All text, classroom instruction and Learning-Doc information offered is designed to acquaint students with generally accepted good practice for operation or maintenance of equipment and/or systems.

They do not purport to be complete nor are they intended to be specific for the products of any manufacturer and H Parker & Company, Inc. (d/b/a HPC Technical Services) will not accept any liability whatsoever for the work undertaken on the basis of the text, classroom instruction or Learning-Docs. The manufacturer's operating and maintenance specifications are the only reliable guide in any specific instance; and where they are not complete, the manufacturer should be consulted.
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ABOUT HPC TECHNICAL SERVICES

HPC Technical Services (HPC) provides professional services to the utility, cogeneration, and related industries. Our goal is to assist operating plants to achieve the highest effectiveness from their personnel and equipment. HPC has provided training, operations, maintenance, and engineering services to many fossil, nuclear, and hydroelectric power generating facilities. The training and engineering support is always supplied by “Subject-Matter-Experts” to ensure the correct person is assigned to each and every project. We are the industry leader in providing turbine generator related training services, and understand how and when to apply high technology innovative solutions to power plant problems.

HPC Technical Services specializes in “Technology Transfer” from the OEM to the user. HPC Technical Services was incorporated as H Parker & Company, Inc. in the State of Florida in December 1992 and is headquartered in Bradenton, FL. Since then HPC has provided technical training services in every state in the United States, every province of Canada, as well as off North America's soil. Internationally, we've serviced clients from Argentina, Aruba, Australia, Bahamas, Barbados, Chile, Columbia, Denmark, Dominican Republic, France, Ghana, Grand Cayman, Germany, Grenada, Guatemala, India, Indonesia, Kuwait, Mexico, Netherlands, Nicaragua, Saudi Arabia, Scotland, South Africa, South Korea, Spain, Suriname, Switzerland, Taiwan, United Kingdom and Venezuela.

As always, any course offered by HPC can be customized for delivery at your site.

HPC is also a member of, or affiliated with, the following organizations:

- American Chemical Society
- American Management Association
- American Society for Testing and Materials
- American Society for Training and Development
- American Society of Mechanical Engineers
- American Society of Power Engineers
- Institute of Electrical and Electronics Engineers
- National Institute for the Uniform Licensing of Power Engineers

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Course Dates/Prices/Locations subject to change without notice
FIELD ENGINEERING SERVICES

HPC Staff/Associates have considerable experience installing and maintaining Steam Turbine and Gas Turbine Generator units. Whether you’re Engineering Service requirements are for Steam Turbine Generator Maintenance, Steam Turbine Controls, Steam Turbine Operations, Generator Excitation and Controls, Gas Turbine Maintenance, or Gas Turbine Controls or Transformers, the staff at HPC can supply your need for technical services.

Steam Turbines

Engineering Services provided by HPC are as follows:

- **Technical Field Assistance:** Assigned Field Engineer provides engineering support in disassembly, inspection, evaluation of test results, repair/reuse/replace decision making, reassembly, and startup. Experience includes units manufactured by ABB, Alstom, GE, Hitachi, Mitsubishi, Parsons, Siemens, Toshiba, and Westinghouse.
- **Outage Planning:** Assigned Field Engineer provides assistance in planning your next outage. Services include evaluation of previous outages, OEM recommendations, evaluation of performance monitoring data collected in-service, and prioritizing plans against budget constraints.
- **Development of Preventive and Corrective Maintenance Procedures**
- **Problem Solving:** Operational Issues, Distortion Issues, Troubleshooting.
- **Controls Calibration/Troubleshooting:** Assigned engineer provides technical direction in the performance of functional checks on steam turbine controls during outages. Related services include "Single Point Failure Analysis", Procedure Writing, Instrument Loop Diagrams, and Consulting re Control System Upgrades, Incremental Regulation Tests (Evaluating/Designing Cams for linearization of actual steam flow versus demand). Staff/associates include experience as listed here:
  - GE Mechanical Hydraulic Controls (includes Toshiba and Hitachi similar units)
  - GE Medium Steam TG Mk-I, Mk-II, Mk-III, Mk-III+, DCM+, Mk-V, Mk-VI, Mk-VIe
  - GE Large Steam TG Mk-I, Mk-II, Mk-V, Mk-VI, Mk-VIe (includes Ansaldo units)
  - GE Mechanical Drive Turbine UT-70, EHC, MDT20, MDT80, Mk-V, Mk-VI, Mk-VIe
  - Woodward 501, 505, Micronet
  - Westinghouse 150#, 300#, AEH, DEH

Generators

Engineering Services provided by HPC are as follows:

- **Technical Field Assistance:** Assigned engineer provides engineering support in disassembly, inspection, evaluation of test results, repair/reuse/replace decision making, reassembly, and startup. Experience includes units manufactured by ABB, Alstom, GE, Hitachi, Mitsubishi, Parsons, Siemens, Toshiba, and Westinghouse.
- **Outage Planning:** Assigned engineer provides assistance in planning your next outage. Services include evaluation of previous outages, OEM recommendations, evaluation of performance monitoring data collected in-service, and prioritizing plans against budget constraints.
- **Development of Preventive and Corrective Maintenance Procedures**
- **Problem Solving:** Operational Issues, Troubleshooting.
- **Controls Calibration/Troubleshooting:** Assigned engineer provides technical direction in the performance of functional checks on steam turbine controls during outages. Related services include "Single Point Failure Analysis", Procedure Writing, Instrument Loop Diagrams, and Consulting re Control System Upgrades. Staff/associates include experience as listed here:
  - GE Alterrex, Althyrex, Generrex, SCT-PPT, Bus-Fed Static Excitation, EX-2000, EX-2100
  - Westinghouse WMA, WTA, WTA-300B
  - ABB Unitrol
  - NEI (Portec)
  - Basler DECS-300
  - PRX 302/400
Combustion (Gas) Turbines

Engineering Services provided by HPC are as follows:

- **Technical Field Assistance:** Assigned engineer provides engineering support in disassembly, inspection, evaluation of test results, repair/reuse/replace decision making, reassembly, and startup. Experience includes units manufactured by GE, Hitachi, Mitsubishi, Siemens, Solar, and Westinghouse.
- **Outage Planning:** Assigned engineer provides assistance in planning your next outage. Services include evaluation of previous outages, OEM recommendations, evaluation of performance monitoring data collected in-service, and prioritizing plans against budget constraints.
- **Development of Preventive and Corrective Maintenance Procedures**
- **Problem Solving:** Operational Issues, Troubleshooting.
- **Controls Calibration/Troubleshooting:** Assigned engineer provides technical direction in the performance of functional checks on steam turbine controls during outages. Related services include “Single Point Failure Analysis”, Procedure Writing, Instrument Loop Diagrams, and Consulting re Control System Upgrades. Staff/associates include experience as listed here:
  - GE Fuel Regulator Controls
  - Speedtronic Mk-I, Mk-II, Mk-IV, Mk-V, Mk-VI, Mk-VIe

 Transformers

Engineering Services provided by HPC are as follows:

- **Technical Field Assistance:** Assigned engineer provides engineering support in maintenance planning, preventive maintenance activities, electrical testing, test results evaluation, sampling, and factor test analysis.
- **Development of Preventive and Corrective Maintenance Procedures**
- **Transformer Condition Assessment:** Assigned engineer evaluates operation and maintenance practices, assessing data to determine maintenance requirements.

Recent Activities include:

- HPC provided a Senior Field Engineer on the turbine generator floor during a reactor refuel. HPC’s engineer represented the utility staff in dealing with contractor personal working on the steam turbine generator. Scheduling and quality assurance were the two biggest issues dealt with on a day-to-day basis.
- HPC provided a Senior Field Engineer on a combined cycle site to provide engineering support on the disassembly/inspection/reassembly of a GE Frame 7EA gas turbine and the disassembly/inspection/reassembly D-11 steam turbine. Outage support included the Mk-VI control system.
- HPC provided a Senior Field Engineer at an industrial site where a steam turbine (30+ years old) was being returned to service after being idle for the last 12 years or so. HPC’s role was that of engineering support during the startup – to make sure all sub-systems were functioning correctly, the controls functioned correctly, and that any start-up issues were dealt with in manner to ensure reliability.
- HPC resolved some engineering issues regarding an industrial unit upgrade impact upon the steam turbine controls.
- HPC provided engineering support in a forced outage where the turbine control valves failed in a “valves open” direction. The problem was identified, resolved and the unit was returned to service.
- HPC provided engineering support in decision making regarding how to respond to changing vibration conditions on a large generator. Data was analyzed and recommendations made.
- HPC provided engineering support in the performance of the conducting of a single-point failure analysis on the steam turbine controls.
HPC CERTIFICATION PROGRAMS

HPC Certification Programs are designed to parallel (or even improve upon) the Field Engineering Programs offered by the OEM to new and previously experienced employees. Many of those who are “expert” on steam turbine operations & maintenance are also near retirement age. This is true in so many areas of power plant O&M and applies specifically to steam turbines as well. HPC, in a classroom environment, combines their (the expert) experience with HPC training and development expertise, to salvage this knowledge for the benefit of the new engineer.

Who is to benefit? The best answer to this question is that YOU will benefit, YOU and those you work for, be it your employer or your client. A GE engineer, for example, goes thru a significant training program. If you’re not an OEM engineer, wouldn’t you like to experience a similar benefit? If yes, this is the means by which it is accomplished.

HPC Certification Programs were designed by Mr. Harold Parker. Mr. Parker's career (in addition to that of a Field and Start-Up Engineer) included assignments at GE's Field Engineering Development (Training) Center in Niskayuna, NY. His positions included that of Training Specialist, Supervisor – Steam Turbine Generators and Manager – Advanced Training Programs. Mr. Parker, at one time, was asked to form a committee to research the GE field engineering offices to find out what they (those managers in direct client with the customer) thought should be contained in the GE Field Engineering Program.

HPC Certification Programs are instructed by personnel who are products of advanced OEM developmental programs, and/or graduates of the HPC Technical Services' programs, and have an appropriate level of experience given the selected topic. It is further recommended the certification program graduate regularly attend other steam turbine related courses, at a rate of 2.0 CEU every three years, at a minimum.

WHY SHOULD YOU WANT TO BE CERTIFIED OR WANT YOUR PERSONNEL TO BE CERTIFIED?
Certification, in any type of program, reflects positively on a company’s commitment to ensure knowledge based decision making, develop skills and improve quality and performance while providing the employee a sense of pride and professionalism in his/her field. Certification comes with many benefits both to the company and employee:

- Assists management in achieving a high degree of excellence in their plant and operations
- Management can use the certification for consideration of advancements and promotions
- Provides a sense of professionalism and high quality performance
- Indicates to co-workers and management that you are qualified in your field
- Value-added advantage to service companies during project bidding

HPC has spent many years teaching and developing training programs to ensure your employees are truly trained in their specialized area increasing their safety, knowledge and skills level.

CERTIFICATION HAS THREE MAJOR PARTS
1. Training course(s)
2. Written examination (must obtain an 80% passing grade)
3. Job Performance Activities (JPA)

Once the participant has successfully completed all requirements of the certification program, he/she will be awarded a certificate stating the accomplishment and a letter (two original copies) that also states the accomplishment. This certification is good for 3-years. To continue this recognition the “Field Engineer” must continue to work in related fields and attend other steam turbine related courses, at a rate of 2.0 CEU every three years, at a minimum.
FAQ:

1. **Who recognizes HPC’s Certification Programs?** No one. We suppose this is not the answer you expected. Recognize that HPC has been wrestling with this certification program design for over a year. It would be ‘great’ if GE and others DID certify our certification program, BUT that is obviously counter to their goals. So the success of this overall program, in the long run, will depend upon persons like you. HPC will do its best to make this certification program successful for its participants.

2. **Why should I be interested in HPC’s Certification Program?** Because it is designed, developed, and delivered by equipment experienced professionals who ARE respected in the industry. Many of these professionals are ex-OEM engineers of various disciplines.

3. **Is an examination required?** Yes. It is required that the participant complete an examination, testing the course objectives as outlined in HPC’s course, with an 80% passing requirement (exam cost is US$50 plus S&H fees, exam is “free” when taking an HPC course or have taken that course within HPC in the last 12 months).

4. **What will I receive upon completing all requirements of any particular course offering?** You will receive a special designed “certification of completion” and two-signed original letters that state the participant accomplishments. This letter is the type one would file with an employer and keep in your file as well.

5. **It takes more than “book-learning” to become an experienced field engineer. How does HPC support this requirement?** HPC provides recommended Job-Performance-Activities (JPA) that is associated with each listed course. Upon completion of the JPA(s), if HPC is notified and proof of accomplishment (supervisor verification) is offered, then HPC will provide final “recognition” paperwork for the Certification Program.

6. **Will HPC accept similar courses offered by others?** Yes, providing a couple requirements are met as listed below:
   - The course is scheduled/presented by the original equipment manufacturer OR the course is scheduled/presented by a professional organization that provides CEU (no less than 80% of HPC’s offering) that are recognized by professional non-for-profit organization equivalent to IACET.
   - The participant completes an examination testing the course objectives as presented by HPC (there is a US$50 fee for this examination) OR the other organization offers an examination and the participant can provide proof that a passing grade was accomplished (80%).

**HPC Certification Programs include:**

- Steam Turbine (1) Field Engineering Program, (2) Mechanical Technician Program, or (3) I&C Technician Program.
- Generator (1) Field Engineering Program or (2) I&C Technician Program.
- Gas Turbine (1) Field Engineering Program, (2) Mechanical Technician Program, or (3) I&C Technician Program.
- Combined Cycle O&M Certification Program.

For more information on HPC Certification Programs, please visit our website, [www.hpcnet.com](http://www.hpcnet.com), or contact Stephen Parker at stparker@hpcnet.com.

A sample course certification letter and course certificate can be seen on the following page.
To Whom It May Concern:

Please be advised that Mr. John Doe has successfully completed HPC Technical Service’s Course on the Steam Turbine Generator Maintenance. This course was completed on 22 July 2014. In the execution of this short-course, it should be recognized that Mr. Doe successfully completed a comprehensive examination on this subject.

Through this Steam Turbine Generator Maintenance short-course, Mr. Doe has accomplished the course objectives described herein. Mr. Doe is able to:

1. List steam turbine generator operational and safety issues that typically cause the scheduling of a maintenance outage.
2. List the considerations that must be included when developing an outage plan or schedule.
3. Describe the major considerations when making a replace/reuse/repair decision.
4. Describe the procedures necessary for the safe and effective disassembly and reassembly of steam turbine generator components.
5. Describe the purpose and operation of the major steam valves.
6. Describe the disassembly and reassembly of the major steam valves.
7. List the five (5) most common causes of steam path damage and their possible affects upon future operation.
8. Describe the causes of steam path damage and their possible affects upon future operation.
9. Describe the type and purpose of clearance and alignment measurements commonly taken during the disassembly and reassembly of a steam turbine generator.
10. Describe the measuring instruments used to determine steam turbine generator component parameters.
11. List and describe the various non-destructive examinations performed during disassembly of the steam turbine generator.
12. Describe the common procedures for cleaning and inspecting steam turbine generator components.
13. Describe the criteria used to evaluate steam turbine generator defects.
15. Describe the purpose of conducting a steam path audit, and how that audit would be accomplished.
16. Describe the common types and operation of journal and thrust bearings.
17. Describe the common causes of bearing damage.
18. Describe the measurements required to determine oil clearances.
19. Describe common bearing inspection and repair procedures.
20. Describe the considerations to be taken into account when evaluating alignment of steam turbine generator components.
21. Describe the methods used to properly align steam turbine generator components.
22. Demonstrate the ability to perform the necessary calculations to align steam turbine generator components.
23. List and briefly describe the electrical tests often performed on generator components.
24. State the purpose of each electrical test listed.
25. Describe the proper disassembly, inspection and reassembly of a generator hydrogen seal.

It certainly has been HPC Technical Services’ and this instructor's pleasure to contribute to Mr. Doe's knowledge in this subject area, and wish the most success in future works opportunities.

Sincerely,

President
HPC Technical Services
HPC TECHNICAL SERVICES
TEL: 941-747-7733 FAX: 941-746-5374

HPC TRAINING COURSES

HPC Technical Services' course schedule is typically revised on a quarterly basis. HPC's website is always more current. Consult www.hpcnet.com for the most current schedule/price information.

