain a shock / vibration recorder to be used during the shipment
5	Obtain a Global Positioning System (GPS) indicator, if needed
6	Construct significant, engineered rotor shipping stands to securely hold rotor. There are vendors who specialize in engineering and building turbine support cradles/containers for water transportation both domestically and internationally. Structures must be built for transportation of the component in rough water conditions as these can occur at any time.

Figure 2-2 shows an example of turbine rotors on a barge ready for shipment.

Figure 2-2
Turbine Rotors on Barge for Shipment

(Picture from P3 files)

2.2.1.4 Turbine Rotor Shipping Best Practices

Turbine rotor shipping best practices are shown in Table 2-6.

Table 2-6
Turbine Rotor Shipping Best Practices

1	Rotor drawing showing weight dimensions, and center of gravity information should be provided to shipper
2	Rotor lifting drawings and instructions should be provider to shipper
3	Rotor should be placed in a suitable cradle or frame to reduce risk of damage during shipment
4	An engineered cradle or frame is recommended to ensure strength capability
5	A metal cradle or frame is preferred over a wooden one
6	Cradle or frame must constructed to not allow rotor to not thrust in any direction
7	Cradle should support rotor at OEM recommended location points
8	Rotor should not be in contact with a wooden cradle at any time
9	A metal and rubber shim should be placed between rotor and any wood contact support points
10	For short term shipments, a coat of light oil should be applied to all the rotor surfaces
11	Rotor bearing surfaces should be coated with corrosion preventative compound and wrapped in VCI paper
12	For international shipments, rotors should be enclosed in a container with an inert gas blanket environment
13	Desiccant bags should be placed inside all rotor shipping enclosures
14	Rotor should be covered with a weatherproof tarpaulin during domestic shipments
15	A shock/vibration recorder should be used on all rail shipments

2.2.2 Turbine Shells and Cylinders

Preparation of turbine shells and cylinders for shipment to an OEM or vendor site for repairs is typically performed by site or contract personnel. Extreme care must be used in handling shells and cylinders to not damage machined and sealing surfaces. Shipping methods can vary from commercial or vendor truck for most shells and cylinders to a rail car or barge for larger shells and cylinders. Shipment by truck is more likely as this variation is due in part to the fact that they are typically shipped in halves or sections.

Shells and cylinders are typically shipped on wooden framing and covered with a tarpaulin for protection from the atmospheric conditions. The shells or cylinders should be mounted on framing in a similar position as they will be used when in service. For example, lower shell halves should be positioned with the horizontal joint at the top position and upper shell halves should be positioned with the horizontal joint at the bottom. Shells or cylinders are typically

attached to the framing with bolting and/or some type of strapping. Metal or rubber on shims should be installed between a wooden frame at the support frame contact points to help eliminate any potential vapor exposure between the wood and the metal shell. If wooden blocking is used for shipments, a metal spacer and a polyethylene or non-hydroscopic Teflon, or Textolite material placed between the metal spacer and shell to limit exposure of the metal rotor to the wood at all contact points.

For protection during shipments, non-machined areas should be wrapped in vapor corrosion inhibitor (VCI) treated paper.

Machined surfaces, such as mating fit surfaces, instrument penetrations, etc., should be protected with a wax based coating that meets the performance requirements of Military Specification MIL-PRF-16173E. Steam inlet and extraction outlets are typically covered with a wood, metal, or plastic cover to protect the sealing surfaces. Non-machined surfaces of shells and cylinders are typically painted with an alkyd based primer.

The entire shell or cylinder should be covered with a waterproof tarpaulin for general environmental protection once mounted on the truck, rail car, or barge.

OEM's or shipping vendors can provide a metal or fabricated enclosure for shipping new shells and cylinders with provisions for an inert dry gas blanket or dehumidified air system to be used. This method is recommended when shipping to an area near a sea coast, near industrial areas with corrosive atmospheres, areas with high humidity, or to sites where the shell or cylinder will not be installed for a period of time greater than three months. Desiccant bags should also be placed inside all types of enclosures for absorption of any residual water or vapor that may develop or if the inert dry gas blanket system should fail.

2.2.2.1 Turbine Shells and Cylinders Shipping via Truck

When shipping shells or cylinders via truck the following items should be addressed by the shipper:

Table 2-7
Turbine Shell and Cylinder Shipped by Truck Items to Address

1	Contact trucking service provider for clearance and weight information to determine routing to destination and permitting requirements
2	Coordinate with trucking service provider for appropriate duty flat trailer for transportation.
3	Construct significant framing and blocking to support shell or cylinder
4	Ensure supports, shells, and cylinders are well secured to trailer both axially and to the trailer bed
5	Determine if the transportation route will be over salted roads and level of protection required
6	Coordinate the final mechanical inspection of the shells or cylinders on the trailer by the trucking service company inspector
7	Obtain a Global Positioning System (GPS) indicator, if needed

2.2.2.2 Turbine Shells and Cylinders Shipping via Rail

The loading guidelines for dimensional loads for your local rail carrier service provider can be found on their website. If any questions arise, please contact your service provider for clarifications. When shipping shells or cylinders via rail car the following items should be addressed by the shipper:

Table 2-8
Turbine Shell and Cylinder Shipped by Rail Items to Address

1	Contact rail service provider for clearance and weight information to determine routing to destination
2	Coordinate with rail service provider for appropriate duty flat car for transportation and loading date
3	Construct significant framing and blocking to support shell or cylinder
4	Ensure supports, shells, and cylinders are well secured to trailer both axially and to the rail car bed
5	Coordinate the final mechanical inspection of the rotor on the rail car by the rail service company inspector
6	Obtain a Global Positioning System (GPS) indicator, if needed

2.2.2.3 Turbine Shell and Cylinder Shipping Best Practices

Turbine shell and cylinder shipping best practices are shown in Table 2-9.

Table 2-9
Turbine Shell and Cylinder Shipping Best Practices

1	Shell and cylinder drawing showing weight dimensions, and center of gravity information should be provided to shipper
2	Shell and cylinder lifting drawings and instructions should be provider to shipper
3	Shell and cylinder should be placed on suitable wooden cribbing and framing
4	Shells and cylinders should be shipped in halves
5	Shell and cylinder should be mounted in a similar position as when used in service
6	Machined and sealing surfaces must be protected at all times
7	A metal and rubber shim should be placed between shell or cylinder and any wooden contact support points. Shell and cylinder should not be in direct contact with wooden cribbing or frame at any time
8	Non-machined areas should be wrapped in VCI paper for protection during shipment
9	All machined and sealing surfaces should be protected with a wax based coating during shipment

10	Steam inlets and extraction outlets should be covered with sealing surfaces protected with a wax based coating
11	For international shipments, shells and cylinders should be enclosed in a container with an inert gas blanket environment
11	Desiccant bags should be placed inside all shell and cylinder shipping enclosures
13	Shells and cylinders should be covered with a weatherproof tarpaulin during domestic shipments

2.2.3 Turbine Stationary Components

Site preparation for shipping turbine stationary components for repair at an OEM or vendor site are usually performed at the site for items, such as diaphragms, blade rings, and flow guides. Typically the shipping requirements for these components can be provided by commercial or vendor truck due to their smaller sizes and configurations and with short time shipping durations usually less than a week.

Metal or wooden frames, boxes, or stands of sufficient strength should be constructed to securely cradle or box the stationary components and accommodate the shipping method. Figure 2-3 shows an example of a frame fabricated for shipping diaphragms. An engineered frame or stand may be required by the shipper or your location engineering support group to ensure strength capability. If wooden frames are used for shipments, a metal spacer/shim with a rubber or plastic spacer should be placed between the wood and component to limit exposure of the metal component to the wood at all contact points. General environmental protection for shipments of short durations for shipment by commercial or vendor truck should be by covering of the component with waterproof tarpaulins.

Figure 2-3
Diaphragm Shipping Frame Example

(Picture from P3 files)

If the shipment is expected to take several days or occur during wet weather conditions, asphalt or petroleum type corrosion preventative compound with an over wrap of vapor corrosion inhibitor treated paper should be used on all machined surfaces for corrosion protection.

OEM's or shipping vendors can provide a metal or fabricated enclosure for shipping stationary components with provisions for an inert dry gas blanket or dehumidified air system to be used. This method is recommended when shipping to an area near a sea coast, near industrial areas with corrosive atmospheres, areas with high humidity, or to sites where the turbine stationary components will not be installed for a period of time greater than three months. Desiccant bags should also be placed inside all of the types of enclosures for absorption of any residual water or vapor that may develop or if the inert dry gas blanket should fail.

2.2.3.1 Stationary Components Shipping via Truck

When shipping shells or cylinders via truck the following issues should be addressed by the shipper:

Table 2-10
Turbine Stationary Components Shipped by Truck Items to Address

1	Contact trucking service provider for clearance and weight information to determine routing to destination and permitting requirements
2	Coordinate with trucking service provider for appropriate duty flat trailer for transportation
3	Construct significant framing, boxing, and blocking to support stationary component
4	Ensure framing and boxes are well secured to trailer bed
5	Determine if the transportation route will be over salted roads and level of protection required
6	Coordinate the final mechanical inspection of the component on the trailer by the trucking service company inspector
7	Obtain a Global Positioning System (GPS) indicator, if needed

2.2.3.2 Turbine Stationary Components Shipping Best Practices

Turbine stationary component shipping best practices are shown in Table 2-11.

Table 2-11
Turbine Stationary Component Shipping Best Practices

1	Metal or wooden frames should be constructed to hold the component during shipment
2	Engineered metal frames are preferred
3	Components such as diaphragms should be mounted in a similar position as when used in service
4	Machined and sealing surfaces must be protected at all times
5	A metal and rubber shim should be placed between the component and any wooden contact cribbing or support points.
6	Non-machined areas should be wrapped in VCI paper for protection during shipment
7	All machined and sealing surfaces should be protected with a wax based coating during shipment
8	For international shipments, components should be enclosed in a container with an inert gas blanket environment
9	Desiccant bags should be placed inside all shell and cylinder shipping enclosures
10	Stationary components should be covered with a weatherproof tarpaulin during domestic shipments

2.2.4 Assembled and Packaged Turbines

Assembled high pressure sections and smaller sized packaged turbines for new or replacement units can be shipped by the OEM fully erected to aid in faster field installation times. If an assembled or packaged turbine requires shipping by the utility, a detailed plan should be developed in conjunction with the OEM. Special rigging, blocking, handling, and shipping will be required. Handling/shipping should be performed by a contractor specializing in moving heavy equipment. Specialized heavy equipment contractors/vendors can be contracted to supply these services.

Assembled turbines are typically shipped by the OEM on wooden framing and shrink wrapped for protection from the atmospheric conditions. Metal or rubber on shims should be installed between the wooden frame and any contact points to help eliminate any potential vapor exposure between the wood and the metal turbine shell or cylinder.

For protection during shipments, non-machined areas should be wrapped in vapor corrosion inhibitor (VCI) treated paper.

Machined surfaces, such as mating fit surfaces, instrument penetrations, etc., should be protected with a wax based coating that meets the performance requirements of Military Specification MIL-PRF-16173E. Steam inlet and extraction outlets are typically sealed with a wood, metal, or plastic cover to protect the sealing surfaces. Non-machined surfaces of shells and cylinders are typically painted with an alkyd based primer.

If not shrink wrapped sealed, the entire assembled turbine should be covered with a waterproof tarpaulin for general environmental protection once mounted on the truck, rail car, or barge.

OEM's or shipping vendors can provide a metal or fabricated enclosure for shipping new assembled turbines with provisions for an inert dry gas blanket or dehumidified air system to be used. This method is recommended when shipping to an area near a sea coast, near industrial areas with corrosive atmospheres, areas with high humidity, or to sites where the assembled turbine will not be installed for a period of time greater than three months. Desiccant bags should also be placed inside all types of enclosures for absorption of any residual water or vapor that may develop or if the inert dry gas blanket system should fail.

2.4.2.1 Assembled and Packaged Turbine Shipping Best Practices

Shipping best practices for assembled or packaged turbines are shown in Table 2-12.

Table 2-12
Assembled and Packaged Turbine Shipping Best Practices

1	A shipping plan should be developed in conjunction with the OEM
2	Special rigging, blocking, handling, and shipping will be required
3	Assembled turbine drawing showing weight dimensions, and center of gravity information should be provided to shipper
4	Assembled turbine lifting drawings and instructions should be provider to shipper
5	Desiccant bags should be placed inside the turbine shell or cylinder for all shipments
6	Seal all openings with gasket material and weatherproof covers
7	All exposed rotor sections should be should be protected with a thin film of asphalt based coating during shipment
8	For international or sea coast location shipments, assembled turbines should always be enclosed in a container with an inert gas blanket environment
9	A hygrometer should be installed for constant relative humidity readings
10	All shipments should include a shock/vibration recorder

2.3 Generator Components

2.3.1 Rotors

Preparation of generator rotors for shipment to an OEM or vendor site for repairs is typically performed by site or contract personnel. Site procedures for shipping each rotor should be developed prior to shipment. Extreme care must be used in handling generator rotors to protect them from physical damage and excessive shock or vibration during handling and shipment. Shipping methods for generator rotors can vary from commercial or vendor truck for smaller rotors to a rail car or barge for larger, heavier rotors. Size and weight characteristics often

determine the shipping method required. The site's rigging and handling procedures must be followed with handling and movement of the rotor.

Generator rotors should be set in suitable cradles or frames when transporting to eliminate or minimize the risk for physical damage, thrust, shock, and vibration. The rotor should be oriented in the frame so that the rotor poles are in a vertical plane to minimize potential damage to the rotor windings. Cradles and frames should be constructed of metal and/or wood with sufficient strength to fully support and securely hold the rotor for the entire transportation period. An engineered frame or cradle may be required by the shipper, OEM, or the site engineering support to ensure strength capacity. There are vendors that specialize in design and construction of rotor enclosures. The rotor must be positioned and supported in the cradle or frame to not allow the rotor to thrust in any direction. Cradles for rotor shipping should be designed and built to be able to be securely attached to the shipping truck, rail, car, or barge via bolting and/or strapping. Rotor cradles also should take into consideration the points of support and rigging connections specified in the OEM's lifting drawings to adequately support the rotor at the correct contact point locations. The cradle support points should not be the journal areas but the support areas designated on the OEM drawings. Rotor lift rigging points from the lifting drawings must also be accessible for installing or removing the rotor from the cradle.

Chains should be used instead of straps for securing the generator rotor to the shipping trailer or rail car. The chains should be engineered to support 1.5 times the rated load. Two chains should wrap the rotor as an additional support to prevent the rotor from rolling. Rubber should be placed between the chains and the rotor body.

For shipping the generator rotor should be enclosed in a heavy duty plastic covering for environmental protection. The enclosure should be filled with an inert dry gas blanket with desiccant bags included for random moisture or in case the inert dry gas seal is broken. Test leads for electrically insulation resistance measurement testing the rotor should be extended outside the enclosure if the shipping time is expected to be longer than a month. An alarm should be installed to monitor the inert dry gas pressure. The humidity inside the enclosure should be monitored using a hygrometer and desiccant bags replaced as needed.

The generator rotor bearing journals and couplings should be coated with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E and then wrapped with waxed or vapor corrosion inhibitor paper. The bearing journals should then have applied a second coat of a thin film of the asphalt or petroleum type corrosion preventive compound and wrapped with waxed or vapor corrosion inhibitor paper and taped. The collector ring should be coated with a single coat of the asphalt or petroleum type corrosion preventive compound and wrapped with waxed or vapor corrosion inhibitor paper and taped.

