ELECTRIC POWER RESEARCH INSTITUTE

Steam Turbine-Generator Notes

July 2009

Fossil and Nuclear Steam Turbine-Generators

Contents

Turbine Generator Auxiliary System Maintenance Guides, Vol. 4: Generator Stator Cooling

Large generators have been designed to use a variety of cooling methods over the years. As generators became larger, hydrogen cooling was introduced—and in 1956, water cooling of stator bars and rotor bars. Water cooling is now a mature technology, and experience has identified typical problem areas. The following are the most important:

- Leaks of hydrogen into the stator cooling water
- Leaks of stator cooling water from the winding
- Plugging of the coolant path in the winding
- Clogging of the coolant path outside the winding (for example, filters and strainers)

EPRI report 1015669 describes the various types of water-cooled generators as well as their cooling systems and components. The report also provides related specifications for operation and layup along with recommendations for monitoring and maintenance. An extensive appendix addresses frequent trouble spots and presents hands-on experience reports on troubleshooting. The report makes the following major recommendations:

- Implement design conditions, allow the system to achieve equilibrium, and then maintain it in this fashion.
- Do not convert stator water chemistry to another chemistry regime without expert advice.
- Be aware of water chemistry status. Trend parameters and investigate any changes.
- Communicate with the plant chemist (this applies to the engineer responsible for the generator).
- Be proactive to prevent or mitigate flow restrictions.
- In case of flow restrictions, cleaning the stator bars alone will offer temporary relief but might not solve the problem. Investigate and mitigate the root cause.
- Be sure that the dissolved oxygen content of makeup water corresponds to dissolved oxygen of the water already in the system.
- Controlling stator coil layup is essential.
- Do not trust a situation in which an out-of-normal condition returns on its own. Research and understand the root cause.
- If flow restrictions are diagnosed, do not wait until the situation deteriorates into urgency or the oxides become so compact that they are hard to remove. Be proactive and take a timely approach to cleanliness issues.

For more information, contact Jan Stein, 650.855.2390, jstein@epri.com.

2009 Boiler and Reactor Feed Pump Turbine Workshop

EPRI Program 65 will hold a Boiler and Reactor Feed Pump Turbine (B/R FPT) workshop on July 27–28, 2009, at the Nashville Marriott at Vanderbilt University in Nashville, Tennessee. This workshop will benefit turbine engineers, system engineers, maintenance scheduling and procurement staff, and those who deal with boiler or reactor FPTs.

The workshop is intended for both the fossil and nuclear industry personnel and will address industry's growing B/R FPT concerns. Topics include valves and controls; controls upgrades; rotor and cylinder end of life; purchasing and replacement; operation and layup; impact of steam path upgrades; coupling designs, capabilities, and alignment processes; auxiliary systems (such as lube oil and steam seals); turbine supervisory instrumentation; balancing; coatings; and lessons learned.

Typical Utility Boiler Feedpump Turbine Installation

For attendees' convenience, the EPRI LPRimLife training is scheduled for July 29–30, following the B/R FPT Workshop and at the same location. Make sure that your turbine specialists participate in these activities so that you are current on industry advances and a step ahead of plant turbine problems.

Each day will begin with instructional, informative presentations from industry experts, followed by roundtable discussions and utility presentations, which will round out the afternoon. We encourage you to bring your concerns related to site and fleet issues to the roundtable discussions and share your ideas, experiences, and topics with others in the industry.

B/R FPT Workshop: Day One, morning

Bob Beck from TurboCare will present "B/R FPT Design and Operating Characteristics." Bob also presented at the 2007 EPRI workshop in conjunction with the Turbine-Generator Users Group meeting in Phoenix, Arizona.

B/R FPT Workshop: Day Two, morning

Siemens will present "Life Extension of Aging Boiler Feedwater Pump Turbines." Siemens has developed many solutions to help customers extend the life and improve the reliability of their boiler feed pumps and turbine drivers. The company has developed a comprehensive life extension program for the boiler feed pump steam turbine drivers and associated auxiliary systems to help the industry get the most from their equipment for the long term. The presentation will focus on increasing the availability and reliability of the boiler feed pump turbine, extending the run time between outages, reducing maintenance requirements, improving operational efficiency, and increasing plant output. Siemens' analysis indicates that although many customers have planned or implemented upgrades to their main power trains, little has been done to most boiler feedwater systems—leading to sub-optimal running conditions and an increase in parasitic plant power losses. Technical details of Siemens' upgrade programs will be presented. Additional industry presentations will round out the day, and the workshop will conclude with lessons learned and key points.

Many B/R FPT issues need to be addressed, and the industry needs to hear about your methods and experiences.

If you are interested in participating in this workshop, contact Gary Golden, 865.218.8111, ggolden@epri.com. The latest information on the workshop can be found on the EPRI Calendar of Events at www.epri.com.

Steam Turbine-Generator Notes

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1300 W.T. Harris Blvd., Charlotte, NC 28262
fax: 704.595.2867

NSTI/Program 65 Contact: ***Alan Grunsky***
phone: 704.595.2056, ***email:*** agrunsky@epri.com

Changes Ahead in 2010 for EPRI Steam Turbine-Generator R&D Program

As most of our members know, the EPRI Generation Steam Turbine-Generator and Balance-of-Plant Program (Program 65 [P65]) has been in existence since the early 1970s, when EPRI was originally founded by the U.S. utility industry.

In 1999, the EPRI Nuclear Steam Turbine-Generator Initiative (NSTI) was created, serving many nuclear members in the United States. During the early 2000s, funding for P65 declined for many reasons. However, the NSTI program was growing in both funding and membership.

From the beginning of NSTI and through a mutual agreement by all advisors of both programs, all projects produced by NSTI were shared by P65 and vice versa.

During the past few years, with several changes in EPRI administrative policies (which are governed by our utility executive council members), many utilities that had been members of NSTI have changed their membership to P65. In addition, many new members are joining P65. With this increased membership activity, the EPRI Turbine-Generator R&D program is as strong as ever.

However, because of this significant change in the "ratio" of P65 to NSTI members, a decision was made with the approval of our NSTI and P65 utility advisors: NSTI will not be offered to our members as a separate program in 2010. Of course, current NSTI members can join P65 in 2010 as they have in 2009. And if a nuclear member funded the NSTI using a nuclear service agreement in 2009, they may do the same in 2010. However, P65—not NSTI—will be listed on the agreement.

The advisory structure will retain a fossil and nuclear focus, and the current P65 and NSTI advisory committee chairpersons will serve as co-chairpersons for fossil and nuclear members of P65. The P65 charter will be modified to reflect these changes.

In addition, because P65 has not historically emphasized the "Balance-of-Plant" portion of the program name and performed little R&D in those areas, the program name will be changed to "Steam Turbine-Generator and Auxiliary Systems" at the request of our advisors.

If you are a current or perhaps future member of the EPRI TG program and have questions about the upcoming 2010 programmatic changes, contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.

LPRimLife Workshop Planned for July 2009

For decades, LP rotor disk rim cracking has been a well-established challenge to steam turbine operators. EPRI has funded various research initiatives to help mitigate this problem. One of those initiatives is a computer program called LPRimLife. LPRimLife uses operating and design data, inspection results, and stress and fracture algorithms to assess the remaining life of LP rotors with disk rim attachment cracking. The program was developed as a beta product in 2000 and distributed to utility funders of the development program. LPRimLife is also used, under a license from EPRI, by Structural Integrity Associates to provide analysis services to utilities.

An upcoming LPRimLife Workshop will describe the functionality of the LPRimLife software program and provide instruction for its practical use. A beta version of the LPRimLife Version 2.1 upgraded software will be used as the basis for instruction. EPRI is working with Impact Technologies, LLC, on the LPRimLife upgrade. The workshop will be held on July 29–30, 2009, at the Nashville Marriott at Vanderbilt University in Nashville, Tennessee. The workshop is targeted toward engineering-level utility personnel responsible for LP rotor life assessment.

For additional information, contact Paul Zayicek, 704.595.2154, pzayicek@epri.com.

Automated Model Validation for Power Plants Using On-Line Disturbance Modeling

Generator model validation and testing is certainly not a new subject. Efforts have been ongoing in this area for many decades. In the aftermath of the 1996 system breakups, the Western Electricity Coordinating Council started a major effort in 1997 to improve system planning models. One aspect of this was the mandated testing of generating units. The North American Electric Reliability Council (NERC) is working to bring similar mandates to bear nationwide.