HPC courses are divided into the following major subject areas:

- B  Boiler
- CT Combustion Turbine and Combined Cycle Power Plants
- E Electrical Skills
- G Generators
- H Hydroelectric Specific
- M Mechanical Skills
- OP Power Plant Equipment
- TG Steam Turbine Generators

Each course is further categorized, according to the course level, by a 3-digit number:

- 100 Introductory Level
- 200 Fundamental
- 300 Experienced operators, technicians, and engineers new to the topic.
- 400 Management and/or Engineers
- 500 Unit-Specific Course
- 700 Advanced Courses

HPC offices are located in Bradenton, Florida, USA. Most courses are conducted in our training facility at these offices, or in nearby hotels.

Frequently asked questions include:

Can this course be conducted, in its entirety, at our location for our employees?
Yes, with the exception of our 700-level advanced courses, all courses are regularly conducted at our client's location. Please contact Stephen Parker at stparker@hpcnet.com or 941-747-7733 x130 for a price quotation. There are three variations of these on-site courses:

1. **Generic**, off-the-shelf, presentation (the same as our open-enrollment course only at your site).
2. **Customized to emphasize or de-emphasize topics**. This version also often includes instructor use of site-specific prints and/or procedures. Most on-site courses are of this variety.
3. **Customized**, in that the textbook is re-written to be specific to the site application.

Is this course conducted, as an open-enrollment presentation, at locations other than Sarasota?
Yes, and some of our courses are regularly located at different cities across North America. Cities are selected as a function of their location and success rate. For example, we would rarely select a city that is too near Sarasota. Another example is Tempe; AZ. Tempe is regularly selected as courses held here are adequately enrolled. If you think your nearby city would be successful, please contact our offices and maybe we can accommodate your request.
BOILER MECHANICAL

B301  Boiler Operations & Maintenance  4-days

WHAT YOU WILL LEARN:
- The natural circulation in a drum style boiler.
- The basic steam generator thermodynamics process.
- The various factors that determine proper combustion in the steam generator.
- The major components of a steam generator.
- The relationship of the major steam generator components.
- Practical burner design with specific attention given to low NOx burners.
- The fundamental means for conducting efficiency testing on a steam generator.
- How one can improve steam generator efficiency.
- Basic boiler metallurgy.
- Use of a fan characteristic curve.
- Areas involved in a utility boiler inspection.
- Given specific failure modes of a fossil-power plant boiler, describe the cause, how this failure might be prevented and routine repair procedures that might be applied.
- Most typical failure modes for boiler tubes.
- Typical repair modes of failed boiler tubes.


B309  Heat Recovery Steam Generator O&M  3-days

Today, more than ever, the need for qualified boiler operators is essential for safe and productive operation. In our combined cycle operations today, a lot of emphasis is placed on the gas turbine and the steam turbine, but very little on the HRSG. This course is designed to give the operator and/or maintenance technician an insight to the proper operation and maintenance of the HRSG. Most HRSG’s are designed to last for a minimum of 30 years. This time can be reduced with improper operation and maintenance. This course will deal with the various types of HRSG’s and the tube layout of the single, double, and triple pressure systems. It will also describe the reheat systems and supplemental fired HRSG’s.


B409  Boiler Design & Construction  5-days

WHAT YOU WILL LEARN:
- Fundamentals of Power Plant Thermodynamics.
- Preliminary Design to include: Site Arrangement, Plant Arrangement, Site Investigations, Environmental Permitting Issues.

B411  Boiler Maintenance & Troubleshooting  4.5-days

WHAT YOU WILL LEARN:
- Monitoring Boiler Performance Indicators.
- Identifying Cause of Loss of Performance.
- Boiler Tube Leak Monitoring.
- Identifying Root Cause of Boiler Tube Leaks.
- Application of the ASME Pressure Vessel Code to Boiler Tube Repairs.
**BOILER OPERATOR - LICENSING**

**B302**  
Boiler Operator Training & Certification  
5-days

**WHAT YOU WILL LEARN:**
- The basic information about NIULPE Certification level.
- The thermodynamics involved in the steam cycle.
- Boiler theory and operation.
- Boiler construction and design.
- Steam system controls.
- Boiler level and pressure controls.
- Combustion and pollution controls.
- Feedwater testing and treatment.
- Fuel systems and controls.
- Draft and flue gas systems.
- Steam turbine basics.
- Basic electricity and power generation.
- The refrigeration cycle.
- Refrigeration cycle controls.

**NIULPE 4th or 3rd Class Certification Exam on Friday PM**

**B406**  
Advanced Boiler Operator Training & Certification  
5-days

**WHAT YOU WILL LEARN:**
- The construction a various types of boilers.
- The importance of boiler safety devices.
- The principles of combustion, complete and incomplete.
- The operation of stoker, pulverized coal, gas and oil fired boilers.
- The boiler feed water system and controls.
- The operation of air compressors and compressed air systems.
- Steam plant accessories and associated systems.
- General knowledge of condensers and condenser operation.
- Basic electricity and power generation.
- Air pollution and emissions control.
- Mathematics and problem solving as it applies to boilers.
- Gas turbine/combined cycle systems.
- The refrigeration cycle and controls.
- Plant safety.
- Management and supervisory fundamentals.

**NIULPE 2nd or 1st class certification exam Friday PM**  
***Prerequisite should be NIULPE 4th OR 3rd or equivalent***

**BOILER CHEMISTRY**

**B303**  
Boiler Water Treatment for Operators  
2-days

**WHAT YOU WILL LEARN:**
- How to better manage power plant boiler water treatment.
- What the proper responses are when chemical parameters are exceeded.
- The consequences of operation while boiler and feed water limits are being exceeded.

**TOPICAL OUTLINE:** Chemistry Fundamentals, Corrosion, Raw Water Treatment, Feedwater and Boiler Water Treatment, In-line Analyzers.

**B317**  
Power Plant Water Chemistry for Technicians  
5-days

**WHAT YOU WILL LEARN:**
- Various chemical treatment programs.
- How to determine chemical limits for a unit.
- Respond properly to chemical excursions.
- The proper sampling and analysis methods.
- The components of a QA/QC program.
- The mechanisms for various types of corrosion and how this corrosion is controlled.

**TOPICAL OUTLINE:** Plant Systems, Corrosion Types and Prevention, Raw Water Treatment, Feed Water Treatment, Boiler Water Treatment, Boiler Tube Leaks, Condenser Leaks, High Air In-Leakage, Phosphate Hideout, Start Up, Chemical Cleaning, Water Analysis, Coal Sampling and Analysis, Oil Analysis.
COMBUSTION TURBINE and COMBINED CYCLE courses

CT and CC FUNDAMENTALS

CT101  Combined Cycle Plant Fundamentals
3-days
This course is directed toward personnel new to a combined cycle power plant. In this course the participant will learn about the combined cycle process (from fuel to electrical power) as well as the purpose and function of each major component.

WHAT YOU WILL LEARN:
• The four phases of the power generation cycle as it pertains to combined cycle systems including: Gas Turbine, Heat Recovery Steam Generator, Steam Turbine, and Condensate/Feedwater System.

CT200  Combustion Turbine Generator Fundamentals
2-days
WHAT YOU WILL LEARN:
• Thermodynamic principles of a combustion turbine CT.
• The basic cycles used for different combustion process.
• The function of major components making up the CT.
• How efficiency of a gas turbine can be changed.
• The flow through a CT, including any extraction points.
• The function and operation of common CT auxiliary systems.
• How humidity, ambient temperature, compressor ratio, firing temperature, exhaust temperature, and exhaust pressure effect CT performance.

CT201  Combined Cycle Turbine Generator Fundamentals
4-days
WHAT YOU WILL LEARN:
• Thermodynamic principles of a combustion turbine CT.
• The basic cycles used for different combustion process.
• The function of major components making up the CT.
• How efficiency of a gas turbine can be changed.
• The flow through a CT, including any extraction points.
• The function and operation of common CT auxiliary systems.
• How humidity, ambient temperature, compressor ratio, firing temperature, exhaust temperature, and exhaust pressure effect CT performance.
• How to determine turbine output and heat rate.
• The major components of the generator auxiliary systems.

CT202  (GE) LM Series Aeroderivative Gas Turbine Fundamentals
5-days
This course is for personnel concerned with day-to-day L&M of the (GE) LM series aeroderivative gas turbines. The intent of this course is to provide the basic knowledge needed to help gain reliable operation from the gas turbine engine and associated equipment. Upon completion of this course, personnel should understand the principles of the construction, the operation and maintenance aspects of the LM aeroderivative gas turbines, and become familiar with the gas turbine control and protection concepts. Course content references the LM2500, 5000 and 6000 aeroderivation gas turbines.

WHAT YOU WILL LEARN:
• Fundamental theory of operation
• Location, function and description of the major components
• Functional operation of the LM aeroderivative gas turbine.
• Identification and functional operation of the typical auxiliary systems
• Maintenance activities typically performed on a LM aeroderivative gas turbine.
CT and CC OPERATIONS

CT315  (GE) Gas Turbine Mk-IV for Operators
4.5-days

WHAT YOU WILL LEARN:

- Conceptually, sequence the turbine through a startup, load changes, shutdown, and emergency conditions.

- The relationship of the various turbine components and how they may be at risk during operations.

- The different fuel systems used in gas turbine operations.

- The purpose of major hardware devices found in the Mk-IV system.

- How to effectively use that Mk-IV Documentation that is pertinent to the operator.

- To navigate the print/file system to trace an alarm drop to the device initiating that alarm.

- Learn normal/abnormal operating conditions for each of the gas turbine auxiliary systems (cooling & sealing air, lube oil systems, fuel forwarding, control and hydraulic oil).

- Conceptually, sequence the turbine through a startup, load changes, shutdown, and emergency conditions.

- How the unit may be at risk in any given alarm condition.

- What might be the most proper actions to take in any given alarm condition.

TOPICAL OUTLINE: Review of Gas Turbine Theory • Review of Gas Turbine Construction & Operating Principles • Introduction to Mk-IV Hardware • Documentation • How to Read Logic Diagrams • Alarm Drops • Auxiliary Systems • Start Up Sequencing • Speed Control • Temperature Control • NOx • Servo Valve Drive Systems • Overspeed/Over Temperature • Protective Circuits • Abnormal Conditions and Response.

CT316  (GE) Gas Turbine Mk-V for Operators
4.5-days

WHAT YOU WILL LEARN:

- Conceptually, sequence the turbine through a startup, load changes, shutdown, and emergency conditions.

- The relationship of the various turbine components and how they may be at risk during operations.

- The different fuel systems used in gas turbine operations.

- The purpose of major hardware devices found in the Mk-V system.

- How to effectively use that Mk-V Documentation that is pertinent to the operator.

- To navigate the print/file system to trace an alarm drop to the device initiating that alarm.

- Learn normal/abnormal operating conditions for each of the gas turbine auxiliary systems (cooling & sealing air, lube oil systems, fuel forwarding, control and hydraulic oil).

- Conceptually, sequence the turbine through a startup, load changes, shutdown, and emergency conditions.

- How the unit may be at risk in any given alarm condition.

- What might be the most proper actions to take in any given alarm condition.

TOPICAL OUTLINE: Review of Gas Turbine Theory • Review of Gas Turbine Construction & Operating Principles • Introduction to Mk-V Hardware • Documentation • How to Read Logic Diagrams • Alarm Drops • Auxiliary Systems • Start Up Sequencing • Speed Control • Temperature Control • NOx • Servo Valve Drive Systems • Overspeed/Over Temperature • Protective Circuits • Abnormal Conditions and Response.

CT324  (GE) Gas Turbine Mk-VI for Operators
4.5-days

WHAT YOU WILL LEARN:

- Conceptually, sequence the turbine through a startup, load changes, shutdown, and emergency conditions.

- The relationship of the various turbine components and how they may be at risk during operations.

- The different fuel systems used in gas turbine operations.

- The purpose of major hardware devices found in the Mk-VI system.

- How to effectively use that Mk-VI Documentation that is pertinent to the operator.

- How to effectively make use of Toolbox software to navigate the print/file system to trace an alarm drop to the device initiating that alarm.

- Learn normal/abnormal operating conditions for each of the gas turbine auxiliary systems (cooling & sealing air, lube oil systems, fuel forwarding, control and hydraulic oil).

- Conceptually, sequence the turbine through a startup, load changes, shutdown, and emergency conditions.

- How the unit may be at risk in any given alarm condition.

- What might be the most proper actions to take in any given alarm condition.

TOPICAL OUTLINE: Review of Gas Turbine Theory • Review of Gas Turbine Construction & Operating Principles • Introduction to Mk-VI Hardware • Documentation • Use of Toolbox Software to Read Logic Diagrams • Alarm Drops • Auxiliary Systems • Start Up Sequencing • Speed Control • Temperature Control • NOx • Servo Valve Drive Systems • Overspeed/Over Temperature • Protective Circuits • Abnormal Conditions and Response.
CT324e  (GE) Gas Turbine Mk-VIe for Operators  
4.5-days

WHAT YOU WILL LEARN:
- The relationship of the various gas turbine components and how they may be at risk during operations.
- The purpose of major hardware devices found on the Mk-VIe system.
- How to effectively use the Mk-VIe documentation that is pertinent to an operator.
- How to effectively make use of toolbox software to navigate the print/file system to trace an alarm drop to the device initiating the alarm.
- Normal / abnormal operating conditions for each of the gas turbine auxiliary systems (cooling & sealing air, lube oil systems, fuel forwarding, control and hydraulic oil).
- Conceptually sequence the gas turbine through a start-up, load changes, shutdown, and emergency conditions.
- How the unit may be at risk in any given alarm condition.
- What might be the most proper action to take in any given alarm condition.


CT325  (GE) Frame 5 Gas Turbine Operations & Alarm Response  
4.5-days

WHAT YOU WILL LEARN:
- The relationship of the various frame 5 gas turbine components and how they may be at risk during operations.
- Description of each auxiliary system to include the purpose, normal operation, operational alarms, and alarm response with each alarm described. Auxiliary systems include the Lube Oil, Cooling and Sealing Air, Inlet and Exhaust Air, Fuel Gas, Liquid Fuel, Trip Systems, Fire Protection, and Water Wash.
- Conceptually sequence the gas turbine and systems through a start-up; including the cranking, initial firing, speed control and synchronizing.
- Conceptually sequence the gas turbine and systems through load changes, shutdown, and emergency conditions.


CT326  (GE) Frame 6 Gas Turbine Operations & Alarm Response  
4.5-days

WHAT YOU WILL LEARN:
- The relationship of the various frame 6 gas turbine components and how they may be at risk during operations.
- Description of each auxiliary system to include the purpose, normal operation, operational alarms, and alarm response with each alarm described. Auxiliary systems include the Lube Oil, Hydraulics, Cooling and Sealing Air, Inlet and Exhaust Air, Fuel Gas, Liquid Fuel, Trip Systems, Fire Protection, and Water Wash.
- Conceptually sequence the gas turbine and systems through a start-up; including the cranking, initial firing, speed control and synchronizing.
- Conceptually sequence the gas turbine and systems through load changes, shutdown, and emergency conditions.


CT327  (GE) Frame 7 (EA & FA) Gas Turbine Operations & Alarm Response  
4.5-days

WHAT YOU WILL LEARN:
- The relationship of the various frame 7 EA gas turbine components and how they may be at risk during operations.
- Description of each auxiliary system to include the purpose, normal operation, operational alarms, and alarm response with each alarm described. Auxiliary systems include the Lube Oil, Hydraulics, Cooling and Sealing Air, Inlet and Exhaust Air, Fuel Gas, Liquid Fuel, Trip Systems, Fire Protection, and Water Wash.
- Conceptually sequence the gas turbine and systems through a start-up; including the cranking, initial firing, speed control and synchronizing.
- Conceptually sequence the gas turbine and systems through load changes, shutdown, and emergency conditions.

CT329  (GE) Frame 9 (EA & FA) Gas Turbine Operations & Alarm Response 4.5-days

**WHAT YOU WILL LEARN:**
- The relationship of the various frame 9EA gas turbine components and how they may be at risk during operations.
- Description of each auxiliary system to include the purpose, normal operation, operational alarms, and alarm response with each alarm described. Auxiliary systems include the Lube Oil, Hydraulics, Cooling and Sealing Air, Inlet and Exhaust Air, Fuel Gas, Liquid Fuel, Trip Systems, Fire Protection, and Water Wash.
- Conceptually sequence the gas turbine and systems through a start-up; including the cranking, initial firing, speed control and synchronizing.
- Conceptually sequence the gas turbine and systems through load changes, shutdown, and emergency conditions.