For water cooled rotors, the water cooling ducts should be drained and sealed with an inert dry gas blanket.

2.3.1.1 Generator Rotor Shipping via Truck

When shipping a rotor via truck the following items should be addressed by the shipper:

Table 2-13
Generator Rotor Shipped by Truck Items to Address

1	Contact trucking service provider for clearance and weight information to determine routing to destination and permitting requirements
2	Coordinate with trucking service provider for appropriate duty flat trailer for transportation
3	Construct significant, engineered rotor shipping stands to securely hold rotor
4	Ensure stands are well secured to trailer both axially and to the trailer bed
5	Ensure the rotor is secured axially within the stands to prevent thrusting
6	Determine if the transportation route will be over salted roads and level of protection required
7	Determine if needed and obtain a shock / vibration recorder to be used during the shipment
8	Determine if needed and obtain a Global Positioning System (GPS) indicator
9	Determine if someone should accompany the rotor during transportation
10	Coordinate the final mechanical inspection of the rotor on the trailer by the trucking service company inspector

Figure 2-4 shows an example of a generator rotor ready to ship via a truck.

Figure 2-4
Generator Rotor Truck Shipping Example

(Picture courtesy of Alliant Energy)

2.3.1.2 Generator Rotor Shipping via Rail

The loading guidelines for dimensional loads for your local rail carrier service provider can be found on their website. If any questions arise, please contact your service provider for clarifications. When shipping a rotor via rail car the following issues should be addressed by the shipper:

Table 2-14
Generator Rotor Shipped by Rail Items to Address

1	Contact rail service provider for clearance and weight information to determine routing to destination
2	Obtain a Global Positioning System (GPS) indicator, if needed
3	Coordinate with rail service provider for appropriate duty flat car for transportation and loading date
4	Construct significant, engineered rotor shipping stands to securely hold rotor
5	Ensure stands are well secured to rail car both axially and to the rail car bed
6	Ensure the rotor is secured axially within the stands to prevent thrusting
7	Obtain a shock / vibration recorder to be used during the shipment
8	Determine if someone should accompany the rotor during transportation
9	Coordinate the final mechanical inspection of the rotor on the rail car by the rail service company inspector

Figure 2-5 shows an example of a generator rotor ready to ship via a railcar.

Figure 2-5
Generator Rotor Rail Car Shipping Example
(Picture courtesy of Exelon Corporation)

2.3.1.3 Generator Rotor Shipping via Barge or Ship

When shipping a rotor via barge or ship the following issues should be addressed by the shipper:

Table 2-15
Generator Shipped by Barge or Ship Items to Address

1	Contact barge or ship service provider for clearance and weight information to determine port for shipping and destination
2	Contact generator rotor OEM supplier for recommendations and requirements
3	Coordinate with barge or ship service provider for appropriate support structure required for handling all movements expected during water transportation.
4	Determine if needed and obtain a shock / vibration recorder to be used during the shipment
5	Construct significant, engineered rotor shipping stands to securely hold rotor and enclosures to environmentally protect the rotor. There are vendors who specialize in engineering and building generator support cradles/enclosures for water transportation both domestically and internationally. Structures must be built for transportation of the component in rough water conditions as these can occur at any time.
6	Obtain a Global Positioning System (GPS) indicator, if needed
7	Obtain a shock / vibration recorder to be used during the shipment

2.3.1.4 Generator Rotor Shipping Best Practices

Generator rotor shipping best practices are shown in Table 2-16.

Table 2-16
Generator Rotor Shipping Best Practices

1	Rotor drawing showing weight dimensions, and center of gravity information should be provided to shipper
2	Rotor lifting drawings and instructions should be provider to shipper
3	Rotor should be placed in a suitable cradle or frame to reduce risk of damage during shipment
4	An engineered cradle or frame is recommended to ensure strength capability
5	A metal cradle or frame is preferred over a wooden one
6	Cradle or frame must constructed to not allow rotor to not thrust in any direction
7	Cradle should support rotor at OEM recommended location points
8	Rotor should not be in contact with a wooden cradle at any time
9	A metal and rubber shim should be placed between rotor and any wood contact support points
10	The rotor should be enclosed in a heavy duty cloth covering at a minimum to keep out dust and dirt. Plastic should never be used.
11	Ideally the rotor should be enclosed in a sealed enclosure with an inert gas blanket

12	Retaining rings should be coated with a thin film of corrosion preventative compound
13	Rotor bearing surfaces should be coated with corrosion preventative compound and wrapped in VCI paper
14	Collector end should be wrapped in rubber sheeting
15	For international shipments, rotors should be enclosed in a container with an inert gas blanket environment
16	Desiccant bags should be placed inside all rotor shipping enclosures
17	Rotor should be covered with a weatherproof tarpaulin during domestic shipments
18	A shock/vibration recorder should be used on all shipments

2.3.2 Stator

Generator stators are typically repaired in the field and shipping of the stator is not usually required or needed. If the generator stator requires shipping, a detailed plan should be developed in conjunction with the OEM. Special rigging, blocking, handling, and shipping will be required. Handling/shipping should be performed by a contractor specializing in moving heavy equipment. Specialized heavy equipment contractors/vendors can be contracted to supply these services.

If shipping of generator stator is required, the stator will need to be prepared for shipment. For smaller units, generator stators may be shipped with the rotors installed if the shipping means can accommodate their combined weights. All stator frame machined surfaces should be coated with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E. Any openings of the stator frame should be sealed with weatherproof covers. The generator rotor ends should be protected as specified in Section 2.3.1. For water cooled stators, the water cooling ducts should be drained and sealed with an inert dry gas blanket. During domestic shipments, the entire stator frame should be covered with a waterproof tarpaulin for general environmental protection once mounted on the truck, rail car, or barge. For international shipments, the OEM should be contacted for specific recommendations. At a minimum, the stator frame should be enclosed in a sealed shrink wrapped structure with desiccant bags for moisture protection when shipped internationally. Figure 2-6 shows a generator stator received on a heavy haul trailer.

Figure 2-6
Stator on Heavy Haul Trailer
(Picture from P3 files)

For larger unit stator frames to be shipped, the generator rotors are normally removed for weight reduction. All machined surfaces on the stator frame should be coated with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E. Any openings of the stator frame and the frame ends should be sealed with weatherproof covers. If feasible, the stator frame should be blanketed with inert dry gas and desiccant bags placed inside for random moisture control. A direct reading hygrometer should be installed for periodic relative humidity readings. An external station to perform electrical insulation resistance measurement and polarization index testing of the windings should be provided for without removing the inert dry gas blanket.

2.3.2.1 Generator Stator Shipping via Truck

Smaller stators may be able to be shipped via truck. When shipping a stator via truck the following issues should be addressed by the shipper:

Table 2-17
Generator Stator Shipped by Truck Items to Address

1	Contact trucking service provider for clearance and weight information to determine routing to destination and permitting requirements
2	Coordinate with trucking service provider for appropriate duty flat trailer for transportation
3	Ensure stator is well secured to trailer both axially and to the trailer bed
4	Obtain a Global Positioning System (GPS) indicator, if needed
5	Determine if the transportation route and level of environmental protection required
6	Coordinate the final mechanical inspection of the stator assembly on the trailer by the trucking service company inspector
7	Obtain a shock / vibration recorder to be used during the shipment

Figure 2-7 shows an example of a generator stator being shipped via a truck trailer.

Figure 2-7
Stator Shipping by Truck Example
(Picture courtesy of XCEL Energy)

2.3.2.2 Generator Stator Shipping via Rail

The loading guidelines for dimensional loads for your local rail carrier service provider can be found on their website. If any questions arise, please contact your service provider for clarifications. When shipping a stator frame via rail car the following items should be addressed by the shipper:

Table 2-18
Generator Stator Shipped by Rail Items to Address

1	Contact rail service provider for clearance and weight information to determine routing to destination
2	Coordinate with rail service provider for appropriate duty flat car for transportation and loading date
3	Ensure stator frame is well secured to rail car bed
4	Obtain a Global Positioning System (GPS) indicator, if needed
5	Obtain a shock / vibration recorder to be used during the shipment
6	Coordinate the final mechanical inspection of the stator frame on the rail car by the rail service company inspector

2.3.2.3 Generator Stator Shipping via Barge or Ship

When shipping a stator via barge or ship the following issues should be addressed by the shipper:

Table 2-19
Generator Stator Shipped by Barge or Ship Items to Address

1	Contact barge or ship service provider for clearance and weight information to determine port for shipping and destination
2	Contact generator stator OEM supplier for recommendations and requirements
3	Coordinate with barge or ship service provider for appropriate support structure required for handling all movements expected during water transportation.
4	Construct significant, engineered stator shipping container to securely hold and environmentally protect the stator during shipment. There are vendors who specialize in engineering and building enclosures for water transportation both domestically and internationally. Structures must be built for transportation of the component in rough water conditions as these can occur at any time.
5	Obtain a Global Positioning System (GPS) indicator, if needed
6	Obtain a shock / vibration recorder to be used during the shipment

2.3.2.4 Generator Stator Shipping Best Practices

Generator stator shipping best practices are shown in Table 2-20.

Table 2-20
Generator Stator Shipping Best Practices

1	A shipping plan should be developed in conjunction with the OEM
2	Special rigging, blocking, handling, and shipping will be required
3	Stator drawing showing weight dimensions, and center of gravity information should be provided to shipper
4	Stator lifting drawings and instructions should be provider to shipper
5	Ship smaller stators with the rotor installed, if possible
6	Seal all openings with a silicone gasket material and weatherproof covers
7	Ideally the stator should be blanketed with an inert gas environment
8	All machined and sealing surfaces should be protected with a thin film of asphalt based coating during shipment
9	An external station to perform electrical testing should be provided
10	Heaters should be placed inside stators not under an inert gas blanketing for moisture control
11	For international shipments, components should always be enclosed in a container with an inert gas blanket environment
12	Desiccant bags should be placed inside the stator for all shipments
13	A hygrometer should be installed for constant relative humidity readings
14	Stator should be covered with a weatherproof tarpaulin during domestic shipments
15	All shipments should include a shock/vibration recorder

2.3.3 Retaining Rings

Generator retaining rings are subject to corrosion when exposed to any moisture. Special care should be taken to ensure spare retaining rings are not exposed to any moisture at any time. EPRI Report TR-102949, Generator Retaining Ring Moisture Protection Guide, September 1993 is a good source for protection of generator retaining rings in operation, standby, maintenance, or storage. Section B Manufacturer's Recommended Practices of EPRI Report TR-102949 contains instructions on handling retaining rings of multiple OEMs.

The OEM should be contacted for their specific instructions on handing a specific spare generator retaining ring. For both domestic and international shipping, retaining rings should be coated with a light film, placed on end inside an environmental bag and positioned in a sealed enclosure. Retaining rings should be packaged and shipped on end to maintain the roundness of the ring. Retaining rings should be supported on hard rubber, aluminum, or copper and

positioned to not come in contact with the environmental bags. Desiccant bags should be placed inside the environmental bag but not be in contact with the retaining ring. Spare retaining rings should not come in contact with wood, paper, or plastic sheeting.

2.3.3.1 Retaining Ring Shipping Best Practices

Best practices for shipping a spare retaining ring are shown in Table 2-21.

Table 2-21
Retaining Ring Shipping Best Practices

1	The OEM should be contacted for specific shipping recommendations for all retaining rings
2	Coat the ring with a light oil film
3	Ring should be supported on hard rubber, aluminum, or copper and placed inside an environmental bag that can be sealed
4	The ring should be packaged and shipped on end to maintain the roundness
5	Desiccant bags should be placed inside the environmental bag before sealing but not come in contact with the retaining ring
6	Do not allow the ring to come in contact with any wood, paper, or plastic
7	For international shipments, retaining rings should be enclosed in a container with an inert gas blanket environment

2.3.4 Stator Coils/Bars

Stator coils and bars are typically shipped in wooden boxes, wrapped in plastic with desiccant bags enclosed or taped to the bar ends. Depending on the stator bar configuration, special supports and enclosures may be required to keep the bars from distortion or bending. Due to various configurations, stator bars should be stored and shipped in the original boxes from the OEM or supplier if possible.

A shock / vibration recorder should be attached to the packaging box during the shipments of stator coils and bars. Spare coils can be damaged if shocked during shipment. A complete visual inspection for damage upon arrival would require complete uncrating the contents. Excessive handling of the coils increases the risk of damage.

2.3.4.1 Stator Coils/Bars Shipping Best Practices

Best practices for shipping spare stator coils and bars are shown in Table 2-22.

Table 2-22
Spare Stator Coils and Bars Shipping Best Practices

1	Stator bars should be shipped in the original boxes from the OEM
2	Wrap coils and bars in plastic with desiccant bags taped to the bar ends
3	Enclose the coils and bars inside wooden boxes with supports to keep bars from distortion or bending
4	Place desiccant bags inside the wooden boxes
5	Always ship with an attached shock/vibration recorder

2.4 Miscellaneous Components

Preparation of miscellaneous components for shipment is usually performed at the site for components, such as crossover piping, turning gear assemblies, lubrication system equipment and piping, and other components. Typically the domestic shipping requirements for these components would be by commercial or vendor truck due to their smaller sizes and configurations. Shipment times typically are less than week duration.

For international shipping, these components should be packaged in plastic lined wooden enclosures for protection from saltwater and spray. Desiccant bags should be placed inside the enclosures for additional moisture protection.

2.4.1 Crossover Piping

The machined gasket surfaces of the crossover piping should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E for protection from corrosion. All openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside the piping. The crossover piping is typically secured to the vendor truck via strapping and wooden blocking.

For international shipments, crossover piping should be boxed into moisture proof packaging with desiccant placed inside to absorb any moisture.

2.4.1.1 Crossover Piping Shipping Best Practices

Figure 2-8 shows an example of crossover piping ready getting prepared for shipment.

Figure 2-8
Crossover Pipe Shipping Example
(Picture courtesy of Entergy Corporation)

Best practices for shipping crossover piping are shown in Table 2-23.

Table 2-23
Crossover Piping Shipping Best Practices

1	Coat all machined and sealing surfaces with a wax based corrosion preventive compound
2	Cover and tape seal all openings with a wooden or fiberglass covering
3	Enclose the piping in moisture packaging with desiccant bags placed inside for international shipping

2.4.2 Turning Gear Assemblies

Turning gear assemblies are typically shipped domestically via commercial vendor truck on a wooden pallet or skid with a VCI paper spacer at all contact points. Turning gear assemblies are typically shipped whole with any exposed machined surfaces coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E. The wooden pallet or skid should be loosely covered with a waterproof tarpaulin for general environmental protection once mounted on the commercial vendor truck.

For shipments at sea, the turning gear should be boxed into moisture proof packaging with desiccant placed inside to absorb any moisture.

2.4.2.1 Turning Gear Assembly Shipping Best Practices

Best practices for shipping turning gear assemblies are shown in Table 2-24.

Table 2-24
Turning Gear Assembly Shipping Best Practices

1	Coat all exposed machined and sealing surfaces with a wax based corrosion preventive compound
2	Cover and tape seal all openings with a wooden or fiberglass covering
3	Place VCI paper between the turning gear assembly and any wooden cribbing
4	Generally ship assembly complete with motor attached if possible
5	Enclose the piping in moisture packaging with desiccant bags placed inside for international shipping
6	Loosely cover with a weatherproof tarpaulin for domestic shipping

2.4.3 Lubrication System Equipment and Piping

2.4.3.1 Main Oil Tank Assembly

The main oil tank and associated equipment is typically shipped domestically via commercial vendor truck on a wooden pallet or skid with a VCI paper spacer at all contact points. The main oil tank may be shipped with the pumps, motors, and instrumentation installed if physical size allows. The motors and instrumentation should be wrapped in waterproof coverings for environmental protection. All openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside the tank. The tank is typically attached to the vendor truck with strapping and wooden blocking. Also the main oil tank assembly should be covered with a waterproof tarpaulin for general environmental protection.