Model validation has typically been achieved through staged testing of the generating facility. This requires bringing the unit off-line, connecting appropriate recording devices to the unit, and performing a series of staged maneuvering actions with the unit off-line and at low loads on-line. This incurs expense both in the engineering time and effort required for the task and in the potential loss of opportunity to sell power while the unit is under test. Furthermore, although quite low, there is always a risk of damage to the unit.

This project investigated and identified methods of model validation using data captured by event recorders (such as digital fault recorders) in the power plant during system-wide disturbances. These data are then used to validate and fine-tune the power plant model. The benefits are that there is no need to schedule time for testing the unit, the unit need not be maneuvered or taken off-line, and there is no additional risk of damage to the unit. Another key benefit is that the unit's response to actual events is seen. However, in order for this process to work, good baseline data on the applicable models for the power plant are required—so some form of staged testing or model validation on plant commissioning is still needed.

EPRI report 1016000 describes a tool developed using the MATLAB® environment and a simple graphic user interface for ease of use. This tool was then used to post-process digitally recorded disturbance data from three volunteer plants to demonstrate and verify the approach.

The Power Plant Parameter Derivation software will be released in the fourth quarter of 2009.

For more information, contact Jan Stein, 650.855.2390, jstein@epri.com.

Upcoming Events

2009 Meetings	Date	Location
NERC Compliance Interest Group	July 21–22, 2009	Charlotte, NC
B/R FPT Workshop	July 27–28, 2009	Nashville, TN
LPRimLife Workshop	July 29–30, 2009	Nashville, TN
DC Ramp Test Seminar	August 7–10, 2009	Denver, CO
Summer Turbine-Generator Workshop and TGUG Meeting	August 10–14, 2009	Milwaukee, WI

2010 Meetings	Date	Location
Winter Turbine-Generator Workshop and TGUG Meeting	January 18–22, 2010	Williamsburg, VA

Program Staff

Alan Grunsky
P65/NSTI Program Manager
704.595.2056, agrunsky@epri.com

Gary Golden
Performance, Testing, B/R FPT
865.218.8111, ggolden@epri.com

Grant Lanthorn
Student Employee
704.595.2125, glanthorn@epri.com

Sharon Parker
Turbine Auxiliaries
704.595.2164, sparker@epri.com

Linda Parrish
Senior Administrative Assistant
704.595.2061, lparrish@epri.com

Jan Stein
Electrical Equipment, Generators
650.855.2390, jstein@epri.com

Paul Zayicek
NDE, Condition Assessment
704.595.2154, pzayicek@epri.com

Looking Forward: Program 65 and NSTI

The projects undertaken by Program 65 (Steam Turbine-Generators and Balance-of-Plant) and the Nuclear Steam Turbine Initiative (NSTI) are the result of input from their respective advisory boards. In addition to planning for the immediate future, the advisory boards guide the development of the program several years in advance. The following is a list of suggested projects tentatively scheduled for delivery in 2010 and 2011 by Program 65 and NSTI.

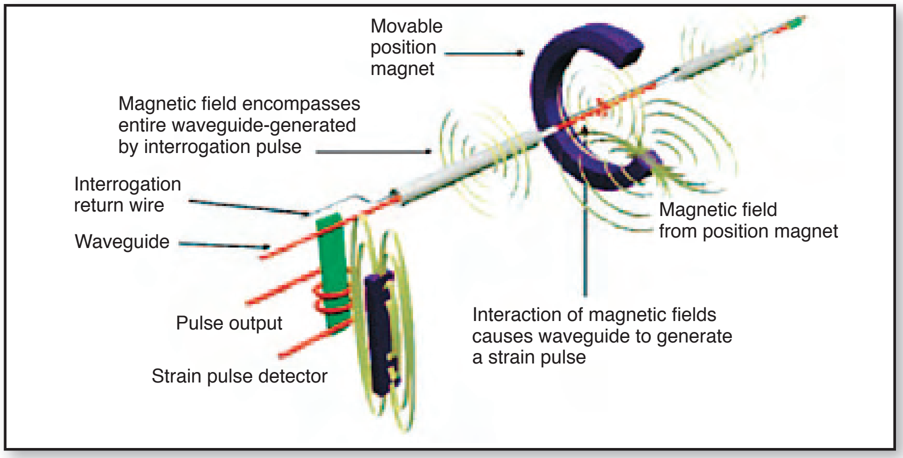
Title of Report or Activity	**Year of Delivery**	**Project Manager**
Turbine Generator Auxiliary Maintenance Guides, Vol. 6	2010–11	TBD
FAST Computer-Based Training Module	2010–11	Paul Zayicek
Implementation of Cracks in Blade Attachment Mockups	2010–11	Paul Zayicek
International Turbine Valve Condition Assessment	2010–11	Sharon Parker
International Turbine Valve Actuator Condition Assessment	2010–11	Sharon Parker
Preventive Maintenance Database Module Additions	2010–11	Alan Grunsky
SAFER-PC Computer-Based Training Module	2010–11	Paul Zayicek
Fatigue Reference Specimens	2010–11	Paul Zayicek
Stator Winding Insulation Condition Assessment Using DC Hipot Ramp Test	2010–11	Jan Stein
Validity of 0.1 Hz Stator Winding Hipot Test	2010–11	Jan Stein
LPRimLife Computer-Based Training Module	2010–11	Paul Zayicek
Turbine Performance Engineer Guideline	2010–11	Gary Golden
Sixth Technology Transfer Workshop	2011	Paul Zayicek
12th EPRI Steam Turbine Generator Workshop and Vendor Exposition	2011	Paul Zayicek

Additional projects will be identified by the EPRI Steam Turbine-Generator Program staff and utility members throughout the year. During the fall 2009 Steam-Turbine Generator Program advisory meeting, the entire project list will be reviewed and prioritized by the advisors for each subsequent year's R&D to be performed by the Turbine-Generator Program.

For more information on this activity, contact Paul Zayicek, 704.595.2154, pzayicek@epri.com.

Project Underway: Demonstration of a Noncontact Position Sensor on Turbine Valve

A project is underway to demonstrate the use of a noncontact sensor to measure turbine valve position. The existing position indicators (linear variable differential transducers [LVDTs]) have experienced failures caused by moving parts. The use of a noncontact sensor would improve the reliability and availability of the valve indication. The sensor (composed of a magnet and waveguide) would be installed on a selected valve and the data recorded on a laptop computer and compared to the existing LVDT data.



Magnetostrictive Sensor Arrangement (Courtesy of Mechanical Testing Systems)

Alternatives were researched for the use of LVDTs. The magnetostrictive technology costs less than the LVDT, has comparable accuracy, eliminates wear, and does not require recalibration. A disadvantage of this sensor, however, is the temperature limitation of 167°F (75°C) for reliable length measurement.

The magnetostrictive sensor consists of a waveguide and a magnet (see figure on the right.) The waveguide contains the sensing element and is mounted on the spring can housing. A movable permanent magnet is installed on the arm of the valve coupling that holds the LVDT. The magnet is a doughnut-shaped object that moves up and down the waveguide, and the waveguide generates a current pulse. The movable permanent magnet passes through the field generated axially by the waveguide. The position of the magnet is calculated by measuring the elapsed time between the application of the pulse and the arrival of the resulting strain pulse with a high-speed counter.

This sensor demonstration project includes installing a magnetostrictive sensor, monitoring and comparing the movement data, and developing a final report.

To install the magnetostrictive sensor on a turbine valve, a bracket is fabricated to hold the waveguide, and a laptop computer with appropriate monitoring software is connected to the sensor.

The sensor and hardware are installed during a unit outage. Data are taken during startup, stroke testing of the valves, load changes, and any unit trips. The sensor is recording valve movement data in parallel with the existing LVDT. The position sensor data and the LVDT data are sent to EPRI for comparison analysis each month.

After 3–6 months of operation, the demonstration project would be concluded. A final report describing the installation, data comparison, and lessons learned would be developed.

If you are interested in being a host demonstration site for this sensor, contact Sharon Parker, 704.595.2164, sparker@epri.com.