CT401  Principles of Gas Turbine Performance 2-days

**WHAT YOU WILL LEARN:**
- The thermodynamic principles that apply to a gas turbine.
- The operational factors that affect gas turbine performance.
- The level and testing that is typically required for determining gas turbine performance.
- To analyze performance data to determine where component deficiency has deteriorated.
- Determine realistic heat rate goals.
- Develop corrective action plans to achieve heat rate goals.
- The use of instrumentation to collect performance data.

**TOPICAL OUTLINE:** Thermodynamic Cycles for Gas Turbines, Component Construction, Operation and Maintenance Considerations, ASME Performance Test Codes Applicable to Gas Turbines, Combustion Turbine Performance issues, and Efficiency Monitoring Programs.

Please note: This course, CT401, is the first 2-days of CT402, Principles of Combined Cycle Power Plant Performance.

CT402  Principles of Combined Cycle Performance 4.5-days

**WHAT YOU WILL LEARN:**
- The thermodynamic principles that apply to a gas turbine, steam turbine and HRSG.
- The operational factors that affect combined cycle plant performance.
- The level and testing that is typically required for determining combined cycle plant performance.
- To analyze performance data to determine where component deficiency has deteriorated.
- Determine realistic heat rate goals.
- Develop corrective action plans to achieve heat rate goals.
- The use of instrumentation to collect performance data.

CT and CC MAINTENANCE

CT309  Fundamentals of Gas Turbine Maintenance 3-days

**WHAT YOU WILL LEARN:**
- Fundamentals of gas turbine operation.
- How operating duty affects turbine components.
- How the integrity of the turbine can affect operations.
- The important issues associated with disassembly/reassembly.
- How equipment is to be taken apart safely.
- Which gas turbine components should be cleaned and how.
- Basics of good visual inspection and which tests might typically be performed.

**TOPICAL OUTLINE:** Construction • Auxiliary System O&M • Outage Planning • Disassembly • Inspection • Repairs.
CT501  (W) 501 Combustion Turbine Maintenance
4.5-days

This course was developed to improve the effectiveness of maintenance activities associated with W501 combustion turbines. Learn to better plan and implement gas turbine maintenance outages. Combustion turbine operation is discussed from the perspective of auxiliary systems and how operating factors may impact maintenance intervals. Combustion, hot gas path and major inspections are discussed.

CT518  (Siemens) V84.2 Combustion Turbine Generator Maintenance
4.5-days

WHAT YOU WILL LEARN:

- Properly identify all the major components and systems.
- To better plan and implement gas turbine maintenance outages.
- Considerations regarding replace/reuse/repair decision making.
- Most common causes of gas path damage and the impact upon efficiency, reliability and availability.
- Operation from the perspective of auxiliary systems and how operating factors may impact maintenance intervals.
- Combustion, hot gas path and major inspections.

TOPICAL OUTLINE: Review of CT Fundamentals • 501 Construction and Operating Principles, Auxiliary Systems • Controls Overview • Maintenance Preparation and Planning • Combustion Section Inspection • Turbine Inspection • Major Inspection and Alignment.

CT519  (GE) Frame 5 Gas Turbine Generator Maintenance
4.5-days

WHAT YOU WILL LEARN:

- To identify all the Frame 5 major components and systems
- To better plan and implement gas turbine generator outages
- Considerations regarding repair/replace/reuse decision making
- Most common causes of equipment damage and the impact upon unit efficiency, reliability & availability
- Operation from the perspective of auxiliary systems and related maintenance activities
- Combustion, Hot Gas Path, and Major Inspection disassembly, inspection, and reassembly detail
- Generator disassembly, inspection, testing, and reassembly


CT520  (GE) Frame 6 Gas Turbine Generator Maintenance
4.5-days

WHAT YOU WILL LEARN:

- To identify all the Frame 6 major components and systems
- To better plan and implement gas turbine generator outages
- Considerations regarding repair/replace/reuse decision making
- Most common causes of equipment damage and the impact upon unit efficiency, reliability & availability
- Operation from the perspective of auxiliary systems and related maintenance activities
- Combustion, Hot Gas Path, and Major Inspection disassembly, inspection, and reassembly detail
- Generator disassembly, inspection, testing, and reassembly

CT521  (GE) Frame 7EA Gas Turbine Generator Maintenance  
4.5-days

WHAT YOU WILL LEARN:
• To identify all the Frame 7E major components and systems
• To better plan and implement gas turbine generator outages
• Considerations regarding repair/replace/reuse decision making
• Most common causes of equipment damage and the impact upon unit efficiency, reliability & availability
• Operation from the perspective of auxiliary systems and related maintenance activities
• Combustion, Hot Gas Path, and Major Inspection disassembly, inspection, and reassembly detail
• Generator disassembly, inspection, testing, and reassembly


CT522  (GE) Frame 7FA Gas Turbine Generator Maintenance  
4.5-days

WHAT YOU WILL LEARN:
• To identify all the Frame 7F major components and systems
• To better plan and implement gas turbine generator outages
• Considerations regarding repair/replace/reuse decision making
• Most common causes of equipment damage and the impact upon unit efficiency, reliability & availability
• Operation from the perspective of auxiliary systems and related maintenance activities
• Combustion, Hot Gas Path, and Major Inspection disassembly, inspection, and reassembly detail
• Generator disassembly, inspection, testing, and reassembly


CT523  (ABB) Series GT8, 11, 13 & 24/26 Combustion Turbine Maintenance  
4.5-days

WHAT YOU WILL LEARN:
• Properly identify all the major components and systems.
• To better plan and implement gas turbine maintenance outages.
• Considerations regarding replace/reuse/repair decision-making.
• Most common causes of gas path damage and the impact upon efficiency, reliability and availability.
• Operation from the perspective of auxiliary systems and how operating factors may impact maintenance intervals.
• Combustion, hot gas path and major inspections.

TOPICAL OUTLINE: CT Overview • Plant Layout • Major Components • KKS ID System • P&IDs • MMI Overview • Operation • Control Philosophy • Supervision, Protection & Testing Systems • Operational Maintenance • Fundamentals of Gas Path Inspection.

CT525  (GE) Frame 9 Gas Turbine Generator Maintenance  
4.5-days

WHAT YOU WILL LEARN:
• To identify all the Frame 9 major components and systems
• To better plan and implement gas turbine generator outages
• Considerations regarding repair/replace/reuse decision making
• Most common causes of equipment damage and the impact upon unit efficiency, reliability & availability
• Operation from the perspective of auxiliary systems and related maintenance activities
• Combustion, Hot Gas Path, and Major Inspection disassembly, inspection, and reassembly detail
• Generator disassembly, inspection, testing, and reassembly

CT530  
(GE) LM2500 Gas Turbine Maintenance
5-days

This 5-day course will provide basic knowledge on the Level 2 maintenance procedures as described in the O&M manuals. Attendees should have completed the LM Gas Turbine Familiarization course prior to attendance. Classroom presentation will include detailed discussion of procedural considerations with use of significant photographs and special drawings to enhance the participants’ understanding.

Level 2 cold maintenance procedural items to be discussed will include the removal, inspection & installation of the following internal engine components: radial drive shaft, inlet gearbox, accessory gearbox, front frame, #3 bearing inner race, HP compressor casing, and the HP compressor rotor blades. Discussion will include that on a static balance program.

CT531  
(GE) LM6000 Gas Turbine Maintenance
5-days

This 8-day course will provide basic knowledge on the Level 2 maintenance procedures as described in the O&M manuals. Attendees should have completed the LM Gas Turbine Familiarization course prior to attendance. Classroom presentation will include detailed discussion of procedural considerations with use of significant photographs and special drawings to enhance the participants’ understanding.

Level 2 cold maintenance procedural items to be discussed will include the removal, inspection & installation of the following internal engine components: VIGVs, the stage 0 blades, the LP compressor module, the #1 air / oil seal, LP compressor stage 1-3 blades, LP compressor stage 0-3 vanes, HP compressor upper case, HP compressor stage blades, and the HP compressor stage vanes.

CT567  
(GE) Frame 5, 6 & 7 Gas Turbine Maintenance
4.5-days

WHAT YOU WILL LEARN:

- The function of all the gas turbine components.
- Differences between a Hot Gas Path, Combustion, and Major Inspection.
- Major considerations when making a replace/reuse/repair decision.
- To safely disassemble / reassemble all components associated with any planned maintenance outage.
- What data needs to be recorded (and how to record that data) during a turbine outage.
- The most common causes of gas path damage and the effects upon turbine operation.
- The various NDE performed on gas turbine components.
- To evaluate the degree of seriousness, given gas turbine component defects.
- Procedures for cleaning / inspecting gas turbine components.
- Common repair methods for gas turbine component defects.
- Considerations for alignment of components.

TOPICAL OUTLINE: Overview of Gas Turbine Fundamentals (a chance to ask basic questions), Construction Principles (including differences between Frame types), Maintenance Preparation and Planning, Combustion Section Inspection (for each frame type), Turbine Inspection (for each frame type), Major Inspection (for each frame type).

CT569  
(GE) Frame 5, 6 & 9 Gas Turbine Maintenance
4.5-days

WHAT YOU WILL LEARN:

- The function of all the gas turbine components.
- Differences between at Hot Gas Path, Combustion, and Major Inspection.
- Major considerations when making replace/reuse/repair decisions.
- To safely disassemble / reassemble all components associated with any planned maintenance outage.
- What data needs to be recorded (and how to record that data) during the turbine outage.
- The most common cause of gas path damage and the effects upon turbine operation.
- The various NDE performed on gas turbine components.
- Evaluate the degree of seriousness, given a found gas turbine defect.
- Procedures for cleaning / inspecting gas turbine components.
- Common repair methods for gas turbine component defects.
- Alignment considerations.

TOPICAL OUTLINE: Overview of Gas Turbine Fundamentals (a chance to ask basic questions), Construction Principles (including difference between the frame types), Maintenance Preparation and Planning, Hot Gas Path inspection (for each frame type), Combustion Inspection (for each frame type), Major Inspection (for each frame type).
HPC COMBUSTION TURBINE
Field Engineering Certification Program (FECP)
4-weeks

HPC’s certification program is designed to parallel (or even improve upon) the Field Engineering Programs offered by the OEM to new and previously experienced employees. Many of those who are “expert” on steam turbine operations & maintenance are also near retirement age. This is true in so many areas of power plant O&M and applies specifically to steam turbines as well. HPC, in a classroom environment, combines their (the expert) experience with HPC training and development expertise, to salvage this knowledge for the benefit of the new engineer.

Who is to benefit? The best answer to this question is that YOU will benefit, YOU and those you work for, be it your employer or your client. A GE Field Engineer, for example, goes thru a significant training program. If you’re not an OEM engineer, wouldn’t you like to experience a similar benefit? If yes, this certification program is the means by which YOU can accomplish your goal.

You could take advantage of this curriculum all at one time, or take the courses over two or more sessions. Examinations are administered at the end of each course (except G706) and recommendations are made for job-performance-activities. To save money, please remember our “3-for-2” policy or our Training Savings Program. Courses (one or all, except G706) can be customized and conducted at your site.

CT FECP Courses
TG105 ..... Mechanical & Electrical Fundamentals
CT200 ..... Combustion Turbine Generator Fundamentals
CT324e ..... (GE) Gas Turbine Mk-Vle for Operators (or the “Controls for Operators” course for your specific unit)
CT309 ..... Fundamentals of Gas Turbine Maintenance
CT522 ..... (GE) Frame 7F Gas Turbine Generator Maintenance (or the maintenance course for your specific unit)

CT FECP Continuing Education Courses
G401........ Turbine-Driven Generators: Construction, Controls, Operations, Maintenance & Testing
G706........ Advanced Generator Maintenance & Reliability Seminar

CT and CC INSTRUMENT & CONTROLS

CT422 Concepts of Gas Turbine Controls
2-days

WHAT YOU WILL LEARN:
• Purpose of typical gas turbine control components.
• How the major control signal path signals are typically developed.
• Types of control systems associated with different emissions control.
• How a valve command signal is typically developed.
• How machine protection is typically designed.


CT513 (GE) Mk-I Gas Turbine Controls
5-days

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

CT514 (GE) Mk-II Gas Turbine Controls
5-days

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.
CT515  (GE) Mk-IV Gas Turbine Controls
5-days

WHAT YOU WILL LEARN:
• To use the OEM provided documentation.
• Purpose of Mk-IV components and how they are accessed.
• Troubleshoot an equipment alarm using alarm drop numbers.
• Interpret more routine diagnostic alarms.
• Follow the major control signal path thru elementaries.
• Trace the derivation of a valve command signal.
• Calibrate the valves.
• Trace a signal from the field device to a digital “signal name”.
• How the “4” circuits provide machine protection.


CT516  (GE) Mk-V Gas Turbine Controls
5-days

WHAT YOU WILL LEARN:
• To use the OEM provided documentation.
• Purpose of Mk-V components and how they are accessed.
• Troubleshoot an equipment alarm using alarm drop numbers.
• Interpret more routine diagnostic alarms.
• Follow the major control signal path thru use of the CSP.
• Trace the derivation of a valve command signal.
• Calibrate the valves.
• Trace a signal from the field device to a digital “signal name”.
• Where and how <Q> and/or <P> might trip the unit.

TOPICAL OUTLINE: Mk-V Hardware, Operator Interface, Documentation, Big Block Language, Use of CSP, FSRSU, FSRN, FSRT, Servo Mechanisms, Emissions Control, Variable IGV, Protective Circuits.

CT524  (GE) Mk-VI Gas Turbine Controls
8-days

This course targets the need for technicians/engineers to operate, maintain, calibrate and troubleshoot control systems such that availability and reliability can be maximized.

The overall benefit of this course is that the participant will walk away with this knowledge. This is accomplished by thoroughly understanding concepts of gas turbine control systems and how to use maintenance screens to quickly determine problems. We are reminded that the gas turbine is the important asset. The Mk-VI control system is the human-machine-interface (HMI). This control system must be calibrated and maintained with the gas turbine needs kept in mind. HPC approaches this course in this manner. As seen by the course objectives, particular attention is given to the development of control systems important to the operation of a gas turbine.


CT524e  (GE) Mk-Vle Gas Turbine Controls
8-days

This course targets the need for technicians/engineers to operate, maintain, calibrate, and troubleshoot control systems such that availability and reliability can be maintained.

The overall benefit of this course is that the participant will walk away with this knowledge. This goal is accomplished by thoroughly understanding the concepts of the gas turbine control systems and how to use maintenance screens to quickly and effectively determine the source of the problem. We are reminded that the gas turbine is the asset and the Mk-Vle control system is a communications tool. The Mk-Vle system must be calibrated and maintained with the gas turbine kept in mind. HPC approaches this course in this manner.

ELECTRICAL MAINTENANCE courses

**E101  Electrical Fundamentals for the Non-Electrician**  
2-days

This class was developed to help non-electricians safely & effectively deal with electrical problems they may encounter in their work environment. Analogies and simple hands-on activities are used to demonstrate (practice) some of the electrical fundamentals. The participant will learn to read basic electrical schematics, will understand how electrical parameters such as voltage, resistance, and current are relevant to these schematics. Using these electrical schematics as an example, the participant will learn the use of test meters to take relevant measurements and troubleshoot problems such as open, grounded, or short circuits. The participant will also learn proper sizing of related circuits; wire sizes, insulation, fuses, and terminations.

Finally, the learner will appreciate the use of ground fault interrupters (GFCI) and how the National Electric Code (NEC) may apply to their work activities. The intent is for this non-electrician to work safely and effectively around building electrical circuits.

E101 and E201 can be combined into one complete 4-Day workshop @ $1695 as these two courses are usually scheduled back-to-back.

**E201  Intro to Electrical Troubleshooting & Preventive Maintenance**  
2-days

This class is intended to help workers develop the minimum troubleshooting skills to ascertain the problem, diagnose the circuit/component, and provide a solution to return the suspect circuit or component back to normal operation as soon as reasonably possible. Safety First; the participant will learn the OSHA Requirements Regarding Troubleshooting and Qualified Persons; the use of electrical drawings; meters and the development a logical, systematic approach to troubleshooting. These topics will be applied to troubleshooting control circuits, motors, power distribution, power quality, lighting circuits, PLCs, and variable frequency drives.