For overseas shipments, the main oil tank should be shipped with pumps, motors, and instrumentation shipped separately. All tank openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside. Desiccant bags and humidity indicators should be placed inside the tank for indication and removal of any moisture during transportation. The pumps, motors and instrumentation should be shipped in their own seal enclosures with desiccant bags and humidity indicators.

2.4.3.2 Lubrication Piping

Lubrication piping is typically pickled and oiled prior to shipment by the OEM or supplier. New lubrication piping is typically packaged in large wooden shipping boxes with both inner and outer piping in major section assemblies. The wooden shipping boxes should be wrapped in plastic for environmental protection for both domestic and international shipments. Once at the

site the plastic should be permanently removed for indoor storage. Machined gasket surfaces of the lubrication system piping should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E for protection from corrosion. All openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside the piping. For domestic shipments, lubrication piping is typically shipped loose in sections and secured to the commercial or vendor truck via strapping and wooden blocking.

2.4.3.3 Lubrication System Equipment Shipping Best Practices

Best practices for shipping lubrication system equipment are shown in Table 2-25.

Table 2-25
Lubrication System Equipment Shipping Best Practices

1	Coat all exposed machined and sealing surfaces with a wax based corrosion preventive compound on the main oil tank assembly
2	Cover and tape seal all main oil tank openings with a wooden or fiberglass covering
3	Generally ship assembly complete with motor, instrumentation, and pumps installed if possible
4	Wrap all motors, instrumentation, and pumps with waterproof covering for moisture protection
5	Place desiccant bags inside the main oil tank
6	For international shipping, motors, instrumentation, and pumps should be shipped separately in their own sealed enclosures from the main oil tank
7	Coat all lubrication piping machined and sealing surfaces with a wax based corrosion preventive compound
8	Cover and tape seal all lubrication piping openings with a wooden or fiberglass covering
9	Enclose the lubrication piping in moisture proof packaging with desiccant bags placed inside for international shipping

2.4.4 High Voltage Bushings

High voltage bushings consist of metal and fragile ceramic components that require packaging for shipment in a box that supports the entire bushing and specifically protects the bushing ceramic insulator from shattering or cracking from any shock impact. The shipping box is typically constructed of wood with the bushing supported on the metal ends with the ceramic insulator framed in the middle of the box. Rubber should be placed between the metal bushing and the wooden box framing for shock protection. EPRI report 1016787 Generator High-Voltage Bushing Installation Guide provides more detailed instructions on shipping and storage of bushings. Domestic shipping a bushing wooden shipping box would not typically require the box to be lined or sealed in plastic unless wet weather conditions are expected. However, desiccant bags should be placed inside the wooden box to absorb any moisture. For international shipping, a high voltage bushing shipping box should be sealed in plastic to keep out any salt water or mist and with desiccant bags placed inside.

2.4.4.1 High Voltage Bushing Shipping Best Practices

Best practices for shipping high voltage bushings are shown in Table 2-26.

Table 2-26
High Voltage Bushing Shipping Best Practices

1	Bushings must be supported to protect ceramic components with main packaging support at the bushing metal ends
2	Shipping enclosures should be generally made of wood
3	Rubber must be placed between the bushing and all wooden support packaging for shock protection
4	Place desiccant bags inside the wooden boxes
5	For international shipping the bushing should be packaged inside sealed waterproof enclosure with desiccant bags inside

2.4.5 Rotating and Brushless Exciters

Rotating and Brushless exciter and components need to be protected from the environmental elements during shipment to and from the site. The exciter unit is generally shipped assembled with the coolers, ventilation assembly, and housing removed. Spare exciter rotors are typically shipped enclosed in an inert gas blanketed enclosure. Exciter stators shipped separately with any openings sealed with weatherproof covers.

If shipping domestically, the exciter is typically assembled and enclosed with a tarpaulin, polyethylene, or other sealed weatherproof cover. Desiccant is placed inside the enclosure for random moisture collection and humidity control. Machined surfaces of the exciter and components should be protected with a light oil coating that meets Military Specification MIL-PRF-16173E and/or wrapped in vapor corrosion inhibitor (VCI) treated paper for protection.

For international shipment, the assembled exciter is typically enclosed in an inert dry gas blanketed enclosure. The enclosure should contain desiccant bags to absorb any water or water vapor that may get into the enclosure and to help maintain the relative humidity inside the enclosure. Machined surfaces of the exciter and components should be protected with a light oil coating that meets Military Specification MIL-PRF-16173E.

Figure 2-9 shows an example of an exciter in shrink wrap ready for shipment or storage.

Figure 2-9
Exciter Prepared for Shipment and Storage Example
(Picture courtesy of Dominion)

2.4.5.1 Exciter Shipping Best Practices

Exciter shipping best practices are shown in Table 2-27.

Table 2-27
Exciter Shipping Best Practices

1	A shipping plan should be developed in conjunction with the OEM
2	Generally ship exciters assembled with the coolers, ventilation assembly, and housing removed
3	Ship smaller exciters with the rotor installed, if possible
4	Machined surfaces should be coated with a light oil coating and/or wrapped in vapor corrosion inhibitor (VCI) treated paper
5	Seal all exterior openings with a silicone gasket material and weatherproof covers
6	For international shipping the exciter should be enclosed in a sealed moisture packaging under an inert gas blanket environment
7	Desiccant bags should be placed inside the enclosure for all international shipments
8	A hygrometer should be installed on the enclosure for constant relative humidity readings
9	Exciters should be covered with a weatherproof tarpaulin during domestic shipments
10	All shipments should include a shock/vibration recorder

2.5 Environmental Considerations

When shipping any turbine generator component, one of the main considerations should be protection of the component from the environmental conditions likely to occur during transportation. Reduction and elimination of exposure to moisture and/or corrosive environments are the primary environmental concerns. Components to be shipped on an ocean or river, near the seacoast, through corrosive industrial areas, or during times of high humidity should always be protected against exposure to moisture and corrosion. For optimal protection, the component should be enclosed in an individual enclosure sealed from the atmosphere. The sealed enclosure may contain an atmosphere of inert dry gas or dehumidified air if expecting harsh environmental conditions. The sealed enclosures should also contain desiccant bags in case the inert dry gas or dehumidified air systems should fail. Consideration should be given for a shrink wrap system if your shipping situation warrants. Component machined journal surfaces should be coated with asphalt or petroleum type based coatings that meet the performance requirements of Military Specification MIL-PRF-16173E. Component non -journal machined surfaces, such as mating fit surfaces, instrument penetrations, etc., should be protected with a wax based coatings that meet the performance requirements of Military Specification MIL-PRF-16173E. All component non-machined areas should be wrapped in vapor corrosion inhibitor (VCI) treated paper.

Heavier component enclosures should not be stacked during shipments to prevent potential damage due to crushing of the sealed enclosures. The sealed enclosures should be stored with enough spacing between each other to allow adequate ventilation to help prevent moisture and condensation. Adequate spacing will also allow for the sealed enclosures to be inspected for integrity during transportation. If allowed by the OEM, thermostatic controlled electrical heaters or heat lamps may also be used inside the enclosures to prevent moisture if special care is taken to eliminate any fire potential. Use of heaters or heat lamps should be discussed with the OEM before use.

2.6 Inspection Requirements During Transportation

2.6.1 Shipping Inspections Prior to Transportation

Shipments must be inspected by the appropriate transporting inspectors before transportation can occur. As an example for rail shipments, inspections by the rail service company inspector prior to shipment are required to ensure the component being shipped is properly attached and positioned on the rail car for protection of both the shipped component and the rail car during the transportation. The rail service company inspector should be able to determine that the component can be safety shipped along the planned rail route.

2.6.2 Inspections During and After Transportation

During transportation the component should be inspected periodically by the transporter to ensure the component moisture protection is maintained. Any breech of the moisture prevention covering should be repaired as soon as found and any desiccant materials located inside any

enclosures reconditioned or replaced as required. Signs of moisture damage to the component should be repaired and any wax or asphalt or petroleum type based coatings reapplied as necessary. Inspect each component to ensure there is no water located in crevices, pockets, holes, or other areas.

If during shipment a packaged component was exposed to low temperatures; i.e. temperatures lower than the temperature at the receiving area/building; it should not be unpacked until sufficient time; typically twenty-four (24) hours; has elapsed for the component to attain ambient temperature. Obtaining ambient temperature of the receiving area will help minimize the potential of the component of sweating and forming condensation with resulting potential moisture or rust damage.

Upon receipt the component should be carefully inspected for any signs of damage or stress. The vibration/shock monitors should be recorded and evaluated for any indication of humping or shock. Any indications should be addressed immediately with the shipper and transportation company.

Interview the transporter to ensure all components of the shipment are received and no parts are stored in other locations on the truck, trailer, rail car, barge, or ship.

During the receiving process, the component should be inspected per the following Table 2-28 with the results documented:

Table 2-28
Shipment Inspections

1	Take “as-received” pictures of the shipped component before, during, and after unloading activities.
2	Visually inspect the component for any signs of damage. Document any damage by taking pictures.
3	Visually inspect for any damage to the support shipping cradle or structure. Look for loose connections, missing tie-downs, damaged blocking, or missing coverings/coatings. Note any abnormal conditions.
4	Visually inspect the component to ensure it is properly positioned in the shipping cradle or structure. Ensure the component has not shifted or moved within the cradle.
5	Visually inspect the component for any signs of exposure to the weather or atmosphere. Check for signs of water marks, corrosion, dampness, dirt, or salt film. Verify all desiccant bags, if used, are not water saturated. Replace or regenerate as needed. Verify enclosures relative humidity, if applicable.
6	If corrosion is found on any part of a component, the entire component should be given a through visual and physical inspection.
7	Visually check that all coatings and preservatives are in place and have not been damaged, are cracked, or peeling. If coatings or preservatives are damaged, remove all coatings and perform detailed inspection of machined surfaces for rust and corrosion.

8	Visually inspect for improper handling. Check for a damaged boxes or enclosures, tears or holes in vapor barriers, obtain and document vibration/shock monitor readings if applicable, and check for signs of physical damage to the component.
9	Verify inert dry gas blanket is intact, if applicable.
10	Check recorder and metered data, if applicable.
11	Visually inspect for any damage to the support shipping cradle or structure. Look for loose connections, missing tie-downs, damaged blocking, or missing coverings/coatings. Note any abnormal conditions.
12	Take pictures of major components during and after unloading.

2.7 References

ASME/ANSI N45.2.2 Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants

EPRI TR-1014717 Project Management Guidance when Upgrading Steam Turbines at Nuclear and Fossil Power Plants, Section 7

EPRI TR-1007914 Lifting, Rigging, and Small Hoist Usage Program guide

EPRI TR-1009706 Rigger's Handbook

ANTONOV Aeronautical Scientific/Technical Complex website http://www.antonov.com

Global Positioning System website http://www.gps.gov

United States Department of Defense specification MIL-PRF-16173E, PERFORMANCE SPECIFICATION CORROSION PREVENTIVE COMPOUND, SOLVENT CUTBACK, COLD-APPLICATION (6 JAN 1993) website http://everyspec.com

EPRI TR-102949 Generator Retaining Ring Moisture Protection Guide, September 1993

EPRI PID 1016787 Generator High-Voltage Bushing Installation Guide

3
STORAGE PRACTICES

3.1 General Discussion

The recommendations given in this guide should be used as general instructions for storage of spare major components and should not be considered complete for all situations as there are many variables required to be taken into consideration for each location and circumstances. Application of this report should be implemented at the discretion of each end user. The main objectives of preparing a component for storage should be to provide protective means to eliminate or greatly reduce chances of physical damage, reduce or eliminate exposure to moisture, reduce or eliminate exposure to corrosive environments, and address any other adverse conditions during storage. The OEM of the steam turbine generator components should be contacted for specific storage instructions and advice for any major component as appropriate.

Caution: Strict adherence to the OEM's or component manufacturer's storage and testing requirements for any new or refurbished components subject to warranty, performance, or other contractual guarantees should be followed on a case-by-case basis to support and maintain contractual requirements.

Generally selection of storage areas for spare turbine generator major components should consider the following:

Table 3-1
Storage Areas Selection Criteria

1	Proximity to end use location
2	Adequate protection from environmental elements
3	Material handling equipment (cranes, fork lift, trucks, etc.) accessibility
4	Accessible for inspections and maintenance
5	Area has adequate drainage and no running water
6	Protection from vegetation, rodents, vermin, etc.
7	Security protection from damage and theft
8	Electrical power availability (for strip heaters and lighting)
9	Component not subject to building or structural vibrations

Whether for short or long term storage spare steam turbine and generator major components should be stored in a controlled environment that protects the component from the elements and allows for periodic inspections and/or maintenance of the components. Consideration should be given for the type of component, the ways it can be degraded due to exposure to the elements, minimization of risk of potential physical damage, and how long the component is expected to be in storage. Generally most steam turbine generator components should be stored indoors with added protection from exposure to corrosive environments, protection from exposure to humidity from temperature changes, and direct exposure to moisture. Components may be stored outdoors if the component is stored in a specialized enclosure designed for outdoor storage for the specific location. The storage area should be free from rapid temperature changes and, if necessary, an additional heat source should be used to maintain the temperature about the current dew point. Some components, such as turbine crossover piping or turbine outer shells, may be routinely stored outdoors if machined surfaces are properly coated and the component weatherproof protected from the elements with proper coverings. Components should be stored with enough spacing to allow ventilation between them with room to perform inspections and maintenance as needed. Whether stored indoors or outdoors, all components should be stored on blocks high enough that any surface or flood water will not come in contact with the component. Proper blocking should set the component in a level position. Also, components should be protected such that no moisture can be sprayed or dripped onto the component in case of a local steam or water leak. Components should not be stored in an area that would subject the component to vibration.

Outdoor storage is a laydown area or yard free of trees, bushes, and rapid growth vegetation that is open to atmospheric conditions. Sufficient blocking must be used to elevate and level the component above any potential standing or running water. The component should be covered with a tarpaulin or equivalent to avoid exposure to rain and airborne dust but allow adequate ventilation to prevent moisture accumulation. Cover all openings for access, ventilation, conduit connections, etc., to prevent entry of rodents, snakes, birds, and insects, etc.

Figure 3-1 shows turbine components packaged and stored outdoors.

Figure 3-1
Turbine Components Stored Outdoors
(Picture courtesy of South Texas Project)

Indoor storage is a weather-tight ventilated building or structure that is typically unheated but may be heated or cooled at locations with temperature extremes. The building typically has a solid floor and not located in a flood plain or zone. Sufficient blocking must be used to elevate and support the component above any potential flood water. Components stored indoors are typically in racks, frames, or boxes. They should not be stacked but arranged for adequate ventilation and inspection. Indoor stored components may be covered with a tarpaulin or equivalent to avoid exposure to dirt and dust but allow adequate ventilation to prevent moisture accumulation.

Controlled environmental storage is an area with uniform temperature control to eliminate condensation due to atmospheric temperature changes or an atmospheric controlled environment such as inert dry gas blanketing. Controlled environmental storage excludes exposure of the component to any moisture, dirt, or dust. It is required for the most sensitive components, such as electrical insulation, electronic instrumentation, machined components, and rotating metal components subject to corrosion or damage due to exposure to the atmosphere.