Reference Book for Steam Turbine-Generator Products

Since its inception, the EPRI Steam Turbine-Generator Program has created a multitude of reports and other products. A compilation of more than 130 product summaries that describe EPRI research performed over the past 20 years is provided in EPRI report 1019321, *Descriptions of Past Research: EPRI Fossil and Nuclear Steam Turbines and Generators—2009.* For easy reference, the summaries are alphabetized and sorted by category. Each product summary includes an abstract; a description of the project's objective, approach, and results; and the EPRI perspective. The report is a useful reference for EPRI members who are seeking past reports on specific topics of interest. Also included this year is a complete list of all Steam Turbine-Generator Program products—more than 450 projects dating back to 1977. This document will be available by the end of the third quarter of 2009.

For more information on this compilation, contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.

LPRimLife Software Program Upgrade

LPRimLife computer code combines the appropriate stress analysis information, material property data, and fracture mechanics algorithms with applicable material degradation data into an integrated methodology to assess the remaining life of low-pressure (LP) rotors with disk rim attachment cracking. Utilities can use LPRimLife to predict the remaining life of rim attachments from both a deterministic and a probabilistic standpoint. Critical crack size can be assessed, and maintenance and repair schedules can be more effectively planned. In conjunction with recent advances made in ultrasonic inspection of rim attachments using phased array technologies, LPRimLife gives utilities the ability to more effectively monitor their turbines. Furthermore, it assists utilities in planning effective maintenance strategies for continued operation of LP rotor rim attachments with known or suspected cracking.

LPRimLife was released in 2000 as a beta software program. Distribution was limited to utilities that funded the development program. EPRI also licensed the software to Structural Integrity Associates to provide analysis services to the utility industry. Recent renewed interest in LPRimLife has resulted in a project to upgrade the original beta software to meet current EPRI software standards and facilitate the distribution of LPRimLife to interested utilities and commercial licensees. The current project schedule shows LPRimLife Version 2.1 beta completed in late July 2009, with the final version available at the end of the year. EPRI is working with Impact Technologies, LLC, on the upgrade. An associated LPRimLife Workshop will be held on July 29–30, 2009, in Nashville, Tennessee, for new users of LPRimLife and those interested in learning about the functionality of the program.

Stress Corrosion Cracking in Disc Rim Attachment

For additional information, contact Paul Zayicek, 704.595.2154, pzayicek@epri.com.

NERC Interest Group

In 2008, an interest group was formed to share compliance experience related to all North American Electric Reliability Council (NERC) standards applicable to power plants. The first meeting, hosted by DTE Energy, was held on August 21–22, 2008.

The second meeting is scheduled for July 21–22, 2009, at the EPRI offices in Charlotte, North Carolina. The agenda includes presentations on and discussion of the following topics:

- Background on Federal Energy Regulatory Commission (FERC), NERC, and Regional Reliability Organization (RRO)
- Roundtable discussion of good compliance practices in nuclear, fossil, and hydro power plants
- A report on proposed and approved standards since August 2008
- Compliance administrative and organizational aspects
  - Breakout session: critical infrastructure protection
  - Breakout session: nuclear plant issues
- Audit experience
- Compliance technical issues
  - Testing at a nuclear power plant
  - Worldwide experience with generator model validation testing
- Ambient monitoring overview
  - Installation and reporting requirements of disturbance monitoring equipment (PRC-002-2)
  - Experience with digital fault recorders (DFRs)
  - Use of DFRs for ambient monitoring

To register for the 2009 meeting, go to: http://guest.cvent.com/EVENTS/info/summary.aspx?e=701b5240-717c-4aa0-bddb-dae7bc530047

For more information, contact Jan Stein, 650.855.2390, jstein@epri.com.

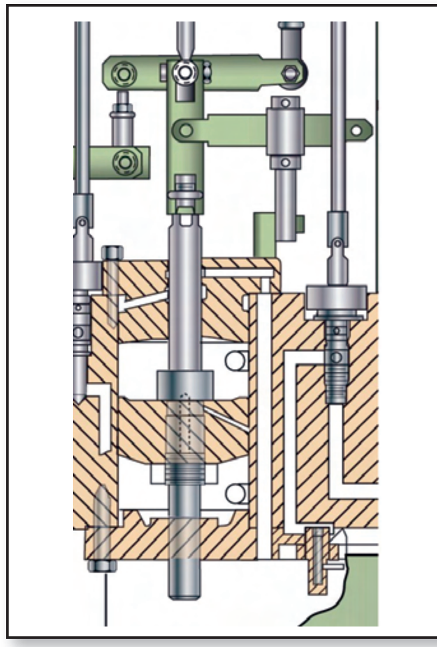
Mechanical Hydraulic Control System Maintenance Guide Completed

A project initiated in 2008 to produce a maintenance guide on turbine mechanical hydraulic control (MHC) systems was completed in early 2009 with the release of EPRI report 1015666, *Mechanical Hydraulic Controls (MHC) System Maintenance Guide.* These types of controls are still in wide use today on older turbine-generator units. A July 2008 *Steam Turbine-Generator Notes* article on this guide contains detailed information on the overall guide content.

This technical report included information on basic MHC operation, inspection, setup, troubleshooting, and maintenance. The guide familiarizes new systems engineers with the problems and corrective actions needed to keep MHC-related unavailability low. The intent of the report was to cover the MHC devices for two steam turbine valve applications: General Electric fossil and Westinghouse fossil.

Although most of these MHC systems are found on fossil steam turbines, several of these types of control systems exist on nuclear units worldwide. In early 2009, work was begun to add a section to the current report (1015666) to cover the special subsystems included on nuclear units that are not part of the typical fossil MHC system, such as the mechanical pressure regulator and electrical pressure regulator. This second version of 1015666 was released in June 2009 as EPRI report 1019313, *Mechanical Hydraulic Controls (MHC) System Maintenance Guide, Revision 1.* With the release of 1019313, the older 1015666 was archived by EPRI. (The newer version, 1019313, will include complete fossil MHC system information as well as the nuclear additions.)

For more information on this project, contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.



Mechanical Pressure Regulator Servomotor Found on Nuclear Mechanical Hydraulic Control Systems

Steam Turbine Electrohydraulic Control Fluid Monitoring Project (1017487)

A project is underway to conduct a demonstration in the steam turbine electrohydraulic control (EHC) system with the EHC fluid sensors that measure impedance of the fluid across a range of frequencies. These data will be stored and analyzed to detect moisture content, acidity, resistivity, and other fluid parameter changes in the operation of the EHC fluid. EHC fluid sample analysis will be then used to correlate the sensor analysis. In addition, the Tennessee Valley Authority (TVA) will provide EHC fluid samples to be tested and analyzed. The results of the testing with the EHC fluid sensor will be compared with tests performed by TVA.

Many of the larger fossil and most of the nuclear turbine-generator control systems are the EHC type, and the condition of the EHC fluid is critical to the system's safe, continued operation. Therefore, periodic sampling and analysis are performed to ensure the quality of the EHC fluid. Quality problems can occur between sampling times, and plant personnel would not be aware of these problems until the sample results are known or the problems have manifested into control operating events.

Having real-time information on the condition of the EHC fluid would allow personnel to detect problems and take actions to mitigate them before the control system is adversely affected. Such is the case with lubrication oils, for which sensors and technology are available to continuously monitor their condition.

The host site is Entergy's Roy S. Nelson Plant in Westlake, Louisiana. The sensor (called the *FS-3 sensor*) was supplied by Impact Technologies, LLC, and has been modified to work in the EHC fluid. It was installed in the EHC fluid reservoir and began taking data on April 20, 2009. The demonstration period is three months, and the final report will be available by the end of 2009.

If you have any questions on this demonstration project, contact Sharon Parker, 704.595.2164, sparker@epri.com.

Impact FS-3 Electrohydraulic Control Fluid Sensor

Effect of Organics/Amines on Turbine Performance and Reliability Project (1015677)

As the demand for power reaches critical points and the cost of electricity production rises, so does the need for increasing turbine efficiency. Program 65 is completing a research project investigating the use of organics/amines to increase steam turbine performance. In theory, when organics/amines (O/As) are injected into the low-pressure (LP) steam path, moisture nucleation in the phase transition zone of the last stage is affected.