Preventive maintenance practices will be discussed throughout.

E101 and E201 can be combined into one complete 4-Day workshop @ $1695 as these two courses are usually scheduled back-to-back.

**E301  Electrical Motors & Motor Controls**  
2-days

This 2-day class is intended for plant electricians, new engineers, mechanics (who work with and around electrical equipment) who have a need to gain a fundamental knowledge of how the AC and DC motors function and are maintained. This fundamental knowledge is a critical piece of and O&M skills. The course provides practical knowledge associated with how a motor is constructed, defining components the component purpose, and how the components may be at risk. This course also provides information on the skills necessary to implement a quality preventive maintenance program, to troubleshoot operational problems and corrective maintenance activities for the more common integrity issues.

Covered in this course are the electric & magnetic fundamentals, AC / DC motor fundamentals, motor control fundamentals, control of motor starting, motor maintenance, motor branch circuit protection, and motor protection.

E301 and E302 can be combined into one complete 4-Day class @ $1995 as these two courses are usually scheduled back-to-back.

**E302  Circuit Breaker & Transformer O&M (Low & Medium Voltage)**  
2-days

This 2-day class is intended for plant electricians, new engineers, mechanics (who work with and around electrical equipment) who work around (with) circuit breakers and transformers. This course provides fundamental knowledge of how the circuit breakers and transformers function and the equipment is maintained. This fundamental knowledge is a critical piece of O&M skills. The course provides practical knowledge associated with how the devices are constructed, defining components the component purpose, and how the components may be at risk. This course also provides information on the skills necessary to implement a quality preventive maintenance program, to troubleshoot operational problems and corrective maintenance activities for the more common integrity issues.

The course begins with an introduction to low & medium voltage switchgear and continues with circuit breaker construction; types of circuit breakers; circuit breaker maintenance & testing; low voltage protective devices; transformers; insulation resistance and power factor testing; and the use of instrument transformers.

E301 and E302 can be combined into one complete 4-Day class @ $1995 as these two courses are usually scheduled back-to-back.
E315  High Voltage Circuit Breaker Maintenance
4.5-days

This course is designed to present some of the more common aspects of high voltage switchgear maintenance. It must be understood that there is an incredible variety of equipment used on low and medium switchgear today. Switchgears play an important role in the distribution and control of electrical power in manufacturing or power plant and in a utility distribution system. Negligent maintenance practices can lead to power system inefficiency and loss of system reliability.

TOPICAL OUTLINE: High Voltage Switchgear • Types of Breakers • Arc Interruption • Insulation Resistance Testing • Power Factor Testing • Instrument Transformer Testing • Low Voltage Protective Devices • Circuit Breaker Construction • Air Circuit Breakers • Vacuum Circuit Breakers.

E319  High Voltage Transformer Maintenance
4.5-days

One of our leading consultants has stated numerous times that the transformer is the “heartbeat” of the grid. Without the transformers we will deliver no power to our customers at all. In this course we will learn how a transformer operates and how it is usually safeguarded. One means of safeguarding transformer operation there is a need to not exceed nameplate ratings and we need to interpret this nameplate data. Next we need to fully appreciate the insulation it is tested. The current, of course generates a tremendous amount of heat, and participants will learn what the limitations are, what the means of cooling are, and how to recognize trouble. Once a participant fully appreciates how the transformer functions, and how it is protected, one can better understand and apply preventive maintenance procedures.

TOPICAL OUTLINE: Transformer fundamentals, transformer ratings, transformer cooling, nitrogen gas systems, insulation systems, maintenance activities, transformer testing techniques.

This course is applicable to technicians and engineers who need a sound understanding of power transformer operation and maintenance.

E401  Emergency & Backup Generators
4-days

Emergency & Backup Diesel Generators have become increasingly important. Weather patterns and concerns over security are certainly two large driving forces for this need. Many have an appreciation for how the Genset functions, but few understand the operation of the prime mover or the generator itself. Participants will gain a practical understanding of both the prime mover and generator operation and maintenance, along with the prime mover and generator control devices. This course, once a thorough review of theory has been completed, emphasizes practical knowledge, with safety always an issue. Course content is of great benefit to technicians and engineers who are responsible for ensuring the availability of their emergency, standby, or remote generators as a reliable source of emergency power.

This 4-day class is conducted such that the participant will learn how electricity is produced, how the commercial power grid functions, and what power quality issues can effect customer services; Learn how a Diesel engine works, proper fuel storage and care; Learn how a generator function, where should the Genset be located, how are gensets paralleled with commercial power, and how are gensets exercised; Learn periodic maintenance routines; learn the purpose of a transfer switch; and Learn genset controls and alarms

E505  (GE) Load Commutated Inverters
3-days
On Site Only

Course is designed for engineers to improve routine maintenance and troubleshooting skills.

TOPICAL OUTLINE: Application • Components • System Overview • Commutation • System Control • Routine Maintenance • Problem Analysis • Troubleshooting.
GENERATOR OPERATIONS

**G310**  Generators: Normal/Abnormal Operation  
2.5-days  
There are NO SMALL PROBLEMS when it comes to your GENERATOR!!  

**WHAT YOU WILL LEARN:**  
- How modern generators work on the power system grid.  
- Startup/synchronizing procedures and why they are important.  
- Construction of modern 2-pole, 4-pole, and hydroelectric generators.  
- Why and how the voltage/frequency varies such that the "best" operating decision can be made.  
- What generator components are at risk and how.  
- Proper use of the generator capability, "V", and performance curves.  
- 12+ abnormal conditions and how the abnormal situation can develop, what are the symptoms, what protective relaying might exist, what are the proper actions, and if actions are not taken then what are the results.  
- Using block diagrams, how the generator controls function.  

This course is intended for Control Room Operators, Shift Supervisors, Engineers, Technicians, and Operation Superintendents/Supervisors who operate these generating units.  

**TOPICAL OUTLINE:** Generator Theory for Non-Engineers • System Operation • Generator Construction • Intro to Generator Controls • Generator Auxiliary Systems • Normal Operations • Abnormal Operations.

**GENERATOR DESIGN and/or MAINTENANCE**

**G305**  Generator Maintenance & Testing  
2-days  
There are NO SMALL PROBLEMS when it comes to your GENERATOR!!  

**WHAT YOU WILL LEARN:**  
- How the generator is constructed.  
- Disassembly/reassembly procedures.  
- To perform visual inspections.  
- When, what and how to clean components.  
- The type of damage typically found on modern generators.  
- Typical repair activities.  
- The function and procedural overview of most common electrical tests.  
- Safety issues w/r to generator outages.  
- The type of damage typically found on modern generators.  
- Typical repair activities.  
- The function and procedural overview of most common electrical tests.  
- Safety issues w/r to generator outages.  

**TOPICAL OUTLINE:** Generator Construction • Planning and Scheduling Generator Outages • Disassembly • Visual Inspection • Reassembly • Resistance Testing • Dielectric • Absorption Testing • DC Current Leakage Test • Dissipation Factor Test • Radio Noise Test • High Potential Testing • Ring Test • Polarization • Index • EL CID.  

Note: This course is the last 2-days of G401.

**G401**  Turbine-Driven Generators: Theory, Controls, Operation, Maintenance & Testing  
4.5-days  
There are NO SMALL PROBLEMS when it comes to your GENERATOR!!  

**WHAT YOU WILL LEARN:**  
- Fundamentals of generator theory.  
- How the generator is constructed.  
- Generator operational procedures/considerations.  
- Generator control concepts.  
- System operation considerations.  
- Interpretation of generator one line diagrams.  
- Abnormal conditions that put the generator at risk, as well as what action to take (or to not take) to protect the machine.  
- Disassembly/reassembly procedures.  
- To perform visual inspections.  
- When, what and how to clean components.  

**TOPICAL OUTLINE:** Generator Theory (Lite) • Systems Operation • Generator Auxiliaries • Generator Excitation Systems & Controls • Normal Operations • Abnormal Operations • Generator Construction • Planning and Scheduling Generator Outages • Disassembly • Visual Inspection • Reassembly • Resistance Testing • Dielectric • Absorption Testing • DC Current Leakage Test • Dissipation Factor Test • Radio Noise Test • High Potential Testing • Ring Test • Polarization • Index • EL CID.
G406 Generator Electrical Testing 3-days

WHAT YOU WILL LEARN:
- What electrical tests are performed on the generator components (stator and rotor) and why.
- The purpose of conducting each of these tests, i.e., what are we looking for as a result of the test?
- Safety considerations associated with each test.
- Identification of test equipment required for each test, and how to setup the equipment to collect meaningful data, safely.
- Appreciate data collection procedures that need be applied to collect meaningful data.
- Interpret test data to evaluate acceptability or areas of concern.
- To plan and implement procedures to troubleshoot routine problems.

G706  ADVANCED Generator Maintenance & Reliability Seminar
4.5-days  
In-Depth Lectures, Case Studies, Vendor Fair/Demonstrations

WHEN:  9-13 December 2019
LOCATION:  Tampa Bay, FL

WHAT YOU WILL LEARN:
- To make the most effective repair/reuse/replace decisions regarding your generator.
- Learn effective industry accepted repair techniques.
- Learn to perform and analyze electrical tests.
- Learn to formulate effective inspection/repair schedules.
- Learn what to look for when performing visual inspections.
- Learn how and how to effectively use flux probes and analyze data collected.
- Learn how to more effectively monitor generator condition.
- Learn how material selection can greatly affect the integrity of your generator.
- Learn to more effectively troubleshoot the source of those abnormalities identified in initial inspection procedures.
- Learn to better appreciate the role and need of protective relaying.
- Learn more about return-to-service issues and monitoring generator operation.


TOPICS INCLUDE:

This seminar is for the more experienced personnel, although fundamentals are reviewed at the seminar beginning.

GENERATOR INSTRUMENT & CONTROLS

G301  Generator Control Concepts  3-days

There are NO SMALL PROBLEMS when it comes to your GENERATOR!! Be prepared. Make sure you fully understand Design, Construction, Operations, and how/why the controls function as they do. Don't be surprised. Be prepared. Register for this course today. We begin with the big-picture; proceed with component identification (including how these components may be of risk in abnormal conditions), discussion of normal/abnormal operations, and how the generator controls should respond to these conditions. This course is designed for plant engineers who have a specific need to better understand how the generator controls function. Plant electrical and operations technicians benefit as well. (This course is the first 3-days of G401).

TOPICAL OUTLINE: Generator Theory • System Operation • Generator Construction • Exciters • Voltage Regulators • Speed Control • Generator Protection • Industry Events.

G404  Generator Protection  4.5-days

This course is directed toward the new engineer or technician involved with generator protection. The course starts with a fundamental description of the one-line diagram, and then proceeds to discuss each significant protective relay typically found on that diagram. For each relay we discuss how the relay protects the asset, typical settings, and how the relay functions.

WHAT YOU WILL LEARN:
• The purpose of the individual protective relays.
• The different type of relays available.
• The functioning of a basic relay circuit.
• Importance of protective relay coordination.
• Use of current and voltage transformers within protective relay circuits.
• Function of current, voltage, and differential protective relay schemes.
• Differential relaying and its application to the power generation sit

G530  (GE) Generrex™ Excitation System  5-days  On Site Only

Learn practical working knowledge of GE’s Generrex™ Excitation System. Discussions include the stationary internal exciter and voltage regulator principles and emphasize principles of operation, circuit analysis, testing and maintenance.

TOPICAL OUTLINE: Excitation Theory • AC Generators • Operating Characteristics • Field Support Circuits • DC Regulation • AC Regulation • AC Regulation Protection • Alarms and Trips • Maintenance • Troubleshooting.

Generrex is a registered trademark of GE

G531  (W) WTA Voltage Regulator  5-days  On Site Only

This course is conducted by an "expert" ex-W Engineer. As we all know, this system can run seemingly, forever. Then there is that "one-day". That is the day you may wish you (or one of your plant technicians/engineers) had attended this course. As stated above, equipment-experienced engineers present the course. Simply put, the overall objective is to develop the individuals responsible for plant operations, testing, calibration and maintenance of this system. To effectively work on these systems, the technicians must "honestly" understand the 'big-picture', he/she must fully appreciate the OEM drawing systems, and then practice use of these prints as it applies to their type of equipment. This course is designed for Engineers, Technicians, and Electricians who have a need to maintain this system.

**G532  (GE) Alterrex™ Excitation System**  
5-days

Simply put, the overall objective of this (GE) Alterrex™ Excitation System training program is to develop the individuals responsible for plant operations, testing, calibration and maintenance of this system. To accomplish we have a need to understand the "big-picture", to understand the OEM print systems, to understand how to read those prints and maintenance instructions, and finally, we need to understand how to apply this knowledge toward the solution of operating problems. This course is designed for Engineers, Technicians, and Electricians who have a need to maintain this system.

**TOPICAL OUTLINE:** Generator Characteristics and Design Features, Operation of an Automatic Voltage Regulator, Excitation System Components, Alternator Field Control, AC Regulator, Protective Features, Station One Line Diagram, Print Interpretation and Drawing Practices, Excitation System Alignment Procedures, Troubleshooting Tips, Techniques and Industry Examples.

Alterrex is a registered trademark of GE

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**G535  (GE) EX2000 Voltage Regulator**  
5-days

**WHAT YOU WILL LEARN:**
- To maintain, repair and calibrate an Excitation System with the EX2000 Voltage Regulator.
- Effective routine maintenance practices.
- What checks may be performed on-line and how they are done.
- Any given circuit's impact upon operations; i.e., quickly linking the symptom(s) to the faulty circuit.
- Verify suspected faulty circuit by analyzing voltage levels and/or signal traces.
- Understanding the necessary calibrations, after the faulty part has been replaced, including how the calibrations are performed.

**TOPICAL OUTLINE:** Excitation System Fundamentals, EX2000 Features, One-Line Diagram, Cabinet Layout • Board Interconnections and Descriptions • Control Core Software Functions • Protective Functions • Programmer • ST2000 • IOS and Peripheral.

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**G536  (ABB) Unitrol™ Excitation System**  
5-days  
On Site Only

Gain working knowledge of ABB’s Unitrol™ Excitation System in order to improve the participants’ ability to maintain, calibrate, troubleshoot and repair this system.

**TOPICAL OUTLINE:** Theory • AC Generators • Pilot Generator • Stationary Uncontrolled Rectifier • Field Breaker and Discharge Resistor • Manual Regulator • Follow Up Controller • SCR • Limiter • Protection • Maintenance.

Unitrol is a registered trademark of ABB

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**G539  (GE) EX2100 Voltage Regulator**  
5-days

**WHAT YOU WILL LEARN:**
- To maintain, repair and calibrate an Excitation System with the EX2100 Voltage Regulator.
- Effective routine maintenance practices.
- What checks may be performed on-line and how they are done.
- Any given circuit's impact upon operations; i.e., quickly linking the symptom(s) to the faulty circuit.
- Verify suspected faulty circuit by analyzing voltage levels and/or signal traces.
- Understanding the necessary calibrations, after the faulty part has been replaced, including how the calibrations are performed.

**TOPICAL OUTLINE:** Fundamental • Block Diagrams • Components • EX2100 Boards • EX2100 Control Software Application • Protection Module Software Programmer • IOS.

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**G543  (GE) Static (Bus Fed) Excitation**  
5-days

This course was designed to provide the participant with the knowledge necessary for maintaining, troubleshooting and repairing GE’s Potential Source and Shunt SCR Static Excitation Systems. This course provides a detailed coverage description of the equipment, principles of operation, as well as maintenance and troubleshooting. This course is a print intensive course with emphasis on expected voltage levels at the test points provided on the cards. This course is recommended for both technicians and engineers.

**TOPICAL OUTLINE:** System Overview, Identification of Major Components, Inner Loop Regulator, AC/DC Gate, Firing Circuit, AC Regulator, Relaying, SCR Bridge, Maintenance and Troubleshooting.
H304  Hydro Turbine Generator O&M  
3-days

Greater hydro turbine generator reliability can be achieved by proper operation, maintenance and alignment of this important rotating equipment. This course targets these goals and more. Participants will learn about the major components that make up a hydroelectric turbine generator, routine outage planning, disassembly/reassembly issues, inspection, and sufficient knowledge to support the need to make quality reuse, replace, repair decisions. The targeted audience is operation mechanics, site supervisors, and engineers that are new to hydroelectric equipment.