Material handling equipment accessibility for moving large turbine generator components can be important if the component is stored outdoors. Access for mobile equipment such as cranes, fork trucks, and trucks should be considered when locating components in storage. A consideration for cold climate storage locations is adequate protection must be provided to prevent salt from being sprayed onto components located near roadways. In colder climates, roadways are commonly sprayed with a salt mixture for elimination of ice and snow and can be very corrosion to contacted metal surfaces.

3.1.1 Emergency Component Spares

Many utilities keep older and used major turbine and generator components as emergency spares should a failure of the replacement component occur. Often it is tempting for the utility to keep the used component but not spend the funds for refurbishment of a component that may never be used again. There are many economic and risk factors not addressed in this guideline that contribute to determination whether the utility has the used component refurbished or remain in the "as removed" condition.

Whether the components are refurbished or not, if they are to be kept for potential future usage, they should be shipped, stored, and maintained as close to new components as possible. Components should be protected from exposure to moisture, have appropriate areas coated with preservatives, kept in a heated, dehumidified or inert gas environment, as needed.

3.2 Turbine Components

3.2.1 Turbine Rotors

Whether for short or long term storage, turbine rotors should be stored indoors and have preservatives applied to bearing journal and other non-bearing surfaces for protection against exposure to moisture and corrosive atmospheres. Some OEM's package spare turbine rotors in an enclosure with inert dry gas blanketing that can be stored outdoors and this needs to be verified before storing the rotor outdoors. Rotors not enclosed in a specifically design environmental enclosure suitable for outdoor storage should be stored in an indoor facility. The indoor storage facility may not be heated but should be able to maintain the rotor temperature 10 degrees F (6 degrees C) above the ambient dew point temperature to prevent condensation from forming on the rotor. The ambient dew point temperature is the temperature at which the liquid water, or dew, evaporates at the same rate at which it condenses. The ambient air dew point will need to be determined and for most locations it is most likely to occur during night and early morning periods. Heaters, heat lamps, or warm air ventilation systems may be used with an enclosure to help maintain temperature above the ambient dew point.

Caution: Care should be given to not create a fire hazard as some of the protective coatings and preservatives are flammable.

3.2.1.1 Short Term Turbine Rotor Storage

For short term storage of less than 6 months, a turbine rotor should be stored indoors in the original shipping cradle with most of the original shipping protection intact. The rotor will need to be stored with high enough blocking to ensure no surface or flood water can come in contact with the rotor surface. Also, the rotor should be positioned in an area and protected from the risk of dripping or spraying water or steam.

Before storing and at 3 month intervals, the rotor should be visually inspected for any signs of exposure to moisture, damage, or deterioration of the preservatives or coatings. Any signs of damage found should be investigated by removing the preservatives, cleaning the rotor area, and removal of any rust or corrosion.

Caution: The OEM procedures, coating Material Safety Data Sheet (MSDS) information, and site safety procedures should be followed when removing coatings to not damage the rotor surfaces nor create an environmental or safety situation.

All VCI paper and wrappings should be removed to reduce the risk of mildew or moisture forming under the paper. Once the rotor has been cleaned and all rust or corrosion repaired, the asphalt or petroleum type and wax coatings should be reapplied. All tarpaulins should be removed or positioned to loosely cover the rotor to allow for adequate ventilation.

If the rotor has been shrink wrap packaged, it should be inspected to verify no breaks in the shrink wrap and that proper desiccant bags are installed and functional with the relative humidity properly maintained. Desiccant bags should also be placed inside all of the enclosures for absorption of any residual water or vapor that may develop or if the inert dry gas blanket, dehumidified air system, or shrink wrap vacuum system should fail.

Wooden cradles or frames can be used for short time support and storage of turbine rotors if non-hydroscopic Teflon, Textolite, polyethylene, rubber, or plastic shims have been installed between the rotor and the wood at all contact points.

If the rotor is enclosed in an environmental bag or metal container under an inert dry gas blanket, the enclosure and inert dry gas blanket should be maintained intact during short term storage. For most sealed enclosures, inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal). Relative humidity should be checked weekly inside the enclosure and be maintained at less than 40% at all times. To eliminate safety concerns, the inert dry gas system may be replaced with a dehumidified air or air conditioning system. Site procedures for purging and installing inert dry gas should be followed. Any desiccant bags should be inspected, reconditioned, and replaced as required.

3.2.1.2 Long Term Turbine Rotor Storage

For long term storage of greater than 6 months, the same procedures apply as for short term storage with the following exceptions.

Metal cradles or frames should be used for long term support and storage of turbine rotors as wood cradles will deteriorate over time. The turbine rotor should be supported as specified on the OEM drawings and not on the machined bearing journal surfaces. Non-hydroscopic Teflon, Textolite, polyethylene, rubber, or plastic shims should be installed between the rotor and the cradle at all contact points.

Turbine rotors stored for long periods of time can be subject to developing a slight temporary sag or bow due to its own weight if not fully supported within the frame or cradle per the OEM recommendations. The longer length of the rotor, the more likely temporary bowing can be an issue. The amount of allowable temporary rotor bow tolerances for any specific rotor will vary from one rotor to another and is typically specified by the OEM. Temporary rotor bows are generally not a problem and are removed by rotating the rotor with the turning gear once it is installed in the unit.

Periodic rotation of the rotor when in storage is one way to keep rotor temporary bowing to a minimum but that comes with a cost and potential risks. To be rotated, the rotor will need to be removed from the storage environment, rotated, preservatives reapplied, and then reinstalled within the storage environment. A crane with enough capacity and rigging must be available to lift and rotate the rotor safely. Potential damage to the rotor or to the preservatives is more likely to occur as the rotor is handled and moved.

A cost effective and less risky solution to reduce rotor bowing is to provide ample center span and cradle supports to keep the rotor straight inside the storage structure.

Decisions on whether to periodically rotate a specific turbine rotor while in storage should be jointly made between the utility and the OEM.

Another possible solution to prevent temporary bowing can be to vertically store the rotor on end, with the heavier end down, if there is ample building structural and crane support for this. However the OEM should be consulted before storing the rotor vertically.

Figure 3-2 shows an example of a turbine rotor storage container. Figure 3-3 shows an example of a turbine rotor stored in shrink wrap.

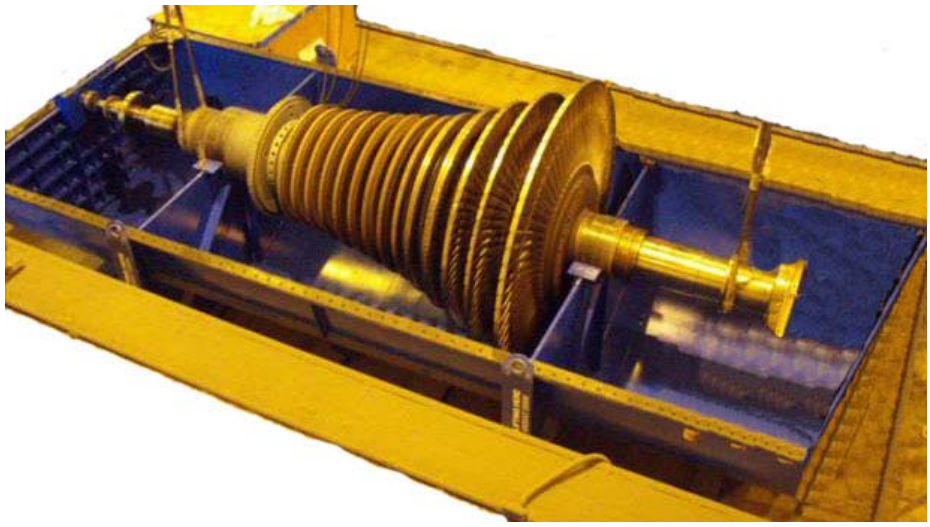

Figure 3-2
Turbine Rotor Storage Container Inside View

(Picture from P3 files)

Figure 3-3
Turbine Rotor Stored in Shrink Wrap
(Picture from P3 files)

3.2.1.3 Turbine Rotor Storage Best Practices

Best practices for storing steam turbine rotors are summarized in the following:

Table 3-2
Turbine Rotor Storage Best Practices

1	Rotors should be stored indoors unless placed in a special designed environmental enclosure for outdoor storage
2	Preservatives should be applied to all bearing journal surfaces
3	The rotor should be supported as specified on OEM drawings and not on bearing journal surfaces
4	Rotor not enclosed in an inert blanket should have all nonbearing surfaces coated with an approved preservative
5	Rotors typically do not have to be rotated during storage if adequately supported to minimize bowing
6	Storage facility should be able to maintain the rotor temperature 10 degrees F (6 degrees C) above the ambient dew point temperature

7	Should be stored with high enough blocking to ensure no surface or flood water can contact the rotor
8	Should be positioned and protected from risk of dripping or spraying water or steam
9	Desiccant bags should be placed inside all enclosures for random moisture control
10	Wooden cradles should only be used for short term storage of rotors of less than 6 months. Cradles should be made of metal for long term storage of rotors
11	Non-hydroscopic Teflon, Textolite, polyethylene, rubber, or plastic shims should be placed between the rotor and all wood cradle contact points. Do not use any Teflon on bearing journal surfaces.
12	Inert gas blanketing pressure should be maintained at all times. Site safety procedures for purging and installing gas pressure should be followed
13	Relative humidity inside all enclosures should be checked weekly
14	The rotor storage location should not be located in a place where structural vibrations can occur. I.e. do not store next to an operating railroad track.

3.2.2 Turbine Shells and Cylinders

Short or long term storage of shells and cylinder components may be located outdoors, if properly prepared, or in an unheated facility. The OEM should be contacted for their recommendations for indoor or outdoor storage of their particular shells and cylinders. Shells and cylinders need to be stored with high enough blocking and blocking to ensure no surface or flood water can come in contact with the shell/cylinder surface. Blocking should elevate the shell/cylinder at least a minimum 12 to 18 inches (30 to 46 cm.) above ground level. Also, if stored indoors, shells and cylinders should be positioned in an area and protected from the risk of dripping or spraying water or steam. Machined surfaces, such as mating fit surfaces, instrument penetrations, etc., should be protected with a wax based coating that meets the performance requirements of Military Specification MIL-PRF-16173E. Steam inlet and extraction outlets are typically covered with a wood, metal, or plastic cover to protect the sealing surfaces. All bolt holes and other potential pockets where water could puddle should be filled with a waterproof grease to prevent moisture exposure or water accumulation. Non-machined surfaces of shells and cylinders are typically painted with an alkyd based primer.

Shells and cylinders are typically stored on wooden blocking and covered loosely with a tarpaulin for protection from the atmospheric conditions. The tarpaulin should be attached for wind resistant if outdoor storage is utilized but allow for adequate ventilation around the shell or cylinder. Shells and cylinders should not be wrapped tightly in any tarpaulin, plastic, or VCI paper to prevent moisture accumulation. The shells or cylinders should be mounted on blocking in a similar position as they will be used when in service. For example lower shell halves should be positioned with the horizontal joint at the top position and upper shell halves should be positioned with the horizontal joint at the bottom. A rubber spacer should be installed between the wooden blocking at the support contact points to help eliminate any potential vapor exposure between the wood and the metal shell/cylinder. Polyethylene or non-hydroscopic Teflon, neoprene, or Textolite material should be placed between the metal spacer and shell/cylinder at all contact points.

3.2.2.1 Turbine Shell Storage Best Practices

Best practices for storing steam turbine shells and cylinders are summarized in the following:

Table 3-3
Turbine Shell and Cylinder Storage Best Practices

1	The OEM should be contacted for specific storage instructions for each shell or cylinder
2	Shells and cylinders can be stored outdoors if properly protected from the environments
3	Preservative coatings should be applied to all machined or sealing surfaces
4	Should be stored and supported in a similar position as used in service
5	A metal shim and rubber should be placed between the shell and cylinder and any wood cribbage contact points
6	All bolt holes and other potential pockets for potential water puddle should be filled with waterproofed grease
7	All steam inlet, extraction outlets, and instrumentation penetrations should be covered and sealed
8	Should be stored with high enough blocking to ensure no surface or flood water can contact the shell or cylinder
9	Should be positioned and protected from risk of dripping or spraying water or steam
10	Should be loosely covered with a tarpaulin for protection from atmospheric conditions

3.2.3 Stationary Components

Stationary components, such as diaphragms, blade rings, and flow guides, are to be stored indoors in an unheated facility and positioned in an area protected from the risk of dripping or spraying water or steam. They should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E. Turbine stationary components should ideally be mounted on metal or wooden frames in a similar position as they will be used when in service. For example lower component halves should be positioned with the horizontal joint at the top position and upper component halves should be positioned with the horizontal joint at the bottom. Figure 3-4 shows an example of a frame fabricated for storing diaphragms. A metal or rubber spacer should be installed between any wooden blocking at the support contact points to help eliminate any potential vapor exposure between the wood and the metal shell/cylinder. Polyethylene or non-hydroscopic Teflon, neoprene, or Textolite material should be placed between the metal spacer and shell/cylinder at all contact points. Stationary components should be loosely covered with a tarpaulin that supplies adequate ventilation and provides protection from dust, dirt, and moisture.

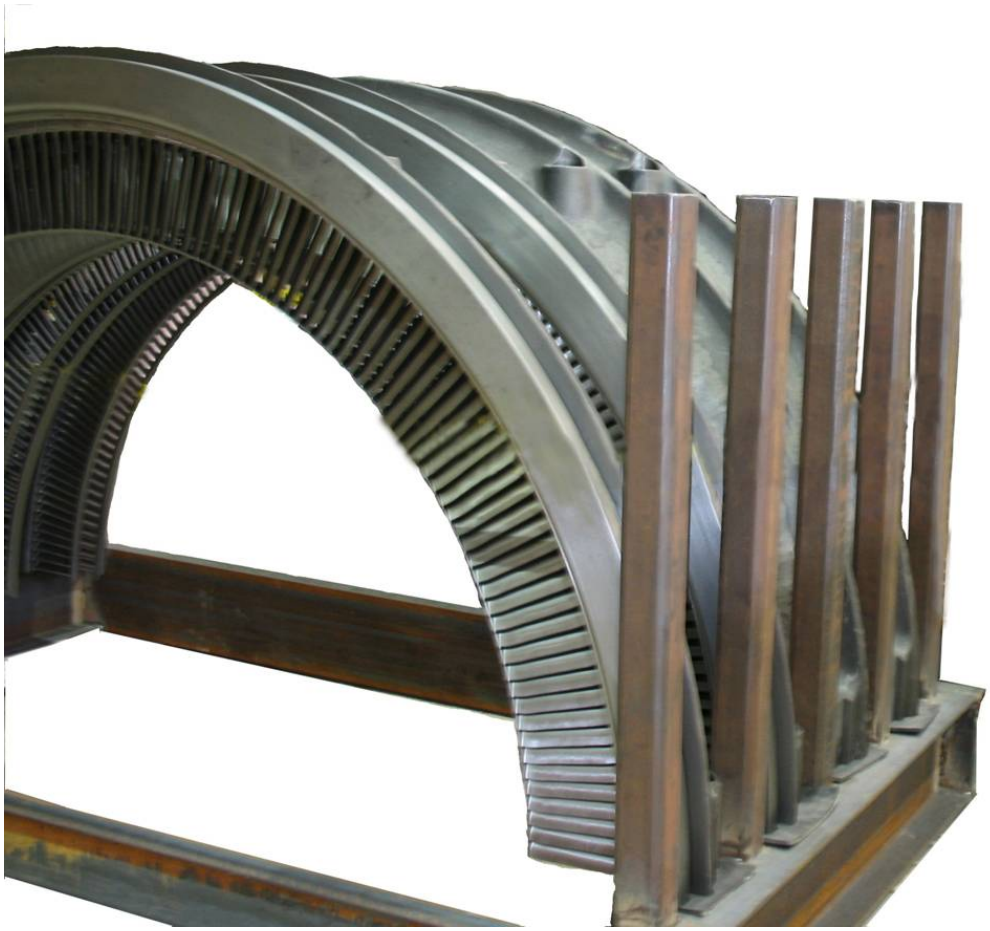

Figure 3-4
Diaphragm Storage Rack
(Picture from P3 files)

In tropical regions, some utilities are storing new and reconditioned spare stationary components inside sealed environmental bags or in sealed enclosures under an inert gas blanketing for added protection. Desiccant bags should be placed inside all bags and enclosures for random moisture protection. Inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal) and relative humidity should be checked weekly and maintained at less than 40% at all times. Site procedures for purging and installing inert dry gas should be followed.