The additives typically used for water treatment might reduce erosion on the last-stage rotating blades, which should improve performance and turbine reliability. The O/As are added to water treatment to prevent corrosion.

The study results are to be presented at the International Conference on Cycle Chemistry in Fossil and Combined-Cycle Plants in Boston, Massachusetts, on June 30, 2009.

An additional project experimentation to investigate findings of this research is being proposed for 2010. The findings are expected to validate the performance improvements uncovered in this research.

For additional information on this project, contact Gary Golden, 865.218.8111, ggolden@epri.com.

Steam Turbine-Generator Program Educational Web Casts

The Steam Turbine-Generator Program is presenting a series of web casts for our members on topics such as steam chemistry, life-cycle management, and turbine performance. Preliminary information was sent out to our advisors; however, if you are a program member and would like to be added to the distribution list, send an e-mail to Grant Lanthorn, glanthorn@epri.com, with the name of the web cast in which you would like to participate. The login information will be provided at least one week before the date of the web cast, and the times and topics of the web casts are listed below. Note that several web casts were broadcast before this issue's publication and are available at www.epri.com/nsti/index.

A recording as well as the Powerpoint slides of all the web casts will be posted to this web site approximately one week after the presentation date and available to our members.

Torsional Vibration
Date: May 19, 2009, 1:30 PM Eastern
Presented by: Jan Stein, EPRI Project Manager and Hans Giesecke, MPR Associates

Turbine Water Induction 101
Date: June 3, 2009, 1:30 PM Eastern
Presented by: Merrill Quintrell, EPRI Senior Project Manager

Steam Turbine Theory and Design Tutorial
Date: June 30, 2009, 1:30 PM Eastern
Presented by: Stephen Hesler, EPRI Senior Program Manager

Steam Turbine Life Cycle Management
Date: August 6, 2009, at 1:30 PM Eastern
Presented by: Tom Alley, EPRI Senior Program Manager

Steam Turbine Chemistry 101
Date: August 25, 2009, 1:30 PM Eastern
Presented by: Jim Mathews, EPRI Program Manager

Steam Turbine Performance 101
Date: August 20, 2009, 1:30 PM Eastern
Presented by: Gary Golden, EPRI Senior Project Manager

For more information, contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.

Translations Available for International Members

Did you know that the EPRI Steam Turbine-Generator Program releases translated copies of *Steam Turbine-Generator Notes*? Versions of the current newsletter will be available for our overseas members in Japanese (1019296), French (1019297), and Spanish (1019298). These translations are published approximately 90 days after the English version of the *Steam Turbine-Generator Notes* newsletter and so should be available for download in October 2009. These are publicly available documents downloadable from www.epri.com.

For more information, contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.

Chemical Cleaning of a Turbine Main Stop/Throttle Valve

The purpose of this project is to demonstrate a chemical cleaning process that removes iron oxide deposits from a fossil main stop/throttle valve.

To remove copper deposits, power plants have used chemical cleaning on their high- and low-pressure turbine sections. These chemical cleaning activities have produced quantifiable results in restoring efficiency losses.

With turbine valves, however, the typical deposits are iron oxides and magnetite. These deposits on the valve stem and bushing accumulate, and the design clearance (typically 0.015–0.025 in. [381–635 μm] diametrical clearance) is then reduced, causing the stem to stick or bind in the bushing. Because the turbine valves control the load and speed of the turbine-generator unit, their function is critical for safe operation. In fact, the closing of the main stop/throttle valves is a major component of the overspeed protection system.

When the turbine valves are disassembled for inspection, the iron oxides are removed by blast cleaning with aluminum oxide material. Removal of the deposits restores the dimensions of the valve stem and bushing. In addition, the blast cleaning prepares the metal surface for nondestructive examination (such as visual, magnetic particle, and ultrasonic).

When problems with valve sticking or binding in the valve bushing arise, deposits from the stem and bushing must somehow be removed. One advantage of using chemical cleaning is that the removal process could occur without disassembling the valve.

The hard, tenacious magnetite scale that develops on the turbine stop valve stems resembles the high-temperature oxides prevalent in boiler superheater and reheater sections. These boiler sections are the most likely source of the material that forms these deposits. To remove iron oxide deposits in the boiler superheater and reheater sections, the chemical cleaning formulations traditionally used have been based on inhibited solutions of ammoniated ethylene-diamine tetraacetic acid (EDTA). Formulations of di-ammonium EDTA appear to demonstrate applicability for removal of the turbine valve stem deposits. Inorganic acids (such as HCl, H_2SO_4, and hydrofluoric acid [HF]) are not recommended for use

Oxide Scale on a Valve Stem

in removing these deposits because of the material's sensitivity to these inorganic compounds (chloride, sulfur, fluorine, and other halogens or oxidizing compounds).

A test cleaning for the stop/throttle valve components will need to be performed. As part of this, a used stop/throttle valve stem will also be needed to demonstrate the chemical cleaning. The deposits on the valve component should be analyzed (including by X-ray diffraction) for exact chemical composition, and the chemicals that would provide the best cleaning solution can then be determined. Restrictions on the chemicals used—including chloride, fluoride, sulfur, nitrates, and nitrides—will, of course, be provided.

For this cleaning, a foam or liquid injection with possible ultrasonic agitation or some other combination of methods could be used. The test should demonstrate the effectiveness of the chemicals used, the length of the actual cleaning, and any other method used that was effective in removing the deposits. Finally, the test demonstration results would be analyzed and adjusted for the actual stop/throttle valve demonstration at the plant.

EPRI is looking for a fossil plant to donate a used stop/throttle valve stem to be used by a chemical company in testing a chemical cleaning process. If you are interested in participating in this work, contact Sharon Parker, 704.595.2164, sparker@epri.com.

Risk Management on a Constrained Budget

Among EPRI's P65 members, there has been a sense for several years that budget constraints have dominated technical issues in management's thinking. Consequently, the continued neglect of many technical issues is resulting in serious economic ramifications as the overall electric generation fleet ages. In response, EPRI has prepared a PowerPoint slide presentation (EPRI 1018218) for use in educating and motivating management to see beyond budget-cycle considerations and to value technical issues and their financial and operational implications more realistically.

For more information, contact Jan Stein, 650.855.2390, jstein@epri.com.

Steam Turbine Valve Actuator Condition Assessment Guide (1015674) Now Available

In 2008, the EPRI Steam Turbine-Generator and Balance-of-Plant Program began to develop a maintenance guide for steam turbine valve actuators. The guide complements a previous EPRI report produced in 2005, *Guidelines and Procedures for Turbine Valve Condition Assessments* (1010211), which provides detailed instruction on valve component inspection and assessment criteria during disassembly and specifications for proper valve reassembly clearances.

The new report (1015674), released in December 2008, provides information on the following steam turbine valve actuators:

- General Electric (GE) mechanical hydraulic control (MHC) stop, control, reheat stop, and intercept valves
- Siemens-Westinghouse (SW) MHC throttle, governor, interceptor, and reheat stop valves
- GE electrohydraulic control (EHC) stop, control, reheat stop, and intercept valves
- SW EHC throttle, governor, interceptor, and reheat stop valves

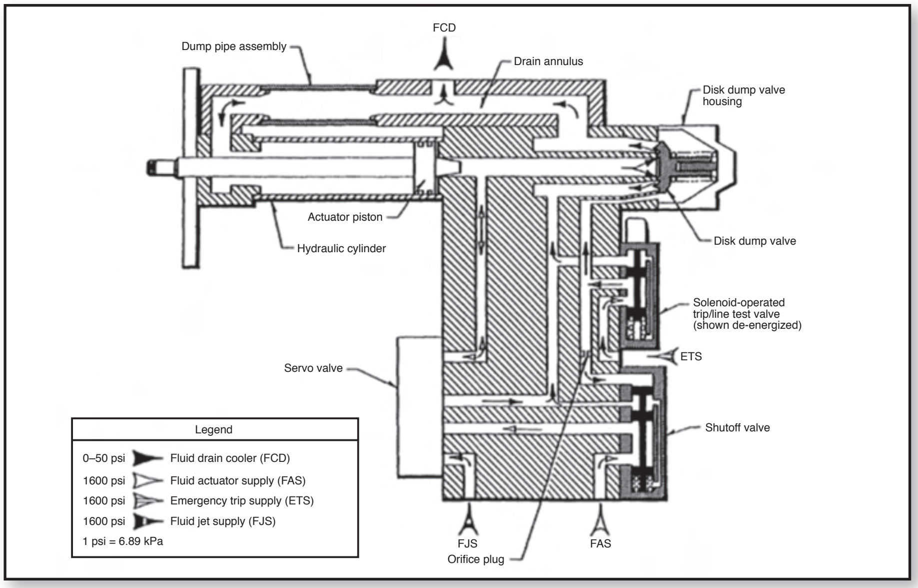
A Technical Advisory Group (TAG) was formed, consisting of the following nuclear and fossil plant representatives:

- Bob Bjune, South Texas Project
- Randy Bunt, Southern Company
- Tony Khalid, Exelon/Corporate
- Mark Miller, Duke Energy/Catawba
- Jim Olson, Tennessee Valley Authority/Corporate
- Charlie Seitz, Exelon/Three Mile Island
- Michael Togliatti, Exelon/Braidwood

In addition, Spartan Hydraulic Inc. and United Servo Hydraulics, Inc. provided valuable report input.