MECHANICAL MAINTENANCE courses

M101  Hand & Power Tools: Proper Use & Safety  
2-days

WHAT YOU WILL LEARN:
- Identify and properly use hand tools
- Perform the safe operation of hand tools
- Demonstrate the proper use of metal fasteners used in a plant
- Perform the proper selection and use of power tools
- Understand the safe operation of power tools

TOPICAL OUTLINE: Basic Hand Tools, Power Tools, Plant Safety

M102  Blueprint Reading & Shop Math  
2-days

WHAT YOU WILL LEARN:
- Understand the basic math needed to perform maintenance including: Addition, Subtraction, Multiplication, Division, and Algebraic Equations
- Identify symbols used on blueprints and drawings
- Demonstrate the ability to read piping diagrams and machine prints

TOPICAL OUTLINE: Blueprints, Mechanical Drawings, Shop Math

M301  Bearing Maintenance & Lubrication  
2-days

WHAT YOU WILL LEARN:
- Identify and properly use / install rolling contact bearings
- Safely and properly remove rolling contact bearings
- Learn the different types of lubricants and their specific uses
- Learn the different types of lubrication systems and their proper use

TOPICAL OUTLINE: Bearing Maintenance & Lubrication, Lubrication Systems

M302  Hydraulic & Pneumatic Principles  
2-days

WHAT YOU WILL LEARN:
- Identify hydraulic systems components
- Perform the safe operation hydraulic systems / tools
- Perform the proper maintenance of hydraulic systems and their components
- Identify pneumatic systems components
- Perform the safe operation pneumatic systems / tools
- Perform the proper maintenance of pneumatic systems and their components

TOPICAL OUTLINE: Hydraulic Principles, hydrodynamics, liquid characteristics, pressure, hydraulic systems, and hydrostatics – Pneumatic Principles, gas characteristics, pressure, volume, pneumatic systems

M301 and M302 can be combined into one complete 4-Day class @ $1995 as these two courses are usually scheduled back-to-back.
M303  Pump Maintenance & Repairs  
2-days

**WHAT YOU WILL LEARN:**
- How pumps really work.
- How to read and interpret pump curves.
- How to read and interpret system curves.
- The different types of pumps found in industrial applications.
- The major components found in pumps.
- The operating principle pumps.

**TOPICAL OUTLINE:** Pump basics, applications, maintenance and operations.

M305  Valve, Fan & Compressor Maintenance  
2-days

**WHAT YOU WILL LEARN:**
- The different types of compressors commonly found in industrial applications.
- The major components found in the listed compressors.
- The operating principles of the listed compressors.
- The knowledge required to troubleshoot compressor operational problems.
- The different types of fans found in industrial applications.
- The major components found in the listed fans.
- The operating principles of the listed fans.
- The knowledge required to troubleshoot fan operational problems.
- To identify various valves and explain the function of each.
- The proper means of installing packing in valves.

M309  AC & Refrigeration  
2-days

**WHAT YOU WILL LEARN:**
- Operational Overview
- Common practices and “tricks-of-the-trade” for everyday O&M of these systems.
- Maintenance schedules and service.
- System diagnostics and troubleshooting
- Steps to improve to improve overall efficiency.

**TOPICAL OUTLINE:** Thermodynamic Fundamentals, Regulation Considerations, Compression Refrigeration Cycle, Refrigerants and Refrigerant Oils, Major System Components, Related Components, System Diagnostics, Servicing & Troubleshooting

M310  Packaged Boiler O&M  
2-days

**WHAT YOU WILL LEARN:**
- The various types of boilers utilized in the industry.
- The difference between watertube and firetube boilers.
- The calculations for temperature and pressure.
- How boilers are constructed.
- Shop math, the math needed to calculate areas and square footage.
- How to remove moisture from steam.
- Why water level is so important in boiler operation.
- How to maintain good water chemistry for boiler longevity.
- The various types of fuels used in today’s boilers.
- How air can affect boiler efficiency.
- Good operating procedures to follow.
- What to look for during a boiler inspection.

M401  Planning, Scheduling & Project Management  
2-days

WHAT YOU WILL LEARN (all material ‘skewed’ to power plant outage work):
• To better develop and define project objectives.
• To better control Project Workscope, Schedule, and Budget.
• Understand the Constraints of Available Resources and Performance Requirements and how to Plan to Insure that Success Will be Achieved.


TOPICAL OUTLINE: The Qualities Required for Leadership Ability.
• An Increased Capability to Make Decisions.
• The Qualities that Enhance the Ability to Effectively Negotiate.

M402  Condition Based Maintenance  
2-days

WHAT YOU WILL LEARN:
• The theory behind an oil analysis program.
• The requirements for and oil analysis.
• The common causes of vibration.
• The advantages of a vibration analysis program.
• The theories and applications for acoustic leak monitoring.
• The theories and applications for ultrasound testing.
• The theories and applications for thermography.
• The advantages and disadvantages of replication monitoring.
• How to implement a predictive monitoring program.

TOPOICAL OUTLINE: Why PM, Types, Oil Analysis, Vibration, Acoustic Leak Monitoring, UT, Thermography, Replication Monitoring, Implementing a PM Plan.

M402 and M403 can be combined into one complete 4-Day class @ $2995 as these two courses are usually scheduled back-to-back.

M403  Root Cause Failure Analysis  
2-days

WHAT YOU WILL LEARN:
• To identify "chronic" vs. "sporadic" failures.
• To describe the difference between physical root cause and latent root cause.
• How to develop, use and interpret a logic tree.
• To determine which failures should be analyzed and which shouldn’t.
• To determine how far to go with the analysis.
• To develop and administer an analysis recommendation.

TOPOICAL OUTLINE: Reason or Cause for Analysis; Failure Analysis Methods, Why Failure Analysis Works; Order, Determinism, Discoverability, What to Analyze; Chronic vs. Sporadic, Chronic System Barriers, Identify Non-Value Added Work, Logic Tree Symbols, Developing The Top Box, Disciplined Approach Through Problem Solving, Where To Stop, Ideas of Control and Influence, Implementing Recommendations.

M402 and M403 can be combined into one complete 4-Day class @ $2995 as these two courses are usually scheduled back-to-back.
PLANT OPERATIONS courses

PLANT FUNDAMENTALS

OP101  Power Plant Fundamentals  
3-days

WHAT YOU WILL LEARN:
• The four phases of a basic steam cycle, including: generation, expansion, condensation and feed.
• The components making up the basic steam cycle.
• The theory of operation of each identified component in that steam cycle.
• Flow of water/steam through this cycle.
• Fundamental description of each of the listed major components within the basic steam cycle, including how that component relates to the cycle.

TOPICAL OUTLINE: Introduction to Steam Power Plants • Fuels and Combustion • Boilers • Combustion Air • Flue Gas • Ash Handling • Air Pollution Controls • Circulating Water • Steam • Condensate • Feedwater • Turbine • Generator • Gas Turbines • Electrical Distribution • Water Treatment • Industrial Waste.

OP202  Electrical Systems for Operators
3-days

WHAT YOU WILL LEARN:
• To trace the flow of electrical generation from the original source of energy to the consumer.
• Components making up the power triangle.
• The purpose of symbols and standard device function numbers while using an electrical schematic.
• The purpose, construction, and operation of current and potential transformers.
• Basic construction and operation of circuit breakers.

TOPICAL OUTLINE: Overall plant description, Review of electrical fundamentals, Reading electrical diagrams, Plant electrical equipment, Motors, Generation and Excitation

PLANT OPERATIONS

OP304  Power Plant Performance for Operators
3 days

WHAT YOU WILL LEARN:
• The function of each thermodynamic process associated with each power plant components.
• The types of heat transfer that occur within the steam cycle.
• The definition of the terms entropy, enthalpy, superheat, latent heat, and sensible heat.
• Major losses associated with boiler operation and how operations can reduce these losses.
• Major losses associated with steam turbine operation and how they can be reduced.
• Major losses associated with heat exchangers and how they can be reduced.

TOPICAL OUTLINE: Thermodynamics (what should be a review), Controlling Boiler Losses, Controlling Turbine Losses, Controlling Heat Exchanger Losses, and Controlling Condenser Losses.

OP316  Protective Relays for Operators
3-days

WHAT YOU WILL LEARN:
• To read and interpret content of one-line diagrams.
• What types of protection are needed and why.
• Which protective relays are appropriate to provide the needed protection?
• How equipment is damaged if there were no protection or faulty protection.

**OP321  Fundamentals of Voltage & Frequency Controls**

**2-days**

**What You Will Learn:**
- Definitions of reactive power.
- Definitions and cause of voltage deviation.
- Types and use of voltage control equipment available to the power system operator.
- Reactive capability of synchronous generators.
- The need to match generator to load and how the load/frequency relationship and system inertia contribute to frequency control.
- The principle of governor action.
- The principle of voltage regulator operation.


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**PLANT ENGINEERING and MANAGEMENT**

**OP416  Power Plant Performance**

**4.5-days**

**What You Will Learn:**
- Gain a working knowledge of terminology used in plant efficiencies.
- Define those terms commonly used power plant performance analysis and the principles of thermodynamics.
- How heat rate affects operating costs of a power plant.
- Basic thermodynamic principles of the boiler, steam turbine and heat exchangers.
- 10 common areas of efficiency loss in an operating plant.
- The principles of plant efficiency using ASME Performance Test Codes.
- Use the principles of performance related instruments.

STEAM TURBINE GENERATOR courses

STEAM TURBINE GENERATOR FUNDAMENTALS

TG105 Mechanical & Electrical Fundamentals
4-days

WHAT YOU WILL LEARN:
- How to properly rig mechanical components.
- How to select and use precision measuring equipment.
- Different types of non-destructive examination (NDE).
- How NDE is conducted and how to evaluate results.
- Basics of planning/scheduling outages.
- How to work safely around electrical equipment.
- How to read electrical prints/schematics.
- How to measure different circuit parameters to facilitate a safe working environment.
- How to properly size wire in preparation for use of electrical equipment.

HPC instructs this course with experienced Field Engineers or Mechanics (often 30+ years’ experience) who have the instructional skills as well. Much of the course is lecture, but it includes efficient use of lab equipment in HPC facilities so that important tasks are demonstrated and practiced (as needed).

TG201 Steam Turbine Fundamentals
3-days

WHAT YOU WILL LEARN:
- How energy conversion occurs within the steam turbine.
- Types of blades found in a steam turbine.
- Function of the various steam turbine components.
- How a steam turbine is sealed.
- How why a steam turbine expands.
- Purpose and components of the steam turbine valves.
- Application of the different types of steam turbines.

TOPICAL OUTLINE: Steam Turbine Operating Principles, Component Descriptions, Steam Valves, Unit Descriptions, Intro to Operations, Turbine Auxiliary Systems

STEAM TURBINE GENERATOR MAINTENANCE

TG300 Steam Turbine Maintenance
3-days

WHAT YOU WILL LEARN:
- To create, schedule, and implement a steam turbine outage plan.
- Disassembly/reassembly procedures.
- To perform visual inspection of ST components.
- To record as-found/as-left data and evaluate same.
- What types of distress are typically found on ST components?
- To make better replace/repair/reuse decisions.
- How to align steam path components.
- How to align centerline components.
- What type of NDE is typically performed on components?
- Ask better question of contractors and better interpret answers given.

TOPICAL OUTLINE: Planning, Scheduling and Decision Making; Maintenance of Shells • Casings & Rotors • Journal and Thrust Bearings • Couplings • Steam Valves • Steam Path Alignment • Job Wrap Up

This course is the first 3-days of TG301.
TG301  Steam Turbine Generator Maintenance  
5-days

WHAT YOU WILL LEARN:

- To create, schedule, and implement a steam turbine generator outage plan.
- Disassembly/reassembly procedures.
- To perform visual inspection of STG components.
- To record as-found/as-left data and evaluate same.
- What types of distress are typically found on STG components?
- To make better replace/repair/reuse decisions.
- How to align steam path components.
- How to align centerline components.
- What type of NDE is typically performed on components?
- Ask better question of contractors and better interpret answers given.

TOPICAL OUTLINE: Planning, Scheduling and Decision Making; Maintenance of Shells • Casings & Rotors • Journal and Thrust Bearings • Couplings • Steam Valves • Generator Maintenance • Steam Path Alignment • Job Wrap Up • Generator Operating Principles, Generator Component Descriptions, and Generator Auxiliary Systems.

TG313  (GE) Steam Turbine Valve Maintenance  
2-days  
On Site Only

Improve the effectiveness of your GE steam turbine valve maintenance activities. REDUCE: Outage Durations, Outage Extensions, Work Duplication, and Rework. INCREASE: Outage Intervals, Reliability, Availability, and Productivity. Greater unit reliability and availability can be achieved through proper routine valve maintenance activity. Quality valve maintenance outages are the result of thorough job planning and a complete understanding of the equipment, specifications, and procedures. This course has been designed for GE steam turbine facility foremen, supervisors, mechanics, engineers, and all other plant personnel who are concerned with increasing the effectiveness and reducing the cost of steam turbine valve maintenance outages. HPC is prepared to instruct this course as developed by equipment-experienced instructors that offer a broad range of practical experience on numerous types and sizes of steam turbine generators.

TG314  (W) Steam Turbine Valve Maintenance  
2-days  
On Site Only

Improve the effectiveness of your Westinghouse steam turbine valve maintenance activities. REDUCE: Outage Durations, Outage Extensions, Work Duplication, and Rework. INCREASE: Outage Intervals, Reliability, Availability, and Productivity. Greater unit reliability and availability can be achieved through proper routine valve maintenance activity. Quality valve maintenance outages are the result of thorough job planning and a complete understanding of the equipment, specifications, and procedures. This course has been designed for Westinghouse steam turbine facility foremen, supervisors, mechanics, engineers, and all other plant personnel who are concerned with increasing the effectiveness and reducing the cost of steam turbine valve maintenance outages. HPC is prepared to instruct this course as developed by equipment-experienced instructors that offer a broad range of practical experience on numerous types and sizes of steam turbine generators.

TG316  Steam Turbine Overhauls & Repairs  
4.5-days

WHAT YOU WILL LEARN:

- The impact of the various types of defects on turbine efficiency and reliability
- The criteria used to evaluate turbine component defects
- The tasks involved in and the duration of steam path audits
- The tasks involved in and the duration of diaphragm area checks
- The tasks involved in and the duration of diaphragm drop checks
- The tasks involved in and the duration of minor and major diaphragm repairs
- The tasks involved in and the duration of bucket/blade repairs
- The tasks involved in and the duration of bearing repairs
- The tasks involved in and the duration of valve repairs

Fundamentally, this is the turbine portion of our TG301, except we make considerable use of steam turbine components available to us only at our Sarasota facility. This course is only presented at our facility in Sarasota, FL.

TOPICAL OUTLINE: Turbine Disassembly & Reassembly • Turbine Cleaning & Inspection • Steam Path Audits • Bearing Inspection & Repair • Valve Inspection & Repair • Turbine Alignment.
TG328  Geothermal Steam Turbine Generator Maintenance  
4.5-days

This course is basically our popular steam turbine generator maintenance course reorganized to better fit the specific and unique requirements of a geothermal application.

WHAT YOU WILL LEARN:
- To better plan the outage.
- Disassembly / reassembly procedures.
- Visual inspection techniques.
- Record / evaluate as-found conditions.
- Types of distress typically found on a geothermal steam turbine.
- To make better replace / repair / reuse decisions.
- Steam path alignment techniques.
- Types of NDE applicable on various geothermal steam turbine components.
- Ask better questions of contractors and better evaluate the answers given.


TG403  Turbine Generator Balancing Workshop  
3-days

WHAT YOU WILL LEARN:
- Fundamental terms and concepts important to vibration analysis.
- To relate the use of vibration measuring instruments to your applications.
- Normal balancing conventions used during balancing.
- To calculate a "first-shot" using the "one-shot method".
- To calculate a "second-shot" using the "measured-effect" method.
- To translate calculated weight information to the actual installation of weights on any given rotor.
- To conduct a "low-speed balancing" program on a bowed rotor.