3.2.3.1 Turbine Stationary Component Storage Best Practices

Best practices for storing steam turbine stationary components are summarized in the following:

Table 3-4
Turbine Stationary Component Storage Best Practices

1	Metal or wooden racks should be constructed to store stationary components
2	Stationary components should be stored indoors in a heated or unheated facility
3	Preservative coatings should be applied to all machined or sealing surfaces
4	Should be stored and supported in a similar position as used in service
5	A metal shim and rubber should be placed between any stationary component and any wooden rack or cribbage contact points
8	Should be stored with high enough blocking to ensure no surface or flood water can contact the stationary component
9	Should be positioned and protected from risk of dripping or spraying water or steam
10	Stationary components stored in tropical regions should be in an environmental bag or sealed enclosure

3.2.4 Assembled and Packaged Turbines

Short or long term storage of assembled or packaged turbines typically should be indoors in an unheated facility. A plan for storing an assembled turbine should be developed in conjunction with the OEM for their particular assembled or packaged turbine. Typically the assembled turbine can be stored in the OEM shipping packaging or shrink wrap for up to three (3) months. If the assembled turbine is to be stored longer, the OEM shipping packaging or shrink wrap should be removed, the components inspected, and any damaged or missing preservatives reapplied. Stored assembled turbines should not be wrapped tightly in any tarpaulin, plastic, or VCI paper for any long periods of time to prevent moisture accumulation.

An assembled turbine needs to be stored with high enough blocking and blocking to ensure no surface or flood water can come in contact with any shell/cylinder surface. Blocking should elevate the assembled turbine at least a minimum 12 to 18 inches (30 to 46 cm.) above ground level. Also, when stored indoors, the assemble turbine should be positioned in an area and protected from the risk of dripping or spraying water or steam.

All machined surfaces on the assembled turbine should be coated with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E. Any openings of the assembled turbine should be sealed and taped.

Ideally, assembled turbines stored long term should be in an enclosure blanketed with inert dry gas pressure between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal) with desiccant bags placed inside for random moisture control. A direct reading hygrometer should be installed for periodic relative humidity readings.

An electrical heater can be installed inside the assembled turbine enclosure and energized at all times for moisture control if the turbine is not under an inert gas blanket. Keep heaters far

enough away from the metal parts of the assembled turbine so that no part's surface temperature exceeds 120 degrees F (49 degrees C). An assembled turbine not blanketed with inert gas should have desiccant bags installed for moisture control with the desiccant bags positioned near an opening within easy reach from outside of the assembled turbine through one of the sealed openings.

3.2.4.1 Assembled and Packaged Turbine Storage Best Practices

Best practices for assembled or packaged turbines are summarized in the following:

Table 3-5
Assembled or Packaged Turbine Storage Best Practices

1	A storage plan should be developed in conjunction with the OEM
2	Electric heaters should be installed inside an assembled turbine enclosure for moisture control if not under an inert gas blanket environment. Keep internal temperatures less than 120 degrees F (49degrees C)
3	Desiccant bags should be placed inside sealed assembled turbine for random moisture control
4	Coat all exposed machined surfaces with a thin film of corrosion preventative compound
5	Ideally the entire assembled turbine should be under an inert gas blanket environment for long term storage
6	A hygrometer should be installed for periodic relative humidity monitoring
7	Should be stored and supported in a similar position as used in service
8	Metal shims and rubber should be placed between the shell or cylinder and any wood cribbage contact points
9	All bolt holes and other potential pockets for potential water puddle should be filled with waterproofed grease
10	All steam inlet, extraction outlets, and instrumentation penetrations should be covered and sealed
11	Should be stored with high enough blocking to ensure no surface or flood water can contact the shell or cylinder
12	Should be positioned and protected from risk of dripping or spraying water or steam

3.3 Generator Components

Generator components should be typically stored indoors in a controlled environment as exposure to any moisture can be damaging to most components. Most mechanical components of the generator can be stored in an unheated indoor facility. The generator bearings, rotor, and electrical components should be stored in an indoor heated facility maintained between 50 to 120 degrees F (10 and 49 degrees C) and with a relative humidity maintained at less than 40% at all times. All components should be protected from any exposure to moisture.

Caution: Do not use water or chemical type fire extinguishers in areas where generator electrical components are stored as damage to windings, insulation, or retaining rings can occur if the extinguisher is utilized. Use only carbon dioxide type fire extinguishers specifically designed for use on electrical fires.

3.3.1 Generator Rotor Storage

Generator rotors should be stored inside a facility at a temperature between 50 degrees F (10 degrees C) and 120 degrees F (49 degrees C) with the relative humidity maintained at less than 40% at all times. Ideally, generator rotors should be stored in an environmentally controlled enclosure under a dry inert dry gas blanket or in a sealed environmental bag enclosure. For some cooler climates, a controlled heated enclosure may be needed to be built around the generator rotor to maintain the rotor temperature above the dew point. If used, keep heaters far enough away from the metal and insulated parts of the rotor so that no part's surface temperature exceeds 120 degrees F (49 degrees C). There are vendors that specialize in design and construction of generator rotor enclosures for various environmental conditions. A generator rotor should be in a metal cradle or frame supported on the body, not the bearing journals or the retaining rings. Wooden frames should not be used for long term storage as they deteriorate over time. The rotor will need to be stored with high enough blocking to ensure no surface or flood water can come in contact with the rotor surface. Non-hydroscopic Teflon, Textolite, polyethylene, rubber, or plastic shims should be installed between the rotor and the cradle at all contact points.

The rotor should be positioned in an area and protected from the risk of dripping or spraying water or steam. The rotor should be oriented in the frame so that the rotor poles are in a vertical plane to minimize potential damage to the rotor windings.

Rotor bearing journal surfaces should be coated with an asphalt or petroleum type or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E.

If the generator rotor retaining rings are 18-5 rings, remove the paint and coat with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E.

3.3.1.1 Short Term Generator Rotor Storage

For short term storage of less than 6 months, the generator rotor should be enclosed in a heavy duty cloth covering to prevent any dust, dirt, or foreign materials from entering the cooling passages. Plastic should not be used as it can allow mildew and moisture to develop and accumulate from temperature changes. The collector end should be wrapped with rubber sheeting with test leads for electrically testing the rotor should be extended outside the sheeting. The entire rotor should be enclosed in an environmentally controlled enclosure under a dry inert dry gas blanket or with heated air. Desiccant bags should be placed inside the enclosure to eliminate any moisture.

The generator rotor bearing journals and couplings should be coated with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E.

3.3.1.2 Long Term Generator Rotor Storage

For long term storage of greater than 6 months, the generator rotor should be covered with a sealed enclosure filled with an inert dry gas blanket and with desiccant bags included for random moisture. There are vendors that specialize in design and construction of generator rotor enclosures. For most sealed enclosures, inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal) with an alarm installed to monitor the inert dry gas pressure at all times. Relative humidity should be checked weekly inside the enclosure and be maintained at less than 40% at all times. The humidity of inside the enclosure should be monitored using a hygrometer and desiccant bags replaced as needed. Site procedures for purging and installing inert dry gas should be followed. To eliminate safety concerns, the inert dry gas system may be replaced with a dehumidified air or heated air system. Test leads for electrically insulation resistance measurement testing the rotor should be extended outside the enclosure for periodic electrical testing.

The generator rotor bearing journals and couplings should be coated with a thick film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E.

Typically generator rotors do not have to be rotated during long term storage if they are adequately protected from bowing. Generator rotors stored for long periods of time are subject to developing a slight bow if not fully supported within the cribbing, frame, or cradle. The slight bow can be removed by turning the rotor on the turning gear once installed in the unit. However, generator alignment during installation can be more difficult due to the bowing. The longer length of the rotor the more this will be an issue. Periodic rotation of the rotor is one way to keep bowing to a minimum. However, the rotor will need to be removed and reinstalled from the storage environment to be rotated which can be time consuming and costly. There is also an increase of damage risk with moving the rotor in the frame or cradle. A more cost effective and less risk solution to reduce rotor bowing is to provide ample center span and other supports as needed to help keep the rotor straight inside the storage structure.

Figure 3-5 shows a generator rotor in shrink rap prepared for storage.

Figure 3-5
Generator Rotor Shrink Wrap Storage
(Picture courtesy of NV Energy)

3.3.1.3 Generator Rotor Storage Best Practices

Best practices for storing generator rotors are summarized in the following:

Table 3-6
Generator Rotor Storage Best Practices

1	Rotors should be stored indoors unless placed in a special designed environmental enclosure for outdoor storage
2	Preservatives should be applied to all bearing journal surfaces
3	The rotor should be supported as specified on OEM drawings and not on bearing journal surfaces or retaining rings
4	Stored rotors should have temperature maintained between 50 degrees F (10 degrees C) and 120 degrees F (49 degrees C) with relative humidity less than 40% at all times
5	Rotors typically do not have to be rotated during storage if properly supported to minimize sagging
6	The collector end should be wrapped in rubber sheeting with test leads extended for periodic electrical testing
7	Should be stored with high enough blocking to ensure no surface or flood water can contact the rotor
8	Should be positioned and protected from risk of dripping or spraying water or steam

9	Desiccant bags should be placed inside all enclosures for random moisture control
10	Wooden cradles should only be used for short term storage of rotors of less than 6 months. Cradles should be made of metal for long term storage of rotors
11	Non-hydroscopic Teflon, Textolite, polyethylene, rubber, or plastic shims should be placed between the rotor and all wood cradle contact points. Do not use any Teflon on bearing journal surfaces.

3.3.2 Stator Storage

All machined surfaces on the stator frame should be coated with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E. Any openings of the stator frame and the frame ends should be sealed with a silicone gasket material and weatherproof covers. At a minimum, electrical heaters should be installed inside the enclosed stator frame and energized at all times for moisture control. Keep heaters far enough away from the metal and insulated parts of the stator so that no part's surface temperature exceeds 120 degrees F (49 degrees C). If not filled with inert dry gas, the stator should have desiccant bags installed for moisture control. The desiccant bags should be positioned near an opening within easy reach from outside of the stator. If feasible, the stator frame can be blanketed with inert dry gas pressure between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal) with desiccant bags placed inside for random moisture control. A direct reading hygrometer should be installed for periodic relative humidity readings. An external station to perform electrical insulation resistance measurement and polarization index testing of the windings should be provided without removing sealed covers or inert dry gas blanket. Any reduction in insulation resistance measurement readings taken should be immediately investigated and corrected. For water cooled stators, the water cooling ducts should be dried, all flanges and fittings sealed, and ducts blanketed with inert dry gas.

3.3.2.1 Generator Stator Storage Best Practices

Best practices for storing generator stators are summarized in the following:

Table 3-7
Generator Stator Storage Best Practices

1	A storage plan should be developed in conjunction with the OEM
2	Electric heaters should be installed inside an enclosed stator frame for moisture control if the stator is not under an inert gas blanket environment. Keep internal temperatures less than 120 degrees F (49 degrees C)
3	Desiccant bags should be placed inside sealed stator frames for random moisture control
4	Coat all machined surfaces with a thin film of corrosion preventative compound
5	All stator frame openings should be covered and sealed with a silicone gasket material and weatherproof covers

6	Ideally the entire stator frame should be under an inert gas blanket environment.
7	A hygrometer should be installed for periodic relative humidity monitoring
8	An extended electrical station should be provided for periodic electrical insulation resistance measurements and polarization index testing of the windings without opening up the sealed frame
9	All water cooling ducts should be sealed and blanketed with an inert gas environment

3.3.3 Retaining Rings

Generator retaining rings are suspect to corrosion when exposed to any moisture and should be stored in an indoor heated environment. Special care should be taken to ensure spare retaining rings are not exposed to any moisture or chlorinated solvents at any time. EPRI Report TR-102949, Generator Retaining Ring Moisture Protection Guide, September 1993 is a good source for protection of generator retaining rings in operation, standby, maintenance, or storage. Section B Manufacturer's Recommended Practices of EPRI Report TR-102949 contains instructions on handling retaining rings of multiple OEMs.

The generator OEM should be contacted for their specific instructions on handing a specific spare generator retaining ring. For storage, retaining rings should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E and placed on end inside an environmental bag positioned on end to maintain roundness of the ring. Retaining rings should be supported on hard rubber, aluminum, or copper and positioned to not come in contact with the environmental bags. Desiccant bags should be placed inside the environmental bag but not be in contact with the retaining ring. Spare retaining rings should not come in contact with wood, paper, or plastic sheeting.

3.3.3.1 Generator Retaining Rings Storage Best Practices

Best practices for storing generator retaining rings are summarized in the following:

Table 3-8
Generator Retaining Rings Storage Best Practices

1	The OEM should be contacted for specific storage instructions for each specific retaining ring
2	Retaining rings should be stored in sealed environmental bags inside a wooden box
3	Rings should be stored on end to maintain roundness
4	Rings should be supported on hard rubber, aluminum, or copper
5	Coat rings with a wax based corrosion preventative compound
6	Environmental bags should not contact rings while in storage
7	Rings should not come in contact with wood, paper, or plastic sheeting while in storage
8	Desiccant bags are placed inside the sealed enclosure for random moisture control and not come in contact with the ring

3.3.4 Stator Coils/Bars

Stator coils and bars should be stored in an unheated facility in wooden boxes wrapped in plastic with desiccant bags taped to the bar ends. Typically stator coils and bars are stored in the original boxes from the OEM or supplier. Depending on the stator bars configuration, special supports and enclosures may be required to keep the bars from distortion or bending while in storage.

3.3.4.1 Stator Coils and Bars Storage Best Practices

Best practices for storing generator stator coils and bars are summarized in the following:

Table 3-9
Generator Stator Coils and Bars Storage Best Practices

1	Store spare coils and bars in an un-heated facility in wooden boxes
2	Wrap bars in plastic with desiccant bags taped to the bar ends for moisture control
3	Store coils and bars in original shipping boxes for protection
4	Special supports and enclosures may be needed to keep bars from distortion or bending
5	Protect coils and bars for exposure to moisture at all times

3.4 Miscellaneous Components

3.4.1 Crossover Piping

Crossover piping can be stored outdoors if properly prepared. The machined gasket surfaces and connections of the crossover piping should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E for protection from corrosion. All openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside the piping. The piping will need to be stored with high enough blocking to ensure no surface or flood water can come in contact with the piping surface. The crossover piping should be covered loosely with a tarpaulin for protection from the atmospheric conditions. The tarpaulin should be attached for wind resistant but allow for adequate ventilation around the piping. Crossover piping should not be wrapped tightly in any tarpaulin, plastic, or VCI paper to prevent moisture accumulation.