The information in this report is organized in the following sections:

- **Section 1, Introduction.** This section includes the background, approach, industry database reviews, report organization, acronyms and abbreviations, and references.
- **Section 2, Technical Description.** This section includes a general description of the function of the steam turbine valve actuators. It also includes descriptions of the GE and SW MHC and EHC systems for the steam turbines. Normal operational testing of the valve actuators and ways to identify problems are addressed, and a table of recommended inspection and rebuild frequencies for each type of valve actuator is included.
- **Section 3, Actuator Disassembly, Inspection, and Assembly Tasks.** This section includes a generic drawing of the actuator for each steam turbine valve for MHC and EHC systems and spring cans, as appropriate. Tasks are provided for removing the actuator and spring can from the steam turbine valve, inspecting and rebuilding the actuator and spring, and reinstalling the actuator and/or spring can. Also included are tasks for inspecting and rebuilding the EHC emergency disk dump valves for both GE and SW systems.
- **Section 4, Actuator Inspection Criteria.** This section provides condition evaluation criteria for the GE and SW actuators described in Section 3. A checklist and corresponding datasheet(s) for each major component is included in Appendix A.
- **Section 5, Maintenance Considerations.** This section includes a table of typical actuator problems, possible causes, and potential corrective actions when troubleshooting a steam turbine valve that is not functioning properly. In addition, a list of recommended spare parts for an MHC and an EHC steam turbine valve actuator is provided. A tool list for inspecting and rebuilding the actuators is provided for both the MHC and EHC systems. Finally, a subsection on industrial safety considerations is included as well as a typical specification for a vendor to inspect and rebuild an actuator for both MHC and EHC systems.
- **Appendix A, Datasheets.** The forms in this appendix are designed to assist in the inspection and documentation of measurements for the steam turbine valve hydraulic actuators, spring can assemblies, and disk dump valves provided in Section 3. Forms for documenting the most common measurements taken on components as part of the inspection are included.
- **Appendix B, Sample Actuator Inspection and Rebuild Specification.** This appendix contains a sample specification for the inspection and rebuild of a steam turbine valve hydraulic actuator by a vendor or contractor.



GE Electrohydraulic Control Controlling Actuator

Report 1015674, Steam Turbine Valve Actuator Condition Assessment Guide, *was made available on December 31, 2008. For more information, contact Sharon Parker, 704.595.2164, sparker@epri.com.*

Additions to Guidelines for Reducing the Time and Cost of Turbine-Generator Maintenance Overhauls and Inspections

The most highly rated project in the EPRI Steam Turbine-Generator (TG) R&D program, *Guidelines for Reducing the Time and Costs of Turbine-Generator Maintenance Overhauls and Inspections*, continued in 2008. As in past years, additions were made to this seven-volume set of information that has been in production for more than eight years.

The 2008 EPRI product number is 1015668 (this is a "kit" number). When ordering this kit from EPRI, the member will receive a four-CD set of disks containing all seven volumes of the kit. Additional information is added each year to various volumes of this seven-volume set of data.

An additional feature of this project was begun in 2007: all new material added to the kit is compiled into one supplemental document. For 2008, this product number is 1018600. By compiling only the additions each year, single-year funders of the TG program who are not eligible to receive all seven volumes can access these yearly additions.

Turbomachinery International, a respected industry periodical, recently highlighted this Guidelines product in the article "Guidelines That Save Money."

Of course, all multi-year funders of the TG program can still obtain all of the information contained in the seven-volume kit by ordering product number 1015668.

The general content of each of volume follows.

- **CD 1**

  Volume 1: General Practices

  – The first volume presents general practices for each of the fundamental maintenance activities usually associated with an outage: TG condition assessment (in-service), pre-outage planning and bidding, unit shutdown procedures, disassembly and recording clearances, foreign material exclusion (FME) process information, TG condition assessment (off-line), oil flushing, rotor alignment and balancing, pre-startup checks, and post-outage activities. Volume 1 also contains, as appendices, a sample TG outage report, more than 150 sample data sheets, and a TG FME program/process guidance document.

  Volume 2: Repair Procedures

  – The second volume provides detailed repair procedures to guide the pre-bid, inspection, disassembly, and repair of critical turbine and generator components. Examples of these procedures are bearing spin-casting and repuddling; diaphragm and nozzle block partition repair; blade tenon repair; hydrogen seal repair; horizontal joint casing repair; main steam stop valve cap repair; generator hydrogen seal inspection and repair; Alterrex inspection and maintenance; and inspection, testing, and rewedging generator stators.

  Volume 3: Balancing and Alignment Specifications

  – The third volume contains comprehensive alignment and balancing primers; high- and low-speed balancing procedures for turbines, generators, and exciters; and a section on alignment best practices.

  Volume 4: Blade and Rotor Procurement Specifications

  – The fourth volume provides detailed specifications for the procurement of turbine buckets, high-pressure/intermediate-pressure/low-pressure (HP/IP/LP) fossil rotors, HP/LP nuclear rotors, a generator rotor rewind, a new generator rotor, a generator stator rewind, a new generator stator, generator excitation system, turbine insulation, complete turbine outage services, and turbine bolting and grit blasting services.

  Volume 5: Turbine Directory and Database

  – The fifth volume presents a directory and database of large (>75 MWe) turbines that operate with last-stage buckets of 23 in. (58 cm) or longer. The list now contains U.S. and international units. Presented in this database are original turbine manufacturers and their equipment designations, and plant/unit status (as of 2001). To further assist users of this directory in identifying operators who might have units that share common features, the data are sorted and presented by L-0 bucket length and the manufacturer's design designation (where this could be identified). Included are plants/units that have been shut down as well as those that have been cancelled. A table that lists North American and International units that have completed major component replacements and modifications is also included.

- **CD 2**

  Volume 6: HP/IP Blade/Disk Design and Inspection Specifications

  – The sixth volume presents blade/disk design audit and inspection procedures for HP and IP steam turbine blades/disks. This information aids turbine maintenance personnel in assessing solid particle erosion, high-cycle fatigue (HCF), low-cycle fatigue (LCF), and creep rupture damage to HP and IP blading.

continued on page 13

continued from page 12

- **CD 3**

  Volume 7: LP Blade/Disk Design and Inspection Specifications

  – The seventh volume presents blade/disk design audit and inspection procedures for LP blades/disks. This information aids turbine maintenance personnel in assessing stress corrosion cracking, HCF, and LCF damage to LP blading.

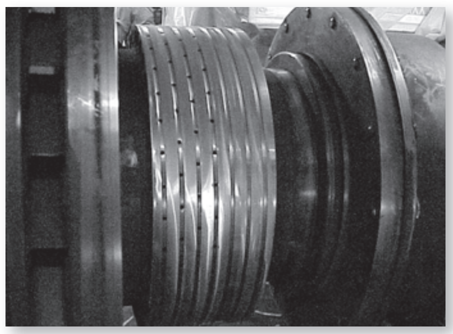
- **CD 4**

  TGAlign and TGAlign-SI Computer Programs and User Manuals

  – TGAlign software (available in English-unit and SI-unit versions) is a robust computer program that determines the optimum coupling alignment for a TG rotor system, thereby reducing the outage time for steam TGs.