TOPICAL OUTLINE: Vibration Theory • Use of Vibration Measuring Equipment • Recording Data, Performing a One-Shot Calculation • Performing Measured Effect Analysis • Installing Balance Weights • Low Speed Balancing. Lots of practice is included throughout.

TG415  Design & Major Repair of Steam Turbines  
4.5-days

WHAT YOU WILL LEARN:
- The steps necessary to design a new steam turbine; to include "rules of thumb" for sizing important features such as inlet and exhaust areas, rotor size, number or shells/cylinders, and type of valve control.
- The basic design criteria used by manufacturers.
- Ideal and actual thermodynamic cycles and the heat balance, such that one could describe the range of expected efficiency for steam turbines designed with the latest technology.
- Design criteria such as velocity ratio, constant pressure ratio and variable pressure ratio stages.
- Steam turbine efficiency loss mechanisms including moisture effect and seal leakages.
- Understanding of the design basis for 2d and 3d airfoil (blade and vane) profiles, on and off design effects, and profile losses.
- Steady and dynamic loading in the blade vane; to include centrifugal loads, vibratory loads, steam bending loads, and the stresses these loads produce.
- Purposes of cover bands (shrouding) and tie wires; to include the function, different types, and how they are attached.
- Design considerations of different types of rotors, to include: rotor function, construction, heat treatment, inspection of bores, inspection of forging, rotor dynamics/critical speed, rotor thermal stability, stresses, and temperature control.
- Types of loads imposed on stationary diaphragms and blade rings, including distortion producing creep.
- Repair options of stationary diaphragms and blade rings, to include the effect of repair tolerance on overall reliability and efficiency.
- Blade vibration producing effects and how these translate to blade stress.
- Casing design including single and double shells, effect of pressure/temperature, torque loading, and relative movement between components.
- Type of repairs (on casings/shells) necessary to correct defects resulting for thermal stresses and high temperature creep.
- Types of materials used in large utility steam turbines and the reasons for specific alloying elements and processes used to produce these high quality materials.
- To make pass/fail, and repair/replace decisions on steam turbine components. Where repair is decided, demonstrate the necessary knowledge regarding the use of acceptable repair techniques.

TOPICAL OUTLINE: Historical perspective of steam turbines, steam power cycles, steam path, blade/bucket profiles, blade vane stress, blade roots and fasteners, root stresses, cover bands, rotors, fixed blades/diaphragms, blade vibration, casings/cylinders, material selection.
TG524  
(GE Nuclear) Steam Turbine Generator Maintenance
4.5-days

The course targets specifically the equipment, components and concerns associated with maintaining these nuclear units. It goes to those individuals who have a need to better understand the maintenance process. This includes engineers (who have not yet received formal training on this topic), experienced-mechanics, mechanical maintenance foremen, planners and management.

**WHAT YOU WILL LEARN:**
- To create, schedule, and implement a steam turbine generator outage plan.
- Disassembly/reassembly procedures.
- To perform visual inspection of STG components.
- To record as-found/as-left data and evaluate same.
- What types of distress are typically found on STG components?
- To make better replace/repair/reuse decisions.
- How to align steam path components.
- How to align centerline components.
- What type of NDE is typically performed on components?
- Ask better question of contractors and better interpret answers given.

**TOPICAL OUTLINE:** Planning and Scheduling • Repair/Replace Criteria • Shell/Casing/Rotor Construction • Disassembly • Visual Inspection • NDT • Steam Path Audit • Repair Issues • Upgrades • Journal Bearings • Thrust Bearings • Couplings • Steam Valves (MSV, MCV, CIV and Bypass Valves for BWR) • Generator Components • Generator Disassembly • Generator Mechanical Maintenance • Generator Electrical Testing • Alignment Tightwire (Laser) • Diaphragm Moves, Shell/Casing Moves • Coupling Rim/Face Alignment Calculations • Bearing Moves • Generator Frame Moves • Vibration Issues • Benefits/Precautions on Low Speed Balancing • Job Wrap Up

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TG525  
(GE Industrial Unit) Steam Turbine Generator Maintenance
4.5-days

**WHAT YOU WILL LEARN:**
- To create, schedule, and implement a steam turbine generator outage plan.
- Disassembly/reassembly procedures.
- To perform visual inspection of STG components.
- To record as-found/as-left data and evaluate same.
- What types of distress are typically found on STG components?
- To make better replace/repair/reuse decisions.
- How to align steam path components.
- How to align centerline components.
- What type of NDE is typically performed on components?
- Ask better question of contractors and better interpret answers given.

**TOPICAL OUTLINE:** Planning, Scheduling and Decision Making; Maintenance of Shells, Casings & Rotors; Journal and Thrust Bearings; Couplings, Steam Valves; Generator Maintenance; Steam Path Alignment; and Job Wrap Up.

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TG526  
(GE) Steam Turbine Generator Auxiliary System Maintenance
2-days

**WHAT YOU WILL LEARN:**
- The purpose and design considerations for each system covered in the course.
- The designed purpose and function of each component.
- To describe normal and abnormal operations.
- The function of all instrumentation.
- The cause and effect of operational problems.
- Recommended preventive maintenance activities.
- Typical outage maintenance activities.
- Modern solutions to historical problems.

**TOPICAL OUTLINE:** Steam Turbine Overview, Turbine Lube Oil System, Steam Seal System, Hydraulic Power Unit, Generator Overview, Seal Oil System, Hydrogen Control System, and the Stator Cooling Water System.

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TG527  
(W) Steam Turbine Generator Auxiliary System Maintenance
2-days

**WHAT YOU WILL LEARN:**
- The purpose and design considerations for each system covered in the course.
- The designed purpose and function of each component.
- To describe normal and abnormal operations.
- The function of all instrumentation.
- The cause and effect of operational problems.
- Recommended preventive maintenance activities.
- Typical outage maintenance activities.
- Modern solutions to historical problems.
- What type of NDE is typically performed on components?

**TOPICAL OUTLINE:** Equipment Familiarization • Turbine Wiring Diagrams • Lube Oil Hydraulics • Gland Seals • Generator Wiring Diagrams • Hydrogen Controls • Core Monitor • Shaft Seals • TC/RTD.
TG531  (GE) Combined Cycle Steam Turbine Maintenance
4.5-days

This course is basically our popular steam turbine maintenance course reorganized to better fit the specific and unique requirements of the (GE) steam turbine used in combined cycle designs.

WHAT YOU WILL LEARN:
- To better plan the outage.
- Disassembly / reassembly procedures.
- Visual inspection techniques.
- Record / evaluate as-found conditions.
- Types of distress typically found on a (GE) combined cycle steam turbine.
- To make better replace / repair / reuse decisions.
- Steam path alignment techniques.
- Types of NDE applicable on various (GE) combined cycle steam turbine components.
- Ask better questions of contractors and better evaluate the answers given.


TG706  Advanced Steam Turbine Maintenance & Controls Issues Course
4.5-days
In-Depth Lectures, Case Studies, Vendor Fair/Demonstrations

LOCATION:  Tampa Bay, FL

In 2008, we changed the title of the annual TG706 course to “Steam Turbine Technologies Course & Exhibit”, as this title better reflects the presented content.

HPC, along with TurboCare, is committed to provide the power industry with a forum for the transfer of the latest “techniques” and “technologies” for improved steam turbine maintenance activities.

These advancements in both technique and technology are designed to accomplish improvements in “Outage Duration”, “Extended Intervals Between Outages,” and an “Increase” in unit “Efficiency” and “Output.”

HPC recognizes that the OEM has similar courses at times – these courses are important, but recognize, the OEM course represents the OEM views and are biased by their business interest. There are also major expositions throughout the year, but you’ll never get this much information on one topic (the steam turbine) in one sitting. Participants benefit by learning the latest techniques/technologies that can have a direct effect upon planning and implementing their next steam turbine outage.

Participants benefit by learning the latest techniques/technologies that can have a direct effect upon planning and implementing their next steam turbine outage.

The following topics were included in the 2008 course: Turbine Bolting/Unbolting, Outage Case Study, On Site Machining, Lube Oil Filtration, Water Chemistry, Tilting Pad Bearings, Steam Path Coatings, Outage Management, Shaft Sealing, Laser Alignment, EHC Systems, Remote Monitoring, Turbine Diagnostics, Turbo Case History, Repair/Replace Parts, Babbitt Bearings, Steam Path Upgrades/Updates, Online Balancing, Infrared Thermography.

The agenda that HPC proposes from year-to-year is designed based upon recommendations received from industry leaders, plant turbine engineers, consultants and past attendees. There are major expositions throughout the year, but you’ll never get this much information on one topic (the steam turbine) in one sitting. Participants benefit by learning the latest techniques/technologies that can have a direct effect upon planning and implementing their next steam turbine outage. See our website, www.hpcnet.com, for detailed information.

PAST PRESENTERS INCLUDE:
- Alstom Power
- Degremont
- Elliot Company
- Siemens
- LUDECA
- HPC Technical Services
- Manning Heat Treatment
- NovaTech
- REACT
- Renewal Parts Maintenance
- Sermatech
- Steam Path Services
- Turbine Diagnostic Services
- Turbine Services Inc.
- TurboCare
- Turbo Components & Engineering
- Turbo Parts
- FARO Technologies Inc.
- RoMoDyn
- WILMAR Engineering
HPC STEAM TURBINE Field Engineering Certification Program (FECP)

5-weeks

HPC’s certification program is designed to parallel (or even improve upon) the Field Engineering Programs offered by the OEM to new and previously experienced employees. Many of those who are “expert” on steam turbine operations & maintenance are also near retirement age. This is true in so many areas of power plant O&M and applies specifically to steam turbines as well. HPC, in a classroom environment, combines their (the expert) experience with HPC training and development expertise, to salvage this knowledge for the benefit of the new engineer.

Who is to benefit? The best answer to this question is that YOU will benefit, YOU and those you work for, be it your employer or your client. A GE Field Engineer, for example, goes thru a significant training program. If you’re not an OEM engineer, wouldn’t you like to experience a similar benefit? If yes, this certification program is the means by which YOU can accomplish your goal.

You could take advantage of this curriculum all at one time, or take the courses over two or more sessions. Examinations are administered at the end of each course (except TG706 and G706) and recommendations are made for job-performance-activities. To save money, please remember our “3-for-2” policy or our Training Savings Program. Courses (one or all, except TG706 and G706) can be customized and conducted at your site.

ST FECP Courses
TG105 ..... Mechanical & Electrical Fundamentals
TG201 ..... Steam Turbine Fundamentals
TG301 ..... Steam Turbine Generator Maintenance, or TG316
TG316 ..... Steam Turbine Overhauls & Repairs, or TG531
TG327 ..... Steam Turbine Operation Practices & Alarm Response, or TG333
TG526 ..... (GE) Steam Turbine Generator Auxiliary System Maintenance

ST FECP Continuing Education Courses
G401 ...... Turbine-Driven Generators: Construction, Controls, Operations, Maintenance & Testing
TG416 ..... Steam Turbine Performance
TG422 ..... Concepts of Steam Turbine Controls
TG706 ..... Advanced Steam Turbine Maintenance & Controls Issues Seminar
G706 ....... Advanced Generator Maintenance & Reliability Seminar
STEAM TURBINE GENERATOR OPERATIONS

TG307  Steam Turbine Generator Operations  
4.5-days

WHAT YOU WILL LEARN:

- Those turbine generator components susceptible to damage in abnormal or fault like conditions, the type of damage that could occur, and what the operator can (or cannot) do to correct for the situation.
- To draw a simple block-diagram that describes all the elements of steam turbine controls: speed, load, and pressure control, the generation of a servomechanism signal, feedback and regulation.
- To draw a simple block-diagram that describes all the elements of a generator voltage regulator including the generation of excitation power, manual control, auto voltage regulation, anti-hunt devices, and limiters.
- The process of synchronizing, including discussion on the effects of synchronizing errors.
- Normal steam turbine generator operating procedures as well as the more routine (using that word loosely) abnormal events.


TG308GE  Steam Turbine (GE) Starting & Loading Instructions  
2-days

WHAT YOU WILL LEARN:

- To describe thermal stress; how it is derived and what is the impact upon steam turbine components.
- To describe how they can minimize the negative impact of thermal stress while minimizing start-up times.
- The importance of the Fracture Appearance Transition Temperature.
- To interpret the OEM starting and loading instructions.
- To apply the OEM starting and loading instructions to his/her application.

TOPICAL OUTLINE: Review of Steam Turbine Fundamentals, Use of TSI, Thermal Stress, Starting and Loading Instructions, Abnormal Events.

This course is recommended for Control Room Operators, Shift Supervisors, Operations Superintendents, and Engineers. The course specifically targets GE or W steam turbines (see open enrollment schedule for dates), and due to their similarities applies to Toshiba, Hitachi and Mitsubishi units as well. Other manufacturers can only be represented in on-site customized courses.

**Attend both the GE and W version, back-to-back, for US$1995**

TG308W  Steam Turbine (W) Starting & Loading Instructions  
2-days

WHAT YOU WILL LEARN:

- To describe thermal stress; how it is derived and what is the impact upon steam turbine components.
- To describe how they can minimize the negative impact of thermal stress while minimizing start-up times.
- The importance of the Fracture Appearance Transition Temperature.
- To interpret the OEM starting and loading instructions.
- To apply the OEM starting and loading instructions to his/her application.

TOPICAL OUTLINE: Review of Steam Turbine Fundamentals, Use of TSI, Thermal Stress, Starting and Loading Instructions, Abnormal Events.

This course is recommended for Control Room Operators, Shift Supervisors, Operations Superintendents, and Engineers. The course specifically targets GE or W steam turbines (see open enrollment schedule for dates), and due to their similarities applies to Toshiba, Hitachi and Mitsubishi units as well. Other manufacturers can only be represented in on-site customized courses.

**Attend both the GE and W version, back-to-back, for US$1995**

TG311  Steam Turbine Generator Controls for Industrial Plant Operators  
4-days  
On Site Only

This course discusses proper operation of the steam turbine generator from the perspective of the control room operator. Emphasis is on speed/frequency, extraction pressure and voltage regulator controls. Equipment discussed is normally a function of participants' background.


For open enrollment, we suggest participation in TG307.
TG323  Steam Turbine Mk-VI for Operators
4.5-days

WHAT YOU WILL LEARN:
- Major Hardware found on a Mk-VI
- How to access / use toolbox software to access relevant control data.
- How to read control data well enough to support operating decisions.
- How to navigate documentation to sufficiently trace an alarm drop to the initiating device.
- Take needed action in any alarm condition.


TG323e  Steam Turbine Mk-VIe for Operators
4.5-days

WHAT YOU WILL LEARN:
- Major Hardware found on a Mk-VIe
- How to access / use toolbox software to access relevant control data.
- How to read control data well enough to support operating decisions.
- How to navigate documentation to sufficiently trace an alarm drop to the initiating device.
- Take needed action in any alarm condition.


TG327  Steam Turbine Operation Practices & Alarm Response
4.5-days

WHAT YOU WILL LEARN:
- Those steam turbine components that is susceptible to damage in abnormal operating conditions.
- The type of damage that could occur and what the operator can (or cannot) do to correct for the situation.
- The function of the turbine support systems, procedural issues, “typical” abnormal conditions, and operator corrective action.
- To draw and describe a simple block - diagram that describes all the elements of steam turbine controls: speed, load, and pressure control, the generation of a servomechanism signal, feedback and regulation.
- Those operating parameters (incl. alarm points) monitored by TSI, including eccentricity, shell expansion, differential expansion.
- The causes of steam turbine vibration to include data to be recorded, detailed discussion on how to recognize the major causes of turbine vibration, and operator actions.
- Normal steam turbine start-up and shutdown procedures.
- Those actions that can be taken by operations to minimize efficiency losses.
- Abnormal conditions often experienced in operating steam turbines, and for each abnormal condition discussed:
  1. Describe any operational symptoms.
  2. Describe how the steam turbine is at risk.
  3. Describe typical controls’ automatic response.
  4. Describe required (recommended) operator response.
TG333  Combined Cycle Steam Turbine Generator Operation
4.5 days

WHAT YOU WILL LEARN:
- Those steam turbine generator components that are susceptible to
damage in abnormal operating conditions.
- The type of damage that could occur and what the operator can
do (or cannot) do to correct the situation.
- The function of the turbine generator support systems, procedural
issues, “typical” abnormal conditions, and operator corrective
actions.
- The purpose of the major steam inlet valves as well as those
auxiliary valves specific to a combined cycle application.
- To draw and describe a simple block diagram that describes all
the elements of steam turbine controls, speed, load, and pressure
control, the generation of a servomechanism signal, feedback and
regulation.
- To monitor the turbine supervisory instruments as a means to
evaluate turbine operation. Instruments to include eccentricity,
shell expansion, differential expansion, thrust and vibration.
- The causes of steam turbine vibration, how to recognize
symptoms to better identify the cause and take corrective actions.
- Turbine startup / shutdown procedures.
- Abnormal conditions relative to steam turbine generator
operations. For each, describe the symptoms, probable causes,
and corrective actions.