3.4.1.1 Crossover Piping Storage Best Practices

Best practices for storing crossover piping are shown in Table 3-10.

Table 3-10
Crossover Piping Storage Best Practices

1	Crossover piping can be stored outdoors if properly prepared
2	Ensure blocking high enough to prevent exposure to any surface or flood waters
3	Coat all machined and sealing surfaces with a wax based corrosion preventive compound
4	Cover and tape seal all openings with a wooden or fiberglass covering
5	Loosely cover the crossover piping with a tarpaulin for protection from atmospheric conditions.
6	Do not tightly wrap in any tarpaulin, plastic, or VCI paper.

3.4.2 Turning Gear Assembly

Turning gear assemblies are typically stored in an unheated facility in the original shipping wooden boxes or pallets from the OEM or supplier. Any exposed machined surfaces should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E. The turning gear assembly can be loosely covered with a waterproof tarpaulin for general environmental protection from dust and dirt.

Spare turning gear electrical motors should be stored indoors in an unheated facility. Electric motors should be protected from moisture, dust, and dirt. The motor windings should be kept a few degrees above the dew point to keep out excessive moisture with use of space or strip heaters.

3.4.2.1 Turning Gear Assembly Storage Best Practices

Best practices for storing turning gear assemblies are shown in Table 3-11.

Table 3-11
Turning Gear Assembly Storage Best Practices

1	Store turning gear assemblies indoors in wooden boxes or on wooden pallets
2	Coat all exposed machined and sealing surfaces with a wax based corrosion preventive compound
3	Cover and tape seal all openings with a wooden or fiberglass covering
4	Place VCI paper between the turning gear assembly and any wooden cribbing
5	Generally store assembly complete with motor(s) attached if possible
6	Enclose the piping in moisture packaging with desiccant bags placed inside
7	Loosely cover with a weatherproof tarpaulin for dust and dirt protection
8	Electric motors should have strip heaters installed for moisture protection

3.4.3 Lubrication System and Piping

3.4.3.1 Main Oil Tank Assembly

If the main oil tank has the pumps, vapor extractors, motors, and instrumentation installed then it should be stored in an unheated indoor facility. All openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside the tank. The tank assembly will need to be stored with high enough blocking to ensure no surface or flood water can come in contact with the tank surface. The main oil tank assembly should be covered loosely with a tarpaulin for general environmental protection from dust and dirt.

If the main oil tank does not have the pumps, motors, and instrumentation installed, then it may be stored outdoors if properly protected. All tank openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside. Desiccant bags and humidity indicators are placed inside the tank for indication and removal of any moisture. The tank assembly will need to be stored with high enough blocking; typically a minimum of twelve (12) inches (30 cm), to ensure no surface or flood water can come in contact with the tank.

Machined surfaces, such as piping connections, mounting connections, pump flanges, instrument penetrations, etc., should be protected with a wax based coating that meets the performance requirements of Military Specification MIL-PRF-16173E. All bolt holes and other potential pockets where water could puddle should be filled with a waterproof grease to prevent moisture exposure or water accumulation.

If stored outdoors, the main oil tank assembly should be covered loosely with a tarpaulin for protection from the atmospheric conditions. The tarpaulin should be attached for wind resistant but allow for adequate ventilation around the tank.

Spare or separate main oil tank pumps, vapor extractor, motors and instrumentation should be stored indoors. Electric motors should be protected from moisture, dust, and dirt. The motor windings should be kept a few degrees above the dew point to keep out excessive moisture with use of space or strip heaters.

3.4.3.2 Lubrication Piping

Lubrication piping is typically acid pickled and immersed in an oil bath prior to shipment by the OEM or supplier. New lubrication piping is typically stored in large wooden boxes with both inner and outer piping in major section assemblies. The wooden storage boxes should be stored indoors for environmental protection for both domestic and international environments. All shipping plastic wrapping and enclosures should be permanently removed for indoor storage. Machined gasket surfaces of the lubrication system piping should be coated with a wax based, general purpose, corrosion preventive compound that meets the performance requirements of Military Specification MIL-PRF-16173E for protection from corrosion. All openings should be covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside the piping.

3.4.3.3 Lubrication System Equipment Storage Best Practices

Best practices for storing lubrication system equipment are shown in Table 3-12.

Table 3-12
Lubrication System Equipment Storage Best Practices

1	Generally store main oil tank assembly complete with motor, instrumentation, and pumps installed in an indoor un-heated facility
2	Store main oil tank and piping on high enough blocking for no exposure to surface or flood waters
3	Place desiccant bags inside the main oil tank for random moisture control
4	Coat all exposed machined and sealing surfaces on the main oil tank assembly with a wax based corrosion preventive compound
5	Cover and tape seal all main oil tank openings with a wooden or fiberglass covering
6	Main oil tank assemblies can be stored outdoors if the motors, pumps, vapor extractors, and instrumentation have been removed
7	All motors, instrumentation, vapor extractors, and pumps should be stored indoors
8	Coat all lubrication piping machined and sealing surfaces with a wax based corrosion preventive compound
9	Cover and tape seal all lubrication piping openings with a wooden or fiberglass covering
10	Enclose the lubrication piping in moisture proof packaging with desiccant bags placed inside for tropical storage applications

3.4.4 High Voltage Bushings

High voltage bushings consist of metal and fragile ceramic components that require packaging for storage in a box that supports the entire bushing and specifically protects the bushing ceramic insulator from shattering or cracking from any shock impact. If received in a properly designed shipping box, high voltage bushings should be kept in the original box and stored in a clean, dry site warehouse. A bushing storage box is typically constructed of wood with the bushing supported on the metal ends and the ceramic insulator framed in the middle of the box. Rubber should be placed between the metal bushing and the wooden box framing for shock protection. EPRI report 1016787 Generator High-Voltage Bushing Installation Guide provides more detailed instructions on storage of high voltage bushings. Desiccant bags should be placed inside the wooden box to absorb any moisture. High voltage bushing wooden storage boxes should not be stacked.

Caution: Do not stack high voltage bushings storage boxes.

3.4.4.1 High Voltage Bushing Storage Best Practices

Best practices for storing high voltage bushings are shown in Table 3-13.

Table 3-13
High Voltage Bushing Storage Best Practices

1	High voltage bushing should be stored in the original shipping box if possible constructed
2	Bushings should always be stored indoors
3	Bushings must be supported to protect ceramic components with main packaging support at the bushing metal ends
4	Rubber must be placed between the bushing and all wooden support packaging for shock protection
5	Desiccant bags should be placed inside the wooden storage boxes
6	For international shipping the bushing should be packaged inside sealed waterproof enclosure with desiccant bags inside

3.4.5 Rotating and Brushless Exciter

The exciter assembly should be stored indoors inside a sealed enclosure for moisture protection. Desiccant should be placed inside the enclosure for random moisture and humidity control. All machined surfaces on the exciter assembly should be coated with a thin film of asphalt or petroleum type corrosion preventive compound that meets Military Specification MIL-PRF-16173E. Electrical strip heaters should be installed inside the enclosed exciter and energized at all times to aid with moisture control. Keep heaters far enough away from the metal and insulated parts of the rotor and stator so that no part's surface temperature exceeds 120 degrees F (49 degrees C).

For protection in a tropical or high humidity region, the exciter should be enclosed and blanketed with inert dry gas pressure between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal). Desiccant bags should also be placed inside the enclosure. A direct reading hygrometer should be installed for periodic relative humidity readings.

An external station to perform electrical insulation resistance measurement and polarization index testing of the windings should be provided for use without removing the sealed covers or inert dry gas blanketing. Any reduction in insulation resistance measurement readings taken should be immediately investigated and corrected.

3.5.4.1 Rotating and Brushless Exciter Storage Best Practices

Best practices for storing high voltage bushings are shown in Table 3-14.

Table 3-14
Rotating and Brushless Exciter Storage Best Practices

1	Exciter assemblies should be stored indoors inside a sealed enclosure
2	Desiccant should be placed inside the sealed exciter enclosure for random moisture control
3	All machined surfaces should be coated with a corrosion preventative compound
4	Electric strip heaters should be placed inside the sealed exciter and energized at all times
5	For protection in a tropical or high humidity region, the exciter should be enclosed and blanketed with inert dry gas
6	A direct reading hygrometer should be installed for periodic relative humidity readings
7	An external station to perform electrical insulation resistance measurement and polarization index testing of the windings should be provided for use without removing the sealed covers or inert dry gas blanketing

3.5 References

EPRI TR-102949 *Generator Retaining Ring Moisture Protection Guide*, September 1993

EPRI 1016787 *Generator High-Voltage Bushing Installation Guide*

4
STORAGE INSPECTION AND MAINTENANCE RECOMMENDATIONS

A planned inspection and maintenance program should be developed for each steam turbine generator component in storage. Planned component inspections should be based at a minimum on the OEM recommendations and adapted for the specific site's actual conditions. A checklist for each component should be developed with specific inspection items and instructions. Inspection records and findings should be well documented, maintained, and reviewed on a routine basis to ensure compliance with the planned inspection program and for adjustment of the plan if needed. Maintenance to be performed should be part of the inspection process as soon as problems are found.

4.1 Turbine Rotor

Stored turbine rotors should be visually inspected on a weekly basis to ensure no moisture has come in contact with rotor and all coatings, preservatives, and coverings are intact. Inert dry gas pressures and humidity readings should be taken for rotors stored in environmental bags or in metal containers under an inert dry gas blanket. Inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal). Relative humidity should be maintained at less than 40% at all times.

If the rotor has been shrink wrap packaged, it should be visually inspected weekly to verify no breaks in the shrink wrap and that proper desiccant bags are installed and functional to maintain the relative humidity inside the packaging.

At three (3) month intervals, the rotor should be visually closely inspected for any signs of exposure to moisture. Damage or deterioration of the preservatives or coatings should be investigated by removing the preservatives, cleaning the rotor area, and removal of any rust or corrosion.

Caution: OEM procedures, coating MSDS information, and site safety procedures should be followed when removing coatings to not damage the rotor surfaces nor create an environmental or safety situation.

At least once per year a spot sample inspection of the rotor should take place with the coatings removed from at least one area and the rotor surface inspected. If the annual spot sample inspection finds any corrosion or pitting, then a full inspection of the rotor is needed. The OEM will need to be consulted on any repairs. The rotor should have the coatings reapplied and stored as specified in sections 3.2.1 and 3.2.2 after inspections and repairs.

Stored rotors which are adequately supported on a frame or cradle typically should not require rotation while in storage to prevent bowing or sagging. The OEM should be contacted for rotation requirements for each specific rotor while in storage.

4.2 Turbine Shells

Stored turbine shells and cylinders should be visually inspected on a monthly basis to ensure no moisture has come in contact with shell and that all coatings, preservatives, and coverings are intact. At three (3) month intervals, shells and cylinders should be visually closely inspected for any signs of exposure to moisture. Damage or deterioration of the preservatives or coatings should be investigated by removing the preservatives, cleaning the shell or cylinder area, and removal of any rust or corrosion. Any source of moisture should be corrected with coatings and coverings reapplied to the shell or cylinder for storage per section 3.2.2.

4.3 Turbine Stationary Components

At three (3) month intervals stored turbine diaphragms, blade rings, and flow guides should be visually inspected to ensure no moisture has come in contact with them and all coatings, preservatives, and coverings are intact. Damage or deterioration of the preservatives or coatings should be investigated by removing the preservatives, cleaning the diaphragm, blade ring, and flow guides area and removal of any rust or corrosion. Any source of moisture should be corrected with coatings and coverings reapplied to the diaphragms, blade rings, and flow guides for storage per section 3.2.3.

4.4 Assembled or Packaged Turbines

Stored assembled or packaged turbines should be visually inspected on a weekly basis to ensure no moisture has come in contact with shell or rotor and all coatings, preservatives, and coverings are intact. Inert dry gas pressures and humidity readings should be taken for assembled turbines stored in enclosures under an inert dry gas blanket. Inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal). Relative humidity should be maintained at less than 40% at all times.

If the assembled turbine is stored in the OEM shrink wrap packaging, it should be visually inspected weekly to verify no breaks in the shrink wrap and that proper desiccant bags are installed and functional to maintain the relative humidity inside the packaging.

At three (3) month intervals, the assembled turbine should be visually closely inspected for any signs of exposure to moisture. Damage or deterioration of the preservatives or coatings should be investigated by removing the preservatives, cleaning the rotor area, and removal of any rust or corrosion. The sealed openings containing desiccant bags should be opened and the assembled internal inspected for any signs of moisture. Desiccant bags should be replaced every six (6) months and the openings resealed.

Caution: OEM procedures, coating MSDS information, and site safety procedures should be followed when removing coatings to not damage the rotor surfaces nor create an environmental or safety situation.

For assembled turbines is not under an inert blanket, at least once per year spot sample inspection of the shell machined and rotor surfaces should take place with the coatings removed from at least one area on each and the surfaces closely inspected. If the annual spot sample inspection finds any corrosion or pitting, then the OEM should be consulted to determine if a full inspection of the assembled turbine is warranted. The OEM should be consulted will need to be consulted on any repairs. The assembled turbine should have the coatings and reapplied and stored as specified in sections 3.2.4 after inspections and repairs.

Stored assembled turbine rotors should typically not require rotation while in storage. However, the OEM should be contacted for rotation requirements for each specific assembled turbine rotor while in storage.

4.5 Generator Rotor

Stored generator rotors should be visually inspected on a weekly basis to ensure no moisture has come in contact with rotor and all coatings, preservatives, and coverings are intact. Inert dry gas pressures and humidity readings should be taken for rotors stored in environmental bags or in metal containers under an inert dry gas blanket. Inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal). Relative humidity should be maintained at less than 40% at all times. If the generator rotor is stored in a dehumidified or a heated enclosure, humidity readings should be documented weekly.

At three (3) month intervals, the rotor bearing journals, retaining rings and couplings should be visually closely inspected for any signs of exposure to moisture. Damage or deterioration of the preservatives or coatings should be investigated by removing the preservatives, cleaning the rotor area, and removal of any rust or corrosion.

Caution: OEM procedures, coating MSDS information, and site safety procedures should be followed when removing coatings to not damage the rotor surfaces nor create an environmental or safety situation.

At least once per year a spot sample inspection of the rotor should take place with the coatings removed from at least one area and the rotor surface inspected. If the annual spot sample inspection finds any corrosion or pitting, then a full inspection of the rotor is needed. The OEM will need to be consulted on any repairs. The rotor should have the coatings reapplied and stored as specified in sections 3.3.1.1 and 3.3.1.2 after inspections and repairs.

Electrical insulation resistance measurement and polarization index testing should occur monthly. Refer to the OEM recommendations for each specific rotor procedures and anticipated readings. Any reduction in electrical readings should be immediately investigated and corrected.

Stored rotors which are adequately supported on a frame or cradle typically should not require rotation while in storage. The OEM should be contacted for rotation requirements for each specific rotor while in storage.

4.6 Stator Inspections

Environmental conditions inside the stored stator should be maintained at all times. Stored generator stators should be visually inspected on a weekly basis to ensure no moisture has come in contact with the stator and that all covers are sealed. Inert dry gas pressures and humidity readings should be documented for stators stored under an inert dry gas blanket. Inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal). Relative humidity should be maintained at less than 40% at all times. Stators stored under a dehumidified air system should have the system checked for proper operation on a weekly basis. Review the past readings to determine if here is a need to further inspect the stator.

Perform electrical insulation resistance measurement and polarization index testing monthly. Refer to the OEM recommendations for each specific stator procedures and anticipated readings. Any reduction in electrical readings should be immediately investigated and corrected.