The utility Technical Advisory Group (TAG) met again in early 2008 through a web cast and decided on the additions to be made to the Guidelines CDs. The following additions were made to the seven-volume set in 2008:

- Volume 2:
  - – A turbine grit blasting cleaning procedure was added as a new Section 9.
  - – In Sections 8.3 and 8.4, hydrogen seal maintenance best practices for General Electric (GE) and Westinghouse design hydrogen seals were added.
  - – In Section 8.13, new information was added for data recording and acquisition during maintenance on generator collector rings.



Spiral (Helical) Groove on a Turbine Collector Ring

- Volume 3:
  - – Alignment best practices were added as a new Section 3.12.
  - – An example purchase specification for grit blasting services request for quote was added as a new Section 14.

The TAG met again by web cast in February 2009 to discuss potential additions. The following information will be added to the Guidelines CD set in 2009 based on budget constraints and availability of the information:

- Generator high-voltage bushing replace/repair/refurbish purchase specification
- Boiler/reactor feedpump blading purchase specification
- Complete TG unit purchase specification
- Parametric analysis of TG vibration on bearing life

For more information on Guidelines for Reducing the Time and Cost of Turbine-Generator Maintenance and Overhauls, *contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.*

Coming Soon: Digital Fault Recorder Report and Software

In 2009, EPRI Programs 40 and 65 delivered software that, when used with recorded disturbance response of a generating unit, can automatically derive parameters for—and thus validate—the models for power plant equipment. The Power Plant Parameter Derivation (PPPD) software includes a suite of IEEE models for generators, generator excitation systems, and combustion and steam turbines.

Most power plants do not have a way to capture the unit response with resolution (that is, several samples per second), which is required for the analysis by PPPD software. Digital fault recorders (DFRs) have also been used to provide data to accomplish the following:

- Investigate major events (for example, torsional events).
- Investigate unit trips. This includes investigating the immediate cause, whether the unit can go back on-line safely, the root cause analysis, and the documentation of the event.
- Improve predictive maintenance. If the device is starting to fail, monitor selected parameters (for example, field winding current, temperature, resistance to ground, and flux probe).
- Verify generator performance. This includes providing records for insurance and legal issues as well as for the North American Electric Reliability Council (NERC).

EPRI will publish a comprehensive guide on the use of DRFs for ambient monitoring of plant response to network disturbances and for monitoring power plant equipment.

The report will include guidance on DFR requirements, installation and interfaces, maintenance, and calibration. It will also describe experiences with plant equipment monitoring and data interpretation.

For more information, contact Jan Stein, 650.855.2390, jstein@epri.com.

Project Underway: Mitigating Actions During Major Turbine-Generator Events Project (1017488)

What happens when a natural disaster threatens your plant? Could such an event keep your turbine-generator (TG) down for months? Does your inadequate emergency planning keep you up at night, or are you prepared? What process should you put in place if a hurricane is approaching or when a levee breaks and a flooded turbine hall is imminent? Of course, you could shut down if the ground is shaking—but when should you shut off the turbine oil to minimize the risk of a large oil fire in the plant?

In an ever-changing power production world with retrofit projects constantly upgrading units to operate past the design life, the time for reviewing processes and procedures for emergencies and mitigating damage is here.

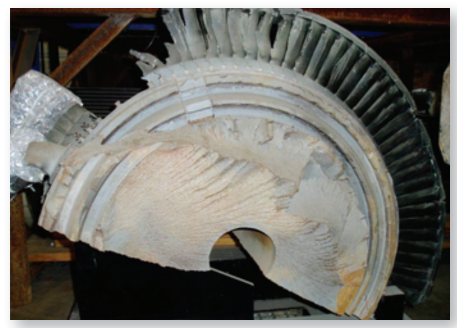
Chances are near 100% that your emergency response program addresses shutdown procedures along with contact information for first responders. However, does it include a decision-making process for reducing damage to the equipment while focusing on safety? Do your operators train for methods of shutdown to reduce damage, and do they have immediate access to the systems engineers for help in decision making?

This project is investigating the experiences of several power plants along with current plans that are in place throughout the industry for mitigating damage to steam TGs during major events. The two primary areas of focus for the resulting report will be natural disasters (such as hurricanes, tornadoes, and flooding) that could occur at the site and major equipment failures (such as losing turbine blading or lube oil during operation). Based on a review of industry experience in these areas, the final product will provide guidance on actions to be taken in the preplanning stage, just before the incident (for example, a natural disaster), and immediately following the incident (for recovery efforts) as well as any longer-term actions needed to finalize the outage event.

For additional information on this project, contact Gary Golden, 865.218.8111, ggolden@epri.com.

Power Plant Fire due to Turbine-Generator Failure

Major Turine Generator Damage due to Turbine Rotor Failure



Turbine Rotor Failure

Confused About Turbine-Generator Jargon? Turbine-Generator Acronyms and Definitions Guide Is Here

At many power plants, the term *turbine* is often used to refer to the *turbine-generator set,* even if the specific part is actually related to the generator.

In 2003, a machinist was killed when he removed a manhole cover from a generator during a pressure decay test. Before he removed the cover, he entered the control room and told the operator that he would be taking a cover off the "turbine." The operator gave the "OK"—thinking that the cover intended for removal was one of the covers on the outside of the LP turbine. Although the operator knew that the generator was pressurized, he did not think that a cover was going to be removed from the generator itself.

Incidents such as this illustrate the need for proper communication at all times. However, this communication is hindered when multiple terms exist for the same part or procedure or when the same term applies to multiple parts.

In an effort to assist in communication and clarify terms related to turbines and generators, EPRI's Program 65 has developed guidance on steam turbine-generator terms and acronyms and posted it on the web site at http://www.epri.com/NSTI/index.html. This document will be periodically updated and should be treated as a guide—not a definitive source. If a doubt or question remains in your mind, we encourage you to consult your site safety personnel.

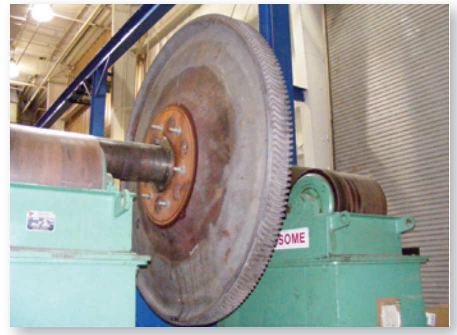
For more information, contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.

Axial Entry Blade Attachment NDE Performance Demonstration

Phased array ultrasonic inspection technology provides excellent flaw detection, sizing, and characterization for a variety of power plant inspection applications including steam turbine disk blade attachment. EPRI previously facilitated a performance demonstration for linear phased array inspection of tangential entry (straddle-mount) steam turbine disk blade attachments; EPRI report 1011677, *Phased Array Performance Demonstration for Blade Attachment Inspection,* documents participant performance in that demonstration activity. As a follow-on to that work, EPRI is conducting a performance demonstration activity for ultrasonic phased array inspection of axial entry disk blade attachments. EPRI invited commercial inspection companies that provide this inspection service to participate in the examination of two EPRI mockups of axial entry-style blade attachments. WesDyne International and Structural Integrity Associates are participating in the demonstration.

Two mockups were used for the data collection phase of the performance demonstration and were mounted on powered rollers to accommodate phased array scanning. The flaw population of these blocks includes man-made electrical discharge machining notch flaws.

The participants collected data on both of the performance demonstration mockups and are analyzing the data and will provide flaw detection, sizing, and characterization information to EPRI. The collected data will be compared against the fabricated flaw dimensions. At the planned conclusion of the project, EPRI will generate a report describing each participant's inspection technique and inspection performance on the mockups.



Low Pressure Rotor Disc Mockup for Axial Entry Performance Demonstrations

For additional information, contact Paul Zayicek, 704.595.2154, pzayicek@epri.com.