TOPICAL OUTLINE:
- Review of Steam Turbine Operating Theory and
Components, Auxiliary Systems, Thermal Stress, Turbine Supervisory
Instrumentation, Steam Turbine Control Concepts, Cold versus Hot
Starts, Use of Starting and Loading Instructions, Failure Modes, and
Abnormal Operations to include: Eccentricity Issues, Packing Rubs,
Effect of Synchronizing Errors, Lube Oil Problems during Startup,
Water Induction, Overspeed (Normal, Emergency and Destructive),
Vibration Trends as a Telltale of Operational Problems, Differential
Expansion Issues, Effects of Frequency Deviation, Vacuum Breaking,
High Exhaust Hood Temperatures, Over Pressure/Temperature,
Generator Fundamentals, Generator Auxiliaries, Generator
Construction, Excitation Systems, Generator Operations.

TG408  Turbine Water Induction Awareness
2-days

WHAT YOU WILL LEARN:
- Recommended design practices that have been initiated to protect
turbine equipment from water induction.
- List instrumentation typically available for detection of a water
induction event.
- Given an alarm situation, what corrective action should be taken
and why.
- What type(s) of damage might occur as a result of water
induction?

TOPICAL OUTLINE:
- Overview of how a turbine might be damaged,
Design Recommendations, Incidents, Detecting the Presence of Water
Induction, Operation to Minimize Damage, Operating
Recommendation, Tests, Case Studies.

TG416  Steam Turbine Performance
4.5-days

This course is based upon KC Cotton’s book Evaluating and Improving
Steam Turbine Performance. Participants will learn how steam turbine
efficiency effects overall power plant operations as well as to apply
diagnostic techniques to identify the problem source, location, type of
damage likely to exist and the extent of deterioration. Steam path audit
techniques will be discussed, specifically addressing how to reduce
repair and replacement costs.

This course is designed for engineers, operation superintendents,
maintenance superintendents who at a minimum are familiar with
steam turbine components and most basic theory.

TOPICAL OUTLINE:
- Thermodynamics and Fluid Flow Review -
Introduction to Turbine Performance - Steam Turbine Stage Efficiency
- Turbine Cycle Monitoring - Control Valves - Abnormal Operating
Conditions - Acceptance Testing - Turbine Characteristics
TG431  Management Overview of Steam Turbine Generator O&M
3.5-days

WHAT YOU WILL LEARN:
• The steam turbine energy conversion process.
• The purpose of the major steam turbine components.
• The purpose of the major steam turbine valves.
• How/why the steam turbine inlet valves are positioned.
• Why and how operations control the turbine heating process during turbine startup.
• The 10 most common abnormal events that could cause considerable steam turbine damage.
• The 10 most common causes of steam turbine distress, the most fundamental cause, and the different corrective action(s) that might be taken, given an identified form of steam turbine distress.
• The transformation of mechanical energy to electrical energy.

• Identify and describe the purpose of the major generator components.
• How the voltage regulator responds to system events.
• The 10 most common abnormal events that could cause considerable generator damage.
• The 10 most common causes of generator distress, the most fundamental cause and the different corrective action(s) that might be taken, given an identified form of generator distress.
• The 5 most common causes of loss of efficiency.

TOPICAL OUTLINE: Steam Turbine Principles, Component Descriptions, Main Steam Valves, Intro to Turbine Controls, Overview of Turbine Operations, Overview of Turbine Maintenance, Generator Fundamentals, Generator Components, Overview of Generator O&M, and Operational Audits.

STEAM TURBINE GENERATOR INSTRUMENT & CONTROLS

TG422  Concepts of Steam Turbine Controls
2-days

Learn practical application of a steam turbine control systems. Learn some of the theory, some of the OEM philosophies. Learn everything you need to know about steam turbine controls, except the print reading or software exercises that go along with unit specifics (these can be learned in HPC unit specific offerings; see our 500 level courses).

TOPICAL OUTLINE: • Turbine Theory and Performance Curves • Fundamental Theory of Operation • Efficiency Issues • Valve Positioning for Efficiency and Reliability • Speed Control • Load Control • Inlet Pressure Control • Extraction Pressure Control • Exhaust Pressure Control • Valving • Start Up • System Frequency Deviations Shutdown • Thermal Stress Issues • Auxiliary Valves • Steam Turbine Protection • Typical Trip Schemes.

GE-MSTG (Lynn) Controls

TG502  (GE-MSTG) EHC Mk-III+ Steam Turbine Controls
On Site Only

This course describes inputs/outputs, their function, how they facilitate turbine operation as well as calibration and troubleshooting.

TOPICAL OUTLINE: System Overview • Hydraulics • Mechanical Components • Speed/Load Control • Pressure • Trip Circuits • Line Up Diagram • Calibration and Troubleshooting.

TG508  (GE) DCM+ Steam Turbine Controls
4-days . . . . 2.6 CEU
On Site Only

This Course describes inputs/outputs, their function, how they facilitate turbine operation as well as calibration and troubleshooting.

TOPICAL OUTLINE: Introduction Mechanical Systems • System Architecture • Documentation One Lines • Software Elementaries • Speed/Load Control • IPC • Sliding Pressure V1, V2 O/S Protection • Emergency Overspeed • Test Procedures • Troubleshooting.

TG519  (GE) EHC Mk-II (Lynn) Steam Turbine Controls
4-days

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

TG520  (GE) Mk-III Steam Turbine Controls
4-days

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.
GE-LSTG (Schenectady) Controls

TG503  (GE-LSTG) EHC Mk-I Steam Turbine Controls
5-days
HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

TG504  (GE-LSTG) EHC Mk-II Steam Turbine Controls
5-days
HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

TG507  (GE) MHC Steam Turbine Controls
4.5-days

**WHAT YOU WILL LEARN:**
- The purpose or function of the entire Hydraulic Control System and the features it must have to safely control turbine operation.
- The major components/sub-systems.
- The purpose of each major component and/or sub-system.
- How each major component functions within the control system and/or sub-system.
- The kinds of tools, instructions, drawings, etc. that is required to maintain a particular system.
- The general methods and techniques for inspecting, testing, adjusting, and troubleshooting the hydraulic control systems.

**TOPICAL OUTLINE:** System Overview, MHC Amplifiers and Related Components, Oil System, Overview of Steam Turbine Controls, Speed/Load Control, Reheat Controls, Pressure Control, Protective and Overspeed Systems, Lever Diagrams and Setting Instructions, Troubleshooting.

**Note:** Course is applicable to GE units as well as non-USA manufacturers (Hitachi and Toshiba) of GE designed steam turbines with mechanical hydraulic controls.

TG513  (GE) Mk-I Front Standard & Valve Actuator Controls
2-days
Many control system upgrades are directed toward the electronics and do not “completely” overhaul the front standard and valve actuators. This course recognizes continued need for information in this area.

**WHAT YOU WILL LEARN:**
- To identify those major components found in the GE Mk-I Front Standard and describe normal operation of those components.
- Routine calibration and preventive maintenance procedures on the GE Mk-I front standard.
- To identify those major components found in a servo-controlled valve actuator.

**TOPICAL OUTLINE:** Steam path overview, Front Standard Components, Front Standard Operation, Conceptual Control Interface, Malfunction & Troubleshooting, Steam Valve Operations, Servo Operated Actuator, Non-Servo Actuator, Operational Sequence, Valve Testing, Valve Malfunctions & Testing.

TG514  (GE) Mk-II Front Standard & Valve Actuator Controls
2-days
Many control system upgrades are directed toward the electronics and do not “completely” overhaul the front standard and valve actuators. This course recognizes continued need for information in this area.

**WHAT YOU WILL LEARN:**
- To identify those major components found in the GE Mk-II Front Standard and describe normal operation of those components.
- Routine calibration and preventive maintenance procedures on the GE Mk-II front standard.
- To identify those major components found in a servo-controlled valve actuator.

**TOPICAL OUTLINE:** Steam path overview, Front Standard Components, Front Standard Operation, Conceptual Control Interface, Malfunction & Troubleshooting, Steam Valve Operations, Servo Operated Actuator, Non-Servo Actuator, Operational Sequence, Valve Testing, Valve Malfunctions & Testing.
GE Mk-V, Mk-VI, Mk-VIe Steam Turbine Controls

TG522  (GE) Mk-V Steam Turbine Controls
5-days

WHAT YOU WILL LEARN:

• To use OEM provided documentation that will include the Control Specifications, Control Sequence Program, I/O Configuration, CSP Cross Reference, Alarm Drop List, Application Manual, and P&IDs.
• How the Mk-V hardware components are accessed and how they communicate.
• To troubleshoot an equipment alarm, given an Alarm Drop Number.
• Interpret the more routine diagnostic alarms and recognize appropriate actions.
• Follow the major "control signal path" through a Control Sequence Program.
• To trace the derivation of a command signal to the servomechanisms.
• How to calibrate turbine valve mechanisms.
• To more efficiently use the Mk-V <I>/<HMI> screens for evaluating/calibrating systems.
• To force logic to facilitate calibration.
• To change constants or re-program ladder logic such as to add contact input/outputs, add alarms, and/or alter sequencing.
• To trace a signal to/from a field device through appropriate terminal boards, through circuit boards, to a digital "signal name".
• To follow signal flow to/from the <P> core to trip/reset the machine.
• Differences between a <Q> trip and a <P> trip. Demonstrate an understanding of on-line and off-line test sequences.


TG523  (GE) Mk-VI Steam Turbine Controls
8-days (10-days for BWR units)

WHAT YOU WILL LEARN:

• Use of the OEM provided documentation.
• The Mk-VI hardware components function and access.
• To use "Toolbox" software.
• To troubleshoot an equipment alarm to the field device.
• To interpret the more routine diagnostic alarms and recognize appropriate actions.
• To trace the derivation of a command signal to the servomechanisms.
• To calibrate turbine valve mechanisms.
• To more efficiently use the Mk-VI screens for evaluating/calibrating systems.
• To force logic to facilitate calibration.
• To change constants or re-program ladder logic such as to add contact input/outputs, add alarms, and/or alter sequencing.
• Trace a signal to/from a field device through appropriate terminal boards, through circuit boards, to a digital "signal name".
• How a trip signal is derived and applied.


TG523e  (GE) Mk-VIe Steam Turbine Controls
8-days (10-days for BWR units)

WHAT YOU WILL LEARN:

• Use of the OEM provided documentation.
• The Mk-VIe hardware components function and access.
• To use "Toolbox" software.
• To troubleshoot an equipment alarm to the field device.
• To interpret the more routine diagnostic alarms and recognize appropriate actions.
• To trace the derivation of a command signal to the servomechanisms.
• To calibrate turbine valve mechanisms.
• To more efficiently use the Mk-VIe screens for evaluating/calibrating systems.
• To force logic to facilitate calibration.
• To change constants or re-program ladder logic such as to add contact input/outputs, add alarms, and/or alter sequencing.
• Trace a signal to/from a field device through appropriate terminal boards, through circuit boards, to a digital "signal name".
• How a trip signal is derived and applied.

GE-MDTD (Fitchburg) Feed Pump Turbine Controls

**TG501**  (GE) Turbine Supervisory Instruments  
3-days

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

**TG501**  (Bently Nevada) 3300 TSI System  
3-days ..... Hands-On

**WHAT YOU WILL LEARN:**
- The purpose of each turbine supervisory instrument and how it is important to turbine operation.
- The general physical location of each turbine supervisory instrument.
- The components along with their location that make up the BN 3300 Monitoring System.
- The proper programming configuration within the Power Supply in selecting the required transducer's voltage and the data communication interface.
- The functions associated with the System Monitor.
- The programming requirement between the Power Supply module and the System Monitor module.
- The module to which the signal from the transducer is wired.
- The difference between a Dual Relay and Quad Relay within the Signal Input Relay module.
- The proper programming configuration within the Signal Input Relay in selecting the proper functionality of the ALERT and/or DANGER Relay.
- The condition that represents the status of the LEDs when given a snapshot of the front panel LEDs on the Dual Vibration XY/Gap Monitor.
- The proper programming configurations when given specified user define features for the Dual Vibration XY/Gap Monitor.
- The programmable option Trip Multiply, and state its purpose.
- The error code number that indicates an incorrect jumper configuration on the Dual Vibration XY/Gap Monitor.


**TG521**  (Bently Nevada) 3500 TSI System  
3-days ..... Hands-On

**WHAT YOU WILL LEARN:**
- The purpose of each turbine supervisory instrument and how it is important to turbine operation.
- The primary function of the Bently Nevada 3500 Machinery Protection System.
- The two modules that must be in every rack, and state their respective position within the rack.
- The two modules that have the responsibility of communicating with the rack monitors. (Note: Only one can be used at a time.)
- The three software packages associated with the BN 3500 Machinery Protection System and explain the function of each.
- The module to which incoming power is connected.
- The two positions of the Grounding Select Switch.
- The module through which the Power Supply Module is software configured.
- The status description on each of the front panel LEDs on the Rack Interface Module.
- The correct positions of the dip switches for a given address number.
- The purpose of the two passwords that are entered during configuration.
- The function of the Keyphasor® Module when it’s receiving one event per revolution.
- The grounding requirement when using Test Equipment.
- The ALERT conditions that must be known prior to performing the Keyphasor® Module self-test or any other monitor self-test. Four functions that the Proximitor®/Seismic Module can be programmed for utilizing the Rack Configuration Software.
- The status description on each of the front panel LEDs on the Proximitor®/Seismic Module.
- The three items that can be used as an aid when troubleshooting the Proximitor®/Seismic Module or its I/O Module.

(W) Steam Turbine Controls

TG505  (W) AEH Steam Turbine Controller
10-days
On Site Only

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

TG506  (W) DEH Steam Turbine Controller
10-days
On Site Only

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

TG509  (W) 300#/150# Steam Turbine Controls
3-days

HPC keeps this outdated topic on our schedule as a service to the industry. For detailed information please see our website.

(Ovation) Steam Turbine Controls

TG530  (Ovation) Steam Turbine Controls
8-days

WHAT YOU WILL LEARN:

• Use of the OEM provided documentation.
• Control system hardware components function and access.
• To use control system software.
• To troubleshoot an equipment alarm to the field device.
• To interpret the more routine diagnostic alarms and recognize appropriate actions.
• To trace the derivation of a servomechanisms command.
• To calibrate turbine valve mechanisms.
• To more efficiently use the operating screens for evaluating/calibrating systems.
• To force logic to facilitate calibration.
• To change constants or re-program logic such as to add contact input/outputs, add alarms, and/or alter sequencing.
• Trace a signal to/from a field device through appropriate terminal boards, through circuit boards, to a digital "signal name”.
• How a trip signal is derived and applied.

HPC Technical Services is now offering our “generic” Learning-Docs online. HPC is currently covering the following major topic areas, with more in development:

- (GE) Fossil Steam Turbines
- (GE) BWR Steam Turbines
- (GE) PWR Steam Turbines
- (GE) D11 Steam Turbines
- (GE) A10 Steam Turbines
- (GE) Frame 7FA Gas Turbines
- (GE) Frame 7EA Gas Turbines
- (GE) Frame 6B Gas Turbines
- (GE) Fossil 2-Pole Generators
- (GE) 7FH2 2-Pole Generators
- (GE) Air Cooled 2-Pole Generators
- (GE) Nuclear 4-Pole Generators

And much, much, much more to come!!

Other areas, depending upon demand, include the Frame 5, 6F, 9E, and 9F gas turbines. On the steam turbine side, possible areas include the Toshiba 4:1 combined cycle steam turbine.