Caution: Before applying any voltage for testing, rope off area around the stator to keep out all personnel. Personal injury or death can result from high voltage contact.

At three (3) month intervals, an internal inspection of the stator should take place and desiccant bags inside the stator should be removed and checked for moisture. Flanges and machined surfaces should be inspected to ensure the coatings are in place and there are no signs of corrosion or rust. Any signs of corrosion or rust should be investigate and repaired if found.

Caution: The OEM procedures, coating MSDS information, and site safety procedures should be followed when removing coatings to not damage the machined stator surfaces nor create an environmental or safety situation. Ensure proper safety procedures are followed for stators stored under an inert dry gas blanket when gaining access to the desiccant bags.

Inert dry gas pressure should be restored to between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal).

4.7 Retaining Rings

Retaining rings should be visually externally inspected weekly to ensure the environmental bags are intact, the heating system is functional, and the rings have not been exposed to any moisture. Humidity readings should be documented and compared to past readings to determine if here is a need to internally inspect the retaining ring. Relative humidity inside the environmental bag should be maintained at less than 40% at all times.

Annually visually inspect the retaining rings inside the environmental bag for signs of corrosion or rust and replace the desiccant bags. Ensure the protective coating on the retaining ring is still intact.

Caution: Ensure desiccant bags placed inside the environmental bag do not come in contact with the retaining ring.

4.8 Stator Coils/Bars

At three (3) month intervals, visually inspect the stored stator coils and bars externally for cleanliness and any signs of exposure to moisture or damage to the storage boxes. If any moisture exposure or damage is found it should be addressed immediately. Typically stator coils ad bars should be maintained in the original OEM or vendor storage boxes.

4.9 Crossover Piping

At three (3) month intervals, visually inspect the stored crossover piping externally for cleanliness and any signs of exposure to moisture. Ensure machined gasket surfaces and connections of the crossover piping have preservative coating intact. Ensure all openings are covered with a wooden or fiberboard covering and tape sealed to prevent any dirt or loose materials from getting inside the piping. If any moisture exposure or coating damage is found it should be addressed immediately.

4.10 Turning Gear Assembly

At three (3) month intervals, visually inspect the stored turning gear assembly externally for cleanliness and any signs of exposure to moisture. Ensure exposed machined gasket surfaces and connections have preservative coating intact. If any moisture exposure or coating damage is found it should be addressed immediately.

Motors stored separated should be inspected per the site's spare electrical motor inspection program. The motor windings should be insulation resistance tested annually with any resistance reduction investigated and corrected.

4.11 Main Oil Tank Assembly

At three (3) month intervals, visually externally inspect the stored main oil tank for cleanliness and any signs of exposure to moisture. Ensure exposed machined gasket surfaces and connections have preservative coating intact. If any moisture exposure or coating damage is found it should be addressed immediately.

Annually perform a visual inspection of the tank internally. Check desiccant bags for moisture and replace or recondition as required.

Motors stored separated should be inspected per the site's spare electrical motor inspection program.

Pumps stored separately should be visually inspected annually to ensure cleanliness.

4.12 Lubrication Piping

At six (6) month intervals, visually inspect the lubrication piping externally for cleanliness and any signs of exposure to moisture. Ensure exposed machined gasket surfaces and connections have preservative coating and coverings intact. If any moisture exposure or coating damage is found it should be addressed immediately.

4.13 High Voltage Bushings

At six (6) month intervals, visually inspect the high voltage bushing storage boxes externally for cleanliness and any signs of exposure to moisture. If any moisture exposure or storage box damage is found it should be addressed immediately. Desiccant bags should be inspected and replaced or reconditioned every two (2) years.

4.14 Rotating and Brushless Exciter

Environmental conditions inside the stored stator should be maintained at all times. Stored assembled exciters should be visually inspected on a weekly basis to ensure no moisture has come in contact with the stator and that all covers are sealed. Inert dry gas pressures and humidity readings should be documented for exciters stored in an inert dry gas blanket. Inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal). Relative humidity should be maintained at less than 40% at all times. Exciters stored with a dehumidified air system should have the dry air system checked for proper operation on a weekly basis.

Perform electrical insulation resistance measurement and polarization index testing monthly. Refer to the OEM recommendations for each specific stator procedures and anticipated readings. Any reduction in electrical readings should be immediately investigated and corrected.

Caution: Before applying any voltage for testing, rope off area around the exciter assembly to keep out all personnel. Personal injury or death can result from high voltage contact.

Inert dry gas pressure should be maintained between 0.5 and 1.0 psig (3.44 and 6.89 kilopascal).

4.15 Storage Inspection and Maintenance Recommendations

Inspection and maintenance recommendations are summarized in the following table:

Table 4-1
Storage Inspection and Maintenance Recommendations

Component	Weekly Inspection	Monthly Inspection	Quarterly Inspection	6 Month Inspection	Annual Inspection
Turbine Rotor	Visually inspect for exposure to moisture. Correct any problems as found.	Visually inspect enclosure, shrink wrap, or sealed enclosure for damage.	Visually inspect for damage or deterioration of coatings and preservatives	Inspect and replace desiccant bags as needed.	Perform spot sample inspection of rotor by removing coatings from one area
	Record inert gas pressure readings. Add inert gas as needed.		Repair or reapply coatings as needed		Perform inspections on other rotor areas if problems found during spot inspection
	Record relative humidity readings. Correct problems as found.				
Turbine Shells and Cylinders		Visually inspect for exposure to moisture. Correct any problems as found.	Visually inspect for damage or deterioration to coatings and preservatives		Visually inspect cribbing for damage or deterioration.
		Inspect tarpaulin cover	Repair or reapply coatings as needed		
Turbine Stationary Components (diaphragms, flow guides, blade rings, etc)		Visually inspect for exposure to moisture. Correct any problems as found.	Visually inspect for exposure to moisture. Correct any problems as found.		

Table 4-1
Storage Inspection and Maintenance Recommendations (continued)

Component	Weekly Inspection	Monthly Inspection	Quarterly Inspection	6 Month Inspection	Annual Inspection
Turbine Stationary Components (diaphragms, flow guides, blade rings, etc) (continued)			Visually inspect for damage or deterioration of coatings and preservatives		
Assembled or Packaged Turbine	Visually inspect for exposure to moisture. Correct any problems as found.	Visually inspect enclosure, shrink wrap, or sealed enclosure for damage.	Visually inspect for damage or deterioration of coatings and preservatives	Inspect and replace desiccant bags as needed.	Perform spot sample inspection of shell sealing surfaces and rotor by removing coatings from one area
	Record inert gas pressure readings. Add inert gas as needed.		Repair or reapply coatings as needed		Perform inspections on other shell sealing surfaces and rotor areas if problems found during spot inspection
	Record relative humidity readings. Correct problems as found.				
Generator Rotor	Visually inspect for exposure to moisture. Correct any problems as found.	Perform electrical insulation and polarization index testing and record results.	Visually inspect for damage or deterioration of coatings and preservatives on bearing journals, retaining rings, and couplings		Perform spot sample inspection of rotor by removing coatings from one area

Table 4-1
Storage Inspection and Maintenance Recommendations (continued)

Component	Weekly Inspection	Monthly Inspection	Quarterly Inspection	6 Month Inspection	Annual Inspection
Generator Rotor (continued)	Record inert gas pressure readings. Add inert gas as needed.		Repair or reapply coatings as needed		Perform inspections on other rotor areas if problems found during spot inspection
	Record relative humidity readings. Correct problems as found.				
Generator Stator	Visually inspect for exposure to moisture. Correct any problems as found.	Perform electrical insulation and polarization index testing and record results.	Perform internal inspection of stator frame.		
	Record inert gas pressure readings. Add inert gas as needed.		Inspect desiccant bags and replace as needed.		
	Record relative humidity readings. Correct problems as found.		Inspect flanges and machined surfaces for protective coating damage or signs of rust		
Retaining Rings	Visually inspect for exposure to moisture. Correct any problems as found.				Visually inspect interior of environmental enclosure

Table 4-1
Storage Inspection and Maintenance Recommendations (continued)

Component	Weekly Inspection	Monthly Inspection	Quarterly Inspection	6 Month Inspection	Annual Inspection
Retaining Rings (continued)	Record relative humidity readings. Correct problems as found.				Replace the desiccant bags from inside enclosure
Stator Coils and Bars	Visually inspect for exposure to moisture. Correct any problems as found.		Visually inspect wooden enclosure for damage or deterioration		
Crossover Piping			Visually inspect externally for cleanliness and any signs of exposure to moisture		
			Ensure machined and gasket surfaces are coated with preservative compound		
			Ensure all openings are covered and tape sealed		
Turning Gear Assembly			Visually inspect externally for cleanliness and any signs of exposure to moisture		Perform electric insulation resistance testing of motor windings

Table 4-1
Storage Inspection and Maintenance Recommendations (continued)

Component	Weekly Inspection	Monthly Inspection	Quarterly Inspection	6 Month Inspection	Annual Inspection
Turning Gear Assembly (continued)			Ensure machined and gasket surfaces are coated with preservative compound		
Main Oil Tank Assembly			Visually inspect externally for cleanliness and any signs of exposure to moisture		Perform visual internal inspection.
			Ensure machined and gasket surfaces are coated with preservative compound		Replace desiccant bags as needed
					Visually inspect pumps for cleanliness and exposure to water if stored separately
Lubrication Piping				Visually inspect externally for cleanliness and any signs of exposure to moisture	
				Ensure machined and gasket surfaces are coated with preservative compound	

Table 4-1
Storage Inspection and Maintenance Recommendations (continued)

Component	Weekly Inspection	Monthly Inspection	Quarterly Inspection	6 Month Inspection	Annual Inspection
Lubrication Piping (continued)				Ensure all openings are covered and tape sealed	
High Voltage Bushings				Visually inspect externally for cleanliness and any signs of exposure to moisture	Internally inspect every 2 years and replace desiccant bags
Rotating and Brushless Exciter	Visually inspect for exposure to moisture. Correct any problems as found.	Perform electrical insulation and polarization index testing and record results.	Perform internal inspection of exciter frame.		
	Record inert gas pressure readings. Add inert gas as needed.		Inspect desiccant bags and replace as needed.		
	Record relative humidity readings. Correct problems as found.		Inspect flanges and machined surfaces for protective coating damage or signs of rust		

5
SAFETY CONSIDERATIONS

Many of the safety considerations for storage and shipping of turbine generator equipment are outlined below. It is a good personnel safety practice for a power plant to develop procedures that outline the site specific safety requirements for the handling, application, and removal of preservatives and protective coatings for enclosures that are utilized to protect the equipment during shipping and storage.

Some site specific safety items for consideration include the following:

5.1 Pre-Job Safety Discussion and Planning

Planning increases the likelihood that desired results will be achieved when performing a task. Planning begins with anticipating and identifying potential safety hazards in a job task and evaluating the subsequent risks of those hazards. Shipping of large and heavy steam turbine generators components require significant planning and precautions to safely handle the components. Also, verify that no asbestos insulation will be involved with the job in older stations.

5.2 Personal Protective Equipment Requirements

During the planning process, attention should be given to identification of the site specific requirements for proper use and selection of equipment to adequately protect the personnel performing activities for storage and shipping of turbine generator components. All personnel should be made fully aware of the proper cautions for exposure to any preservatives, solvents, and gases that are used to protect the equipment when storing or shipping steam turbine generator components. Site specific procedures should be followed. Respirators may be required for removal or application of the applied coatings on turbine generator components. Properly purging enclosures that contain inert dry gas will be required before entering.

5.3 Rigging Requirements

Preparation for shipping, receiving, and storage of turbine generator components typically require some type of rigging and lifting by mechanical means (chokers, cranes, and/or chain falls), and shipping frames and utilizing containers to protect the component during shipping and storage. Familiarity with OEM lifting drawings with center of gravity points noted will be required to safely ship components such as rotors and shells. Site specific procedures for maintaining, inspecting, and training of personnel on the use of rigging equipment should be

followed. For larger components such as generator stator, generator rotors, or turbine rotors, a specialized contractor in heavy equipment handling and shipping may be required.

5.4 Inert Dry Gas Blanketing

Steam turbine generator components may be store with an inert dry gas blanket to prevent corrosion and oxidation. A warning sign that the component is stored under inert dry gas blanketing must be prominently displayed on all coverings and fittings that identifies the component is filled with inert dry gas and states breathing concentrated inert dry gas is hazardous. The site should develop and maintain safety procedures for handling nitrogen or another inert dry gas blanket environments. For any components stored under an inert dry gas blanket, the proper ventilation and verification of adequate air supply must be verified prior to inspecting or working on the equipment. Site specific procedures for enclosed spaces and monitoring and testing of atmospheric conditions should be followed.

5.5 Proper Handling of Preservatives and Solvents

In many cases preservatives and protective coatings or enclosures are utilized to protect the equipment during shipping and storage. These can include paints, primers, cleaning compounds, oils, greases, and specialized shipping containers with an inert gas atmosphere. Because some preservatives and solvents may be toxic, flammable, or explosive, proper ventilation must be provided to avoid injury or death. When exposed to these products, personnel should understand the hazards associated with the specific materials being used as outlined in material data sheets (MSDS). Site specific procedures for handling, applying, and disposing of the products should be followed. Applying preservations should be done in a well ventilated area. Skin contact should be prevented through the use of protective clothing such as neoprene gloves. Eye contact should be prevented through the use of chemical safety goggles and/or a face shield. Only use solvents for removal of the intended preservatives and do not allow excessive solvents to come in contain with other parts of the component as it can damage electrical components and unintentionally wash away other preservatives. Clean up of removed solvents should be per the site and local environmental procedures.