New Member Benefit: Program 65/NSTI Contracts with Industry Consultants for Additional Expertise

This year, Program 65 has enlisted the help of three experts to address questions and issues our that members may be facing related to turbines and generators. By making these experts available, we hope to provide another valuable resource to those who participate in our program. Dr. Lyle Branagan (Pioneer Motor Bearing Co.) will be available to address turbine-generator bearing issues, Ken Brown (Eco Fluid Center Ltd.) will advise members on electrohydraulic control fluid questions, and Don Osborne (Mechtell, Inc.) will handle turbine vibration/alignment issues. If you have a question about any of these areas, first direct it to any one of the EPRI Program 65/NSTI staff members. If it is determined that they do not have the expertise on hand to quickly address your question, they can direct you to one of these industry experts.

For more information, contact Alan Grunsky, 704.595.2056, agrunsky@epri.com.

Program 65 Seeking Industry Experience with Turbine Failures

This year, Program 65 has begun to document industry turbine and generator failures. The final product will be a technical report that includes information about each failure, the actions taken, root cause analysis, contact information, and anything else available for distribution.

EPRI is soliciting the industry's help in obtaining information on these failures. If you have been involved in any turbine-generator failures you think might be of interest to EPRI members, contact Grant Lanthorn, Program 65 Student Employee, 704.595.2125, glanthorn@epri.com.

Eleventh EPRI Steam Turbine-Generator Workshop and Vendor Exposition

The Eleventh EPRI Steam Turbine-Generator Workshop and Vendor Exposition will be held on August 10–11, 2009, at the Hilton Milwaukee City Center in Milwaukee, Wisconsin. The workshop will feature presentations from a variety of utility, vendor, OEM, consultant, and EPRI personnel on subjects related to steam turbine-generator operations and maintenance, upgrades, repairs, performance, inspection, and life assessment. The workshop will be composed of three presentation tracks and will include the following presentation subject matter:

Track 1: International Conference on Electric Generator Predictive Maintenance and Refurbishment

- Incipient failure diagnosis and refurbishment/replacement decisions
- On-line monitoring and data interpretation
- Failure root cause investigation
- Rotor, stator core, and stator winding vibration
- Water damage mitigation
- Generator frame foot loading verification
- Experience with air-cooled rectifier modules
- Experience with grounding brush-induced rotor vibration
- Experience with tagging compounds
- Decision process for stator winding rewedging
- Isophase bus maintenance
- Excitation system maintenance and replacement
- Experience with operation and maintenance of large air-cooled generators

Tracks 2 and 3: Steam Turbines and Generators

- Steam turbine rotor maintenance/repair
- Nondestructive evaluation
- Life assessment
- Life cycle management
- Risk management
- On-line monitoring
- Condition assessment
- Upgrades/uprates
- New builds
- Performance
- Reactor/boiler feed pump turbines
- Root cause analysis

The workshop will be followed by the EPRI TGUG meeting, Wednesday through Friday, August 12–14, 2009. The TGUG meeting will include a tour of the ReGenCo facilities in nearby West Allis, Wisconsin, on Thursday afternoon, August 13.

For additional information on the Eleventh EPRI Steam Turbine-Generator Workshop and Vendor Exposition, see the EPRI Calendar of Events, or contact Paul Zayicek, 704.595.2154, pzayicek@epri.com.

Inspection Criteria for Generator Reports Software to Be Released in 2009

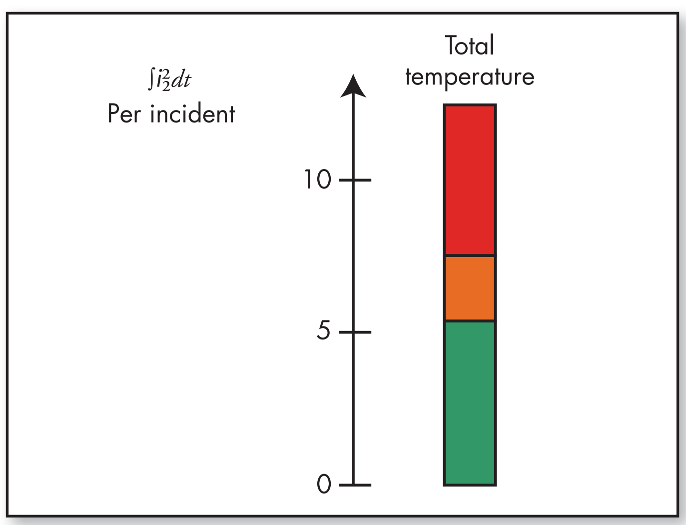
Negative sequence heating of the rotor is induced by the following:

- Asynchronous operation of the rotor, such as motoring
- Phase unbalance in the stator winding caused by unsymmetrical loads or faults
- Harmonic currents introduced in the grid, for example, by static frequency converters

The objective of this multi-year project is to define the level of negative sequence current that will warrant rotor inspection for damage to the forging, retaining rings, and rotor wedges. EPRI reports 1014910 and 1015671 (published in 2007 and 2009, respectively) provide models for estimating the tooth and wedge temperature during a negative sequence fault, heating of teeth, pole face and retaining ring shrink fit, and heating effects experienced during rotor motoring.

User-friendly software will be available in the fourth quarter of 2009.

For more information, contact Jan Stein, 650.855.2390, jstein@epri.com.

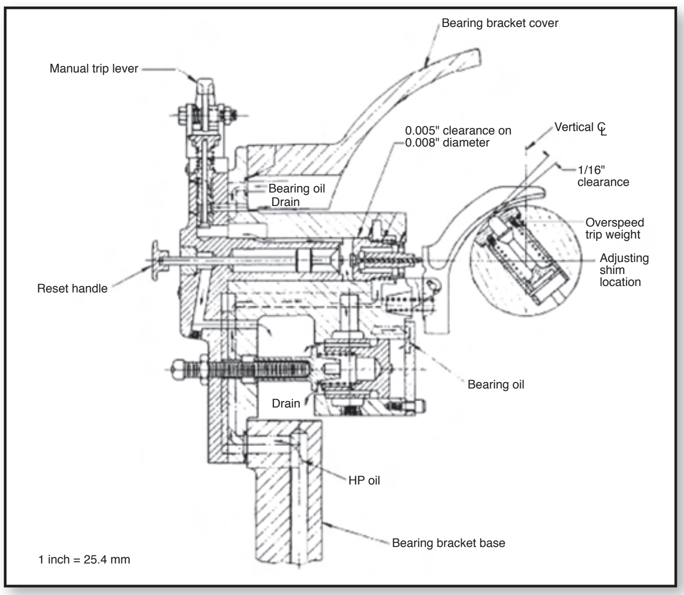


Computer code output showing the amount of negative sequence and the corresponding, color coded, temperatures estimates.

Turbine-Generator Auxiliary System Maintenance Guides, Vol. 5: Main and Feedpump Turbine Trip System Guide (1017486)

Scheduled for release in late 2009, *Turbine-Generator Auxiliary System Maintenance Guides, Vol. 5: Main and Feedpump Turbine Trip System Guide* (EPRI report 1017486) will provide detailed information on the operation of the main and feedpump turbine trip systems. The information will include adequate diagrams and explanations of the various trip features of the turbine control system and will likely include inspection, testing, and maintenance recommendations for each trip feature.

In 2009, EPRI report 1015666, *Steam Turbine Mechanical Hydraulic Control (MHC) System,* was produced. It describes the basic operation, inspection, setup, troubleshooting, and maintenance for the MHC systems on the General Electric (GE) and Siemens-Westinghouse (SW) fossil and nuclear turbine units. The upcoming report (1017486) will cover the trip system for the MHC and electrohydraulic control (EHC) main turbine and feedpump turbines for U.S. GE and SW units.



Westinghouse Oil Loss, Overspeed, and Manual Trip

The turbine trip system consists of the trip functions that protect the main turbine from damage in operation caused by speed, pressure, mechanical damage, and conditions—including generator and boiler/reactor conditions—external to the turbine. A separate section for feedpump turbine trip systems will be included, and a general description of the turbine protection systems will be provided. The following is a general outline of the guide:

- Section 1, Introduction: background, approach, and organization
- Section 2, GE Large Steam Turbine EHC Mk-I Trip System
- Section 3, GE Large Steam Turbine EHC Mk-II Trip System
- Section 4, GE Mechanical Drive Turbine UT70 Trip System
- Section 5, GE Mechanical Drive Turbine MDT20 Trip System
- Section 6, GE Mk-V Trip System
- Section 7, GE Mk-VI Trip System
- Section 8, Westinghouse Large Steam Turbine Analog Electrohydraulic Trip System
- Section 9, Westinghouse Large Steam Turbine Digital Electrohydraulic (DEH) Trip System
- Section 10, Westinghouse Feed Pump Turbine Trip System

Sections 2–10 each address technical description, operational tests, inspection and testing, maintenance practices, troubleshooting, glossary, and references for a specific system.