A
APPENDIX

Table A-1
Turbine Rotor Shipping Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:		
Components Lifting Drawings Available:	Yes:		No:		N/A:		
Site Lifting Procedures Available:	Yes:		No:		N/A:		
Suitable Dunnage Available:	Yes:		No:		N/A:		
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:		
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:		
Waterproof Tarpaulin Available:	Yes:		No:		N/A:		
Shock/Vibration Recorder Available:	Yes:		No:		N/A:		
Global Positioning System (GPS) Available:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-2
Turbine Shell and Cylinder Shipping Checklist

Company: _____
Station: _____
Unit: _____
Component Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:		
Components Lifting Drawings Available:	Yes:		No:		N/A:		
Site Lifting Procedures Available:	Yes:		No:		N/A:		
Suitable Dunnage Available:	Yes:		No:		N/A:		
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:		
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:		
Waterproof Tarpaulin Available:	Yes:		No:		N/A:		
Shock/Vibration Recorder Available:	Yes:		No:		N/A:		
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-3
Turbine Stationary Component Shipping Checklist

Company: _____
Station: _____
Unit: _____
Component Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:	
Components Lifting Drawings Available:	Yes:		No:		N/A:	
Site Lifting Procedures Available:	Yes:		No:		N/A:	
Suitable Dunnage Available:	Yes:		No:		N/A:	
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:	
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:	
Waterproof Tarpaulin Available:	Yes:		No:		N/A:	
Shock/Vibration Recorder Available:	Yes:		No:		N/A:	
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	

Special Instructions: _____

Table A-4
Turbine Miscellaneous Component Shipping Checklist

Company: _____
Station: _____
Unit: _____
Component Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:		
Components Lifting Drawings Available:	Yes:		No:		N/A:		
Site Lifting Procedures Available:	Yes:		No:		N/A:		
Suitable Cribbing and Dunnage Available:	Yes:		No:		N/A:		
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:		
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:		
All Openings Covered with Wooden or Fiberboard:	Yes:		No:		N/A:		
Waterproof Tarpaulin Available:	Yes:		No:		N/A:		
Shock/Vibration Recorder Available:	Yes:		No:		N/A:		
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-5
Generator Rotor Shipping Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country, Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:		
Components Lifting Drawings Available:	Yes:		No:		N/A:		
Site Lifting Procedures Available:	Yes:		No:		N/A:		
Suitable Dunnage Available:	Yes:		No:		N/A:		
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:		
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:		
Waterproof Tarpaulin Available:	Yes:		No:		N/A:		
Shock/Vibration Recorder Available:	Yes:		No:		N/A:		
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____
_____

Table A-6
Generator Stator Shipping Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country, Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:		
Stator Lifting Drawings Available:	Yes:		No:		N/A:		
Site Lifting Procedures Available:	Yes:		No:		N/A:		
Suitable Dunnage Available:	Yes:		No:		N/A:		
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:		
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:		
Waterproof Tarpaulin Available:	Yes:		No:		N/A:		
Shock/Vibration Recorder Available:	Yes:		No:		N/A:		
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-7
Generator Retaining Ring Shipping Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country, Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:		
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:		
Suitable Environmental Bag Available:	Yes:		No:		N/A:		
Site Lifting Procedures Available:	Yes:		No:		N/A:		
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:		
Desiccant Bags Installed inside Enclosure:	Yes:		No:		N/A:		
Suitable Dunnage Available:	Yes:		No:		N/A:		
Waterproof Tarpaulin Available:	Yes:		No:		N/A:		
Shock/Vibration Recorder Available:	Yes:		No:		N/A:		
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____
_____

Table A-8
Generator Exciter Shipping Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country, Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:	
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:	
Site Lifting Procedures Available:	Yes:		No:		N/A:	
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:	
Desiccant Bags Inside Enclosure:	Yes:		No:		N/A:	
Suitable Dunnage Available:	Yes:		No:		N/A:	
Waterproof Tarpaulin Available:	Yes:		No:		N/A:	
Shock/Vibration Recorder Available:	Yes:		No:		N/A:	
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	

Special Instructions: _____
_____

Table A-9
Generator Stator Coils and Bars Shipping Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country, Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:		
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:		
Site Lifting Procedures Available:	Yes:		No:		N/A:		
Protective Coatings and Sealing Applied:	Yes:		No:		N/A:		
Desiccant Bags Installed on Bar Ends:	Yes:		No:		N/A:		
Suitable Dunnage Available:	Yes:		No:		N/A:		
Waterproof Tarpaulin Available:	Yes:		No:		N/A:		
Shock/Vibration Recorder Available:	Yes:		No:		N/A:		
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____
_____

Table A-10
High Voltage Bushing Shipping Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Shipping Method: Truck: _____ Rail: _____ Barge: _____ Ship: _____ Other: _____
Pickup Date: _____
Anticipated Delivery Date: _____

Shipping Destination

Company: _____
Street Address: _____
City,State, Country, Zipcode: _____
Purchase Order Number: _____
Return Authorization Number: _____
Delivery Contact/Telephone Number: _____

Transportation Routing and Permits Obtained:	Yes:		No:		N/A:	
Suitable Shipping Enclosure Constructed:	Yes:		No:		N/A:	
Site Lifting Procedures Available:	Yes:		No:		N/A:	
Shock Protective Rubber Installed:	Yes:		No:		N/A:	
Desiccant Bags Installed inside Wooden Box:	Yes:		No:		N/A:	
Suitable Dunnage Available:	Yes:		No:		N/A:	
Waterproof Tarpaulin Available:	Yes:		No:		N/A:	
Shock/Vibration Recorder Available:	Yes:		No:		N/A:	
Global Positioning Stystem (GPS) Available:	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	

Special Instructions: _____
_____

Table A-11
Turbine Rotor Storage Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Storage location: _____
Initial Storage Date: _____
Inventory Code (If applicable): _____
Refurbished Date (If Applicable): _____
Refurbishment Purchase Order Number: _____
Responsible Company Contact: _____
Responsible Contact E-Mail/Phone Number: _____

Rotor Stored Indoors:	Yes:		No:		N/A:		
Rotor Stored in OEM Approved Outdoor Enclosure:	Yes:		No:		N/A:		
Rotor Positioned on Metal Frame/Cradle per OEM Drawings:	Yes:		No:		N/A:		
Rotor Properly Supported per OEM Drawings:	Yes:		No:		N/A:		
Storage Blocking Height above Potential Water Line:	Yes:		No:		N/A:		
Shipping VCI Paper and Wrappings removed:	Yes:		No:		N/A:		
Protective Coatings Applied on Bearing Journal Areas:	Yes:		No:		N/A:		
Protective Coatings Applied on Non-bearing Journal Areas:	Yes:		No:		N/A:		
Rotor Stored in Environmental Enclosure:	Yes:		No:		N/A:		
Rotor Stored in Inert Gas Enclosure (Min. 0.5 psig Pressure):	Yes:		No:		N/A:		
Rotor Stored in Conditioned or Dehumidified Air Enclosure:	Yes:		No:		N/A:		
Rotor Stored in Shrink Wrapped Enclosure:	Yes:		No:		N/A:		
Humidity Monitor Installed inside Enclosure and Functional:	Yes:		No:		N/A:		
Desiccant Bags Installed inside Enclosure:	Yes:		No:		N/A:		
Tarpaulin Loosely Covering for Dust/Dirt Control:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-12
Turbine Shell and Cylinder Storage Checklist

Company: _____
Station: _____
Unit: _____
Shell/Cylinder Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Storage location: _____
Initial Storage Date: _____
Inventory Code (If applicable): _____
Refurbished Date (If Applicable): _____
Refurbishment Purchase Order Number: _____
Responsible Company Contact: _____
Responsible Contact E-Mail/Phone Number: _____

Shell/Cylinder Stored Outdoors:	Yes:		No:		N/A:		
Shell/Cylinder Stored Outdoors Protected from the Environments:	Yes:		No:		N/A:		
Shell/Cylinder Positioned Similar as Inservice Position:	Yes:		No:		N/A:		
Shell/Cylinder Properly Supported per OEM Recommendations:	Yes:		No:		N/A:		
Storage Blocking Height above Potential Water Line:	Yes:		No:		N/A:		
Shipping VCI Paper and Wrappings removed:	Yes:		No:		N/A:		
Bolt holes and Potential Water Pockets filled with Grease:	Yes:		No:		N/A:		
Protective Coatings Applied on Machined Surfaces:	Yes:		No:		N/A:		
All Steam Inlets, Extraction Outlets, and Penetrations Sealed:	Yes:		No:		N/A:		
Tarpaulin Loosely Covering for Dust/Dirt Control:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-13
Turbine Stationary Component Storage Checklist

Company: _____
Station: _____
Unit: _____
Component Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Storage location: _____
Initial Storage Date: _____
Inventory Code (If applicable): _____
Refurbished Date (If Applicable): _____
Refurbishment Purchase Order Number: _____
Responsible Company Contact: _____
Responsible Contact E-Mail/Phone Number: _____

Component Stored Indoors:	Yes:		No:		N/A:		
Component Stored on Adequate Metal or Wooden Racks:	Yes:		No:		N/A:		
Component Stored Similar as Inservice Position:	Yes:		No:		N/A:		
Metal Shim and Rubber Between any Wooden Rack or Cribbage Contact Points:	Yes:		No:		N/A:		
Storage Blocking Height above Potential Water Line:	Yes:		No:		N/A:		
Protective Coatings Applied on Machined and Sealing Surfaces:	Yes:		No:		N/A:		
Tarpaulin Loosely Covering for Dust/Dirt Control:	Yes:		No:		N/A:		
Tropical Location Storage in Environmental Bag or Enclosure:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-14
Generator Rotor Storage Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Storage location: _____
Initial Storage Date: _____
Inventory Code (If applicable): _____
Refurbished Date (If Applicable): _____
Refurbishment Purchase Order Number: _____
Responsible Company Contact: _____
Responsible Contact E-Mail/Phone Number: _____

Rotor Stored Indoors:	Yes:		No:		N/A:		
Rotor Stored in OEM Approved Outdoor Enclosure:	Yes:		No:		N/A:		
Rotor Positioned on Metal Frame/Cradle per OEM Drawings:	Yes:		No:		N/A:		
Rotor Properly Supported per OEM Drawings:	Yes:		No:		N/A:		
Storage Blocking Height above Potential Water Line:	Yes:		No:		N/A:		
Shipping VCI Paper and Wrappings removed:	Yes:		No:		N/A:		
Protective Coatings Applied on Bearing Journal Areas:	Yes:		No:		N/A:		
Protective Coatings Applied on Non-bearing Journal Areas:	Yes:		No:		N/A:		
Rotor Stored in Environmental Enclosure:	Yes:		No:		N/A:		
Rotor Stored in Shrink Wrapped Enclosure:	Yes:		No:		N/A:		
Rotor Stored in Inert Gas Enclosure (Min. 0.5 psig Pressure):	Yes:		No:		N/A:		
Rotor Stored in Conditioned or Dehumidified Air Enclosure:	Yes:		No:		N/A:		
Relative Humidity inside Enclosure Maintained < 40%:	Yes:		No:		N/A:		
Humidity Monitor Installed inside Enclosure and Functional:	Yes:		No:		N/A:		
Desiccant Bags Installed inside Enclosure:	Yes:		No:		N/A:		
Electrical Test Lead Station Located Outside of Enclosure:	Yes:		No:		N/A:		
Tarpaulin Loosely Covering for Dust/Dirt Control:	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		
	Yes:		No:		N/A:		

Special Instructions: _____

Table A-15
Generator Stator Storage Checklist

Company: _____
Station: _____
Unit: _____
Stator Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Storage location: _____
Initial Storage Date: _____
Inventory Code (If applicable): _____
Refurbished Date (If Applicable): _____
Refurbishment Purchase Order Number: _____
Responsible Company Contact: _____
Responsible Contact E-Mail/Phone Number: _____

OEM Contacted for Specific Storage Recommendations:	Yes:		No:		N/A:	
Stator Stored Indoors:	Yes:		No:		N/A:	
Storage Blocking Height above Potential Water Line:	Yes:		No:		N/A:	
Protective Coatings Applied on Machined and Bearing Journal Areas:	Yes:		No:		N/A:	
Water or Air Cooling Ducts Sealed:	Yes:		No:		N/A:	
Source of Heat Installed inside Stator Frame:	Yes:		No:		N/A:	
Stator Stored in Inert Gas Atmosphere (Min. 0.5 psig Pressure):	Yes:		No:		N/A:	
Stator Stored in Conditioned or Dehumidified Air Enclosure:	Yes:		No:		N/A:	
Relative Humidity inside Stator Frame Maintained < 40%:	Yes:		No:		N/A:	
Hygrometer Installed inside Stator Frame and Functional:	Yes:		No:		N/A:	
Desiccant Bags Installed inside Stator Frame:	Yes:		No:		N/A:	
Electrical Test Lead Station Located Outside of Stator Frame:	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	

Special Instructions: _____
_____

Table A-16
Retaining Ring Storage Checklist

Company: _____
Station: _____
Unit: _____
Retaining Ring Description: _____
Size: Weight: _____ Height: _____ Width: _____ Length: _____
Storage location: _____
Initial Storage Date: _____
Inventory Code (If applicable): _____
Refurbished Date (If Applicable): _____
Refurbishment Purchase Order Number: _____
Responsible Company Contact: _____
Responsible Contact E-Mail/Telephone Number: _____

OEM Specific Storage Recommendations Utilized:	Yes:		No:		N/A:	
Storage Blocking Height above Potential Water Line:	Yes:		No:		N/A:	
Stored in Sealed Environmental Bag or Enclosure:	Yes:		No:		N/A:	
Environmental Bag not in Contact with Ring:	Yes:		No:		N/A:	
Ring not in Contact with Wood, Paper, Or Plastic:	Yes:		No:		N/A:	
Stored on End to Maintain Roundness:	Yes:		No:		N/A:	
Rings Coated with OEM Recommneded Corrosion Compound:	Yes:		No:		N/A:	
Rings Supported on Hard Rubber, Aluminium, or Copper Surface:	Yes:		No:		N/A:	
Desiccant Bags Installed inside Sealed Enclosure:	Yes:		No:		N/A:	
Electrical Test Lead Station Located Outside of Stator Frame:	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	

Special Instructions: _____

Table A-17
Turbine Rotor Weekly Inspection Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Storage Location: _____
Inspected By: _____
Inspection Date: _____

Weekly Inspection						
Visual Inspection for Evidence of Moisture Exposure:	Yes:		No:		N/A:	
Humidity Monitor Installed inside Enclosure and Functional:	Yes:		No:		N/A:	
As Found Humidity Reading (_____%):	Yes:		No:		N/A:	
As Left Humidity Reading (_____%):	Yes:		No:		N/A:	
As Found Inert Gas Pressure Reading >0.5 and <1.0 psig:	Yes:		No:		N/A:	
As Found Inert Gas Pressure Reading (_____%):	Yes:		No:		N/A:	
As Left Inert Gas Pressure Reading (_____%):	Yes:		No:		N/A:	
Visual Inspection of Frame/Cradle Structure:	Yes:		No:		N/A:	
Environmental Bag Intact:	Yes:		No:		N/A:	
Inert Gas Enclosure Intact:	Yes:		No:		N/A:	
Conditioned or Dehumidified Air System Intact and Functional:	Yes:		No:		N/A:	
Shrink Wrap Covering Intact:	Yes:		No:		N/A:	
Protective Coatings in Good Condition on Bearing Journal Areas:	Yes:		No:		N/A:	
Protective Coatings in Good Condition on non-Bearing Journal Areas:	Yes:		No:		N/A:	
Desiccant Bags Installed Inside Enclosure:	Yes:		No:		N/A:	
Tarpaulin Loosely Covering for Dust/Dirt Control:	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	

Inspection Findings and Recommendations: _____

Table A-18
Generator Rotor Weekly Inspection Checklist

Company: _____
Station: _____
Unit: _____
Rotor Description: _____
Storage Location: _____
Inspected By: _____
Inspection Date: _____

Weekly Inspection						
Visual Inspection for Evidence of Moisture Exposure:	Yes:		No:		N/A:	
Humidity Monitor Installed inside Enclosure and Functional:	Yes:		No:		N/A:	
As Found Humidity Reading (_____%):	Yes:		No:		N/A:	
As Left Humidity Reading (_____%):	Yes:		No:		N/A:	
As Found Inert Gas Pressure Reading >0.5 and <1.0 psig:	Yes:		No:		N/A:	
As Found Inert Gas Pressure Reading (_____%):	Yes:		No:		N/A:	
As Left Inert Gas Pressure Reading (_____%):	Yes:		No:		N/A:	
Visual Inspection of Frame/Cradle Structure:	Yes:		No:		N/A:	
Environmental Bag Intact:	Yes:		No:		N/A:	
Inert Gas Enclosure Intact:	Yes:		No:		N/A:	
Conditioned or Dehumidified Air System Intact and Functional:	Yes:		No:		N/A:	
Shrink Wrap Covering Intact:	Yes:		No:		N/A:	
Protective Coatings in Good Condition on Bearing Journal Areas:	Yes:		No:		N/A:	
Protective Coatings in Good Condition on non-Bearing Journal Areas:	Yes:		No:		N/A:	
Desiccant Bags Installed Inside Enclosure:	Yes:		No:		N/A:	
Tarpaulin Loosely Covering for Dust/Dirt Control:	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	
	Yes:		No:		N/A:	

Inspection Findings and Recommendations: _____

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