This report should help power plant turbine-generator technical personnel understand, test, troubleshoot, and maintain the main and feedpump turbine trip systems. Development of the guide began in April 2009 and is expected to be completed by December 31, 2009.

If you are interested in participating in the Technical Advisory Group for this guide, contact Sharon Parker, 704.595.2164, sparker@epri.com.

Generator Bushing Installation and Maintenance Guide (1016787)

Proper installation of generator high-voltage bushing (HVB) is essential to a unit's safe operation. To prevent pressurized hydrogen from escaping from the generator, the bolted connection between the lead box and the bushing flange must be gas-tight. EPRI report 1016787 focuses on the following key areas of generator HVBs:

- Site preparation before removal and installation
- Gasket and bolting selection
- Geometries of flange-to-porcelain interface
- Torque calculation
- Testing
- Failure history and failure modes
- Inspection intervals

For more information on this project, contact Jan Stein, 650.855.2390, jstein@epri.com.

Guide for Inspection of LP Turbine Blades

Failure of LP turbine blades in service results in significant damage to the unit—up to and including catastrophic failure. Many operational drivers influence the service life of LP turbine blades. Timely and proficient inspection of LP turbine blades can help mitigate the consequences of catastrophic failure. EPRI report 1016789, *Guide for Inspection of LP Turbine Blades,* will provide pertinent information on the inspection of LP turbine blades using visual, magnetic particle, eddy current, liquid penetrant, ultrasonic, and emerging inspection techniques. Inspection of LP turbine blades includes airfoils, blade root, tie wires, lashing lugs, and tenons as applicable. In addition, the guide describes the modeling process for development of ultrasonic inspection techniques and gives an overview of failure mechanisms and modes.

For additional information, contact Paul Zayicek, 704.595.2154, pzayicek@epri.com.

Recap: Fifth Biennial EPRI Technology Transfer Workshop

On Monday and Tuesday, August 11–12, 2008, the Fifth EPRI Technology Transfer Workshop was held at the Embassy Suites Convention Center in Concord, North Carolina. The event included a vendor fair, with 41 vendors and original equipment manufacturers (OEMs) participating.

Approximately 250 registrants participated in the event. The Technology Transfer Workshop consisted of three parallel tracks with various topics throughout the day in each track.

Track 1 featured the following Turbine 101 courses:

- Turbine design
- Turbine performance
- Turbine chemistry
- Turbine life cycle management and remaining life assessment
- Turbine water induction

Track 2 featured two sessions, Conference on Generator Predictive Maintenance and Hipot Testing, and Track 3 included the following Technology Transfer topics:

- Generator hydrogen system guide (auxiliary series #3)
- FAST and HEW-CA program overview
- Guidelines overview
- Turbine casing cracks inspection and repair
- Turbine bolting guide
- Turbine blading root cause analysis
- Turbine blading on-line vibration monitoring
- PM Basis overview
- Improved Steam Path Primer overview

Participants provided positive feedback on both workshop content and the hotel venue. The EPRI Technology Transfer Workshop was followed on Wednesday by the Turbine-Generator Users Group (TGUG) meeting, which continued through Friday. The Sixth EPRI Technology Transfer Workshop will be held in August 2010 in St. Louis, Missouri.

For additional information, contact Paul Zayicek, 704.595.2154, pzayicek@epri.com.

Turbine-Generator Users Group Update

August 2008 U.S. Meeting

The 18th meeting of the EPRI Turbine-Generator Users Group (TGUG) was held on Wednesday through Friday, August 13–15, 2008, at the Embassy Suites Convention Center in Concord, North Carolina. In conjunction with this meeting, the Fifth Turbine-Generator Technology Transfer Workshop and Vendor Exposition were held at the same location on Monday and Tuesday, August 11–12. A vendor exposition was also held on Monday and Tuesday evenings. More than 250 registrants and 41 vendors participated in the two-day workshop and exposition.

New TGUG member utilities introduced at this meeting were the CANDU Owners Group, Genesis Power, and NRG Energy.

On Thursday afternoon of that week, the group boarded buses for an afternoon tour of the Pioneer Motor Bearing Company in Kings Mountain, North Carolina. Approximately 80 TGUG members participated in the tour. A complete tour of the Pioneer facility was conducted in three groups by the Pioneer staff, and many complimentary comments were made by the TGUG members about the quality of the tour and the information shared by Pioneer.

January 2009 U.S. Meeting

The 19th meeting of the EPRI TGUG was held on Wednesday through Friday, January 21–23, 2009, at the Hyatt Regency Savannah Hotel in Savannah, Georgia. In conjunction with this meeting, the winter 2009 TGUG workshop was held at the same location on Monday and Tuesday, January 19–20.

New TGUG member utilities attending this meeting were Korea Hydro and Nuclear Power (KHNP), Dominion Chesterfield Station, Wolf Creek Nuclear Operating Company, and Tractebel (Brazil).

With the tenure of the current set of TGUG officers expiring with this meeting, the group elected the following officers who will serve for the 2009–2011 term:

- Tom Kordick (Ameren), chairperson
- James Wieters (SCANA), vice chairperson
- David Glosecki (Dynegy Generation), secretary

On Thursday afternoon, the group toured the local Continental Field Systems (CFS) shop, hosted by Jeremy Blankston of CFS. This tour gave attendees an opportunity to evaluate and inspect another option for shop and/or field services that might be needed during TG outages.

Student OR

The EPRI Steam Turbine-Generator Program continually reaches out to local universities where our meetings are held and, in coordination with the school's Engineering Department staff, invites that university's engineering students to attend our workshops and TGUG meetings. As a result of this effort, six University of North Carolina at Charlotte (UNCC) mechanical engineering/electrical engineering (ME/EE) students attended the 18th workshop and TGUG meeting, and four Georgia Institute of Technology-Savannah campus ME/EE students attended the 19th workshop and TGUG meeting.

Additional TGUG Meetings in 2009 and 2010

Several other TGUG meetings and workshops were held or are planned in 2009 and 2010.

The First European TGUG meeting in Madrid, Spain, was held at the Intercontinental Hotel in Madrid the week of June 22, 2009, with more than 130 attendees. A vendor exposition was also conducted at this workshop on Monday and Tuesday evenings, June 22–23, with 7 vendors and original equipment manufacturers (OEMs) participating. The turbine and generator workshop sessions were focused on TG condition assessment, repair, and replacement.

The 20th meeting of the EPRI TGUG will be held on Wednesday through Friday, August 12–14, 2009, at the Hilton Milwaukee City Center in Milwaukee, Wisconsin. In conjunction with this meeting, the Eleventh EPRI Steam Turbine-Generator Workshop and Vendor Exposition will be held at the same location August 10–11 (Monday through Tuesday). See page 19 for additional information on the workshop. On Thursday of that week, TGUG will tour the local Toshiba/ReGenCo facility.

The 21st meeting of the EPRI TGUG will be held on Wednesday through Friday, January 20–22, 2010, at the Williamsburg Lodge in Williamsburg, Virginia. Again, in conjunction with this meeting, the TGUG winter workshop will be held at the same location on Monday and Tuesday, January 18–19. On Thursday of that week, TGUG will tour the Alstom Repair Facility in nearby Richmond, Virginia.

TGUG will visit Australia for the third time in March/April 2010. A TGUG meeting and workshop in Noosa, Australia, will be conducted in conjunction with the EPRI Boiler Life and Availability Program. When the exact meeting and workshop dates have been finalized, details will be posted to www.epri.com/TGUG and www.epri.com/nsti.

Consult the EPRI Calendar of Events for additional information on these meetings as it is posted; you may also contact any of the EPRI TG Program staff for workshop and meeting details.

The Electric Power Research Institute, (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI's members represent more than 90 percent of the electricity generated and delivered in the United States, and international participation extends to 40 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass.

Together...Shaping the Future of Electricity

1019295 July 2009

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304 • PO Box 10412, Palo Alto, California 94303 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com