What is a Learning-Doc?

Learning-Docs are HPC Technical Services’ answer to the need for easy to access learning and reference materials on gas turbine, steam turbines, and generators. All Learning-Docs were written by, and reviewed by, ex-OEM field engineers with extensive experience. HPC’s Learning-Docs are now available on our new website: www.professorturbine.com.

The four major uses of these Learning-Docs will include:

1. **Knowledge Transfer** – Capture knowledge and experience of an aging group of field engineers & plant engineers and deliver in a format more usable by today’s generation.
2. **Just-in-Time Training** – The Learning-Doc provides detailed information about test procedures and preventive maintenance activities. Wouldn’t it make sense that, before you initiate the particular activity that you fully understand the intent of the actions to be taken and the expected results?
3. **Alarm Response Assistance** – HPC’s Learning-Docs puts all the information in front of you with easy-to-access interactive screens that will allow you to locate the needed information much quicker and much more accurately. Our argument is that we cannot solve the problem for you, but what is it worth if we can help you solve the problem sooner and get the machine back on, or started on schedule?
4. **Initial Training** – The Learning-Docs present need-to-know information regarding the component (system) purpose, basic operation, testing, startup/shutdown, and alarm response. To support effort, Learning-Docs contain Learning Objectives, Check-You-Understanding questions/answers, recommended On-The-Job Learning Activities and a Final Exam.

HPC’s Learning-Doc includes:

- Written learning objectives describing what is expected to be learned by studying this material.
- Well-written content describing the overall function and detailed operation of the system.
- Material written by- and reviewed by- equipment experienced personnel (often ex-GE field engineers)
- Color highlighted graphics.
- Check-Your-Understanding questions strategically located to help the reader understand the content.
- Recommended On-the-Job Learning Activities on what the reader should do to help apply this information to their worksite.
- Interactive functions throughout.
- Alarm response discussions to include (for each common alarm) the implication, probable causes, immediate actions to be taken, and instruments that are used for this purpose.
- Final examination taken on line (the exam includes two randomly chosen questions (from a file of questions maintained on line) for each of the learning-objectives).

As a reference, HPC was hired by GE and 28 nuclear power plants across the USA to develop a generic set of Learning-Docs applicable to the GE steam turbine generators found in these BWR and PWR nuclear power plants. While attending the BWR Owners Group meetings the #1 comment received was that these Learning-Docs “far exceeded their expectations”. The same principles used in the development of these BWR steam turbine generator generic Learning-Docs have been used in developing our generic Learning-Docs.
7FA Gas Turbine Fundamentals
At the completion of this Learning-Doc the learner will understand the purpose of a 7FA gas turbine and the basic theory of how energy is transformed from fuel gas to torque; air intake, compressor operation, combustion, expansion through the gas turbine, and exhaust. With these discussions one will understand the function and relative locations of those major components that make up the 7FA gas turbine.

7FA Gas Turbine Construction (Imperial and Metric)
In this Learning-Doc the learner will be able to describe the 7FA gas turbine major components, including the purpose / function and construction of these major components. Discussion will include the base and supports, the compressor (casing, inlet guide vanes, casing & rotor), combustion (can arrangement and components, spark plugs, flame detectors, and the DLN2.6 nozzles), turbine section (structure, wheel space, turbine buckets and the turbine shell), exhaust frame, bearings, turning gear, and instruments. Alarms relative to the turbine will be discussed, including the implication of the said alarm, likely causes, and actions to be taken.

7FA Gas Turbine Lube Oil System
This LD describes the major components of the lube oil system; the reservoir, AC lube oil pumps, coolers/filters, the operating manifold, and the DC emergency pumps. Discussion will include startup, normal operation, shutdown, emergency shutdown, and the routine operational tests, common sense operational items, and preventive maintenance. Finally, the learner will understand those typical alarms that may occur, the probable causes, instruments used, and actions to be taken.

7FA Gas Turbine Hydraulic System
Learn the major components that make up the hydraulic system and how these components are used during startup, normal operation, shutdown, and emergency shutdown. Learn also, the operation of those hydraulic devices that are used to position the gas and liquid fuel valves. Discussions include routine operational tests, common sense operational items, and preventive maintenance. Typical alarms are discussed; why they may occur, the probable causes, instruments used, and actions to be taken.

7FA Gas Turbine Cooling & Sealing Air
Learn the purpose and operation of the cooling & sealing air system. Topics include the 9th and 13th stage compressor bleed system, the turbine nozzle cooling air subsystem, the exhaust frame and #2 bearing are cooling, compressor discharge pressure connections, and water wash provisions. Typical alarms are discussed; the alarm source, the implication, the probable causes, and the actions to be taken.

7FA Gas Turbine Inlet & Exhaust Air
This LD describes the air flow through the gas turbine. Detailed discussion includes the inlet air filters (and cleaning), evaporative coolers, inlet bleed heating, the variable inlet guide vanes (simple cycle and combined cycle operation), exhaust air and performance monitoring instrumentation. Alarm discussion includes why the alarm situation is of concern, likely causes, and probable actions to be taken.

7FA Gas Turbine LCI Starting Means
The material describes the role of the LCI (load commutated inverter) starting means and, functionally, how the LCI accomplishes the actual starting of the gas turbine. Discussion includes bearing lift oil, turning gear, an overview of the static start system, the start sequence, and the LCI cooling system. Related alarms and alarm response are included.

7FA Gas Turbine Fuel Gas & DLN 2.6
This LD describes fuel gas flow from the supply through to the gas turbine combustion cans. Content includes the gas fuel supply, the Stop Speed Ratio Valve construction and operation, the gas control valves’ construction and operation, DLN2.6 modes of operation in startup and shutdown, and alarm response.

7FA Gas Turbine Liquid Fuel
Discussion on the liquid fuel includes the liquid fuel forwarding skid, control of flow to the combustion cans, the use of atomizing air, the use of water injection and purge systems. Alarms on each of these topics are discussed as well: implication, likely causes and actions to be taken.

7FA Gas Turbine Ventilation, Heating & Fire Protection
LD topics include site orientation, ventilation & heating of the enclosures, the use of CO2 in fire protection, CO2 storage, temperature sensors, the use of multiple zones, and distribution of the initial and extended CO2 flows. Alarm response discussions are included.

7FA Gas Turbine Water Wash
The purpose of water washing is discussed, including those conditions that are required to proceed. Topics include the water wash skid, the spray manifolds, off-line water wash procedures, and on-line water wash procedures. Alarm response discussions are included.

7FA Gas Turbine Control Concepts
The Control Concepts LD includes discussion on how the control system interacts between turbine components and operators during all phases of turbine operation. Topics include discussion of the FSR split, ready-to-start requirements, the start-up sequence, speed/load control, temperature control, combustion monitor, gas fuel operation, and liquid fuel operation. Discussions move from the determination of the control signal to the positioning of the valves. Content will also include detailed alarm response discussions.

7FA Gas Turbine Protection
There are two versions of this topic, Mk-V and Mk-VI. Discussions include the trip header, the 20TV-1 and 20FG-1 solenoids, generation of trip signals to the gas and liquid fuel system and how the control cabinet communicates to the fuel valves. Then the discussion involve the generation of the master trip signals, L4, in the primary cores and the generation of trip signal in the protective cores. Alarm discussions are included; implications, probable causes, and actions to be taken.
At the completion of this Learning-Doc the learner will understand the purpose of a 7EA gas turbine and the basic theory of how energy is transformed from fuel gas to torque; air intake, compressor operation, combustion, expansion through the gas turbine, and exhaust. With these discussions one will understand the function and relative locations of those major components that make up the 7EA gas turbine.

7EA Gas Turbine Fundamentals
At the completion of this Learning-Doc the learner will understand the purpose of a 7EA gas turbine and the basic theory of how energy is transformed from fuel gas to torque; air intake, compressor operation, combustion, expansion through the gas turbine, and exhaust. With these discussions one will understand the function and relative locations of those major components that make up the 7EA gas turbine.

7EA Gas Turbine Construction (Imperial and Metric)
In this Learning-Doc the learner will be able to describe the 7EA gas turbine major components, including the purpose / function and construction of these major components. Discussion will include the base and supports, the compressor (casing, inlet guide vanes, casing & rotor), combustion (can arrangement and components, spark plugs, flame detectors, and the DLN2 nozzles), turbine section (structure, wheelspace, turbine buckets and the turbine shell), exhaust frame, bearings, turning gear, and instruments. Alarms relative to the turbine will be discussed, including the implication of the said alarm, likely causes, and actions to be taken.

7EA Gas Turbine Lube Oil System
This LD describes the major components of the lube oil system; the reservoir, AC/DC lube oil pumps, the gear driven oil pump, coolers/filters, and the operating manifold. Discussion will include startup, normal operation, shutdown, emergency shutdown, and the routine operational tests, common sense operational items, and preventive maintenance. Finally, the learner will understand those typical alarms that may occur, the probable causes, instruments used, and actions to be taken.

7EA Gas Turbine Hydraulic System
Learn the major components that make up the hydraulic system and how these components are used during startup, normal operation, shutdown, and emergency shutdown. Learn also, the operation of those hydraulic devices that are used to position the gas and liquid fuel valves. Discussions include routine operational tests, common sense operational items, and preventive maintenance. Typical alarms are discussed; why they may occur, the probable causes, instruments used, and actions to be taken.

7EA Gas Turbine Cooling & Sealing Air
Learn the purpose and operation of the cooling & sealing air system. Topics include the 11th stage compressor bleed system, bearing sealing air, the turbine nozzle cooling air supply, exhaust frame cooling, pressurized air supply, and water wash provisions. Typical alarms are discussed; the alarm source, the implication, the probable causes, and the actions to be taken.

7EA Gas Turbine Inlet & Exhaust Air
This LD describes the air flow through the gas turbine. Detailed discussion includes the inlet air filters (and cleaning), evaporative coolers, inlet bleed heating, the variable inlet guide vanes (simple cycle and combined cycle operation), exhaust air and performance monitoring instrumentation. Alarm discussion includes why the alarm situation is of concern, likely causes, and probable actions to be taken.

7EA Gas Turbine Starting Means
The material describes the role of the starting means and, functionally, how the starting means accomplishes the actual starting of the gas turbine. Discussion includes the torque and crank motors, the ratchet mechanism, the start sequence, and cooldown. Related alarms and alarm response are included.

7EA Gas Turbine Fuel Gas & DLN1
This LD describes fuel gas flow from the supply through to the gas turbine combustion cans. Content includes the gas valve module, the Stop Speed Ratio Valve construction and operation, the gas control valves’ construction and operation, DLN1 modes of operation in startup and shutdown, and alarm response.

7EA Gas Turbine Liquid Fuel
Discussion on the liquid fuel includes the liquid fuel forwarding skid, control of flow to the combustion cans, the use of atomizing air, the use of water injection and purge systems. Alarms on each of these topics are discussed as well: implication, likely causes and actions to be taken.

7EA Gas Turbine Ventilation, Heating & Fire Protection
LD topics include site orientation, ventilation & heating of the enclosures, the use of CO2 in fire protection, CO2 storage, temperature sensors, the use of multiple zones, and distribution of the initial and extended CO2 flows. Alarm response discussions are included.

7EA Gas Turbine Water Wash
The purpose of water washing is discussed, including those conditions that are required to proceed. Topics include the water wash skid, the spray manifolds, off-line water wash procedures, and on-line water wash procedures. Alarm response discussions are included.

7EA Gas Turbine Control Concepts
The Control Concepts LD includes discussion on how the control system interacts between turbine components and operators during all phases of turbine operation. Topics include discussion of the FSR split, ready-to-start requirements, the start-up sequence, speed/load control, temperature control, combustion monitor, gas fuel operation, and liquid fuel operation. Discussions move from the determination of the control signal to the positioning of the valves. Content will also include detailed alarm response discussions.

7EA Gas Turbine Protection
There are two versions of this topic, Mk-V and Mk-VI. Discussions include the trip header, the 20TV-1 and 20FG-1 solenoids, generation of trip signals to the gas and liquid fuel system and how the control cabinet communicates to the fuel valves. Then the discussion involves the generation of the master trip signals, L4, in the primary cores and the generation of trip signal in the protective cores. Alarm discussions are included; implications, probable causes, and actions.
(GE) FRAME 6B GAS TURBINE

Frame 6B Gas Turbine Fundamentals
At the completion of this Learning-Doc the learner will understand the purpose of a frame 6B gas turbine and the basic theory of how energy is transformed from fuel gas to torque; air intake, compressor operation, combustion, expansion through the gas turbine, and exhaust. With these discussions one will understand the function and relative locations of those major components that make up the frame 6B gas turbine.

Frame 6B Gas Turbine Construction
In this Learning-Doc the learner will be able to describe the frame 6B gas turbine major components, including the purpose / function and construction of these major components. Discussion will include the base and supports, the compressor (casing, inlet guide vanes, casing & rotor), combustion (can arrangement and components, spark plugs, flame detectors, and the DLN1 nozzles), turbine section (structure, wheelspace, turbine buckets and the turbine shell), exhaust frame, bearings, turning gear, and instruments. Alarms relative to the turbine will be discussed, including the implication of the said alarm, likely causes, and actions to be taken.

Frame 6B Gas Turbine Lube Oil System
This LD describes the major components of the lube oil system; the reservoir, AC/DC lube oil pumps, the gear driven oil pump, coolers/filters, and the operating manifold. Discussion will include startup, normal operation, shutdown, emergency shutdown, and the routine operational tests, common sense operational items, and preventive maintenance. Finally, the learner will understand those typical alarms that may occur, the probable causes, instruments used, and actions to be taken.

Frame 6B Gas Turbine Hydraulic System
Learn the major components that make up the hydraulic system and how these components are used during startup, normal operation, shutdown, and emergency shutdown. Learn also, the operation of those hydraulic devices that are used to position the gas and liquid fuel valves. Discussions include routine operational tests, common sense operational items, and preventive maintenance. Typical alarms are discussed; why they may occur, the probable causes, instruments used, and actions to be taken.

Frame 6B Gas Turbine Cooling & Sealing Air
Learn the purpose and operation of the cooling & sealing air system. Topics include the 11th stage compressor bleed system, bearing sealing air, the turbine nozzle cooling air supply, exhaust frame cooling, pressurized air supply, and water wash provisions. Typical alarms are discussed; the alarm source, the implication, the probable causes, and the actions to be taken.

Frame 6B Gas Turbine Inlet & Exhaust Air
This LD describes the air flow through the gas turbine. Detailed discussion includes the inlet air filters (and cleaning), evaporative coolers, inlet bleed heating, the variable inlet guide vanes (simple cycle and combined cycle operation), exhaust air and performance monitoring instrumentation. Alarm discussion includes why the alarm situation is of concern, likely causes, and probable actions to be taken.

Frame 6B Gas Turbine Starting Means
The material describes the role of the starting means and, functionally, how the starting means accomplishes the actual starting of the gas turbine. Discussion includes the torque and crank motors, the ratchet mechanism, the start sequence, and cooldown. Related alarms and alarm response are included.

Frame 6B Gas Turbine Fuel Gas & DLN1
This LD describes fuel gas flow from the supply through to the gas turbine combustion cans. Content includes the gas valve module, the Stop Speed Ratio Valve construction and operation, the gas control valves’ construction and operation, DLN1 modes of operation in startup and shutdown, and alarm response.

Frame 6B Gas Turbine Liquid Fuel
Discussion on the liquid fuel includes the liquid fuel flow, control of flow to the combustion cans, the use of atomizing air, the use of water injection and purge systems. Alarms on each of these topics are discussed as well: implication, likely causes and actions to be taken.

Frame 6B Gas Turbine Ventilation, Heating & Fire Protection
LD topics include site orientation, ventilation & heating of the enclosures, the use of CO2 in fire protection, CO2 storage, temperature sensors, the use of multiple zones, and distribution of the initial and extended CO2 flows. Alarm response discussions are included.

Frame 6B Gas Turbine Water Wash
The purpose of water washing is discussed, including those conditions that are required to proceed. Topics include the water wash skid, the spray manifolds, off-line water wash procedures, and on-line water wash procedures. Alarm response discussions are included.

Frame 6B Gas Turbine Control Concepts
The Control Concepts LD includes discussion on how the control system interacts between turbine components and operators during all phases of turbine operation. Topics include discussion of the FSR split, ready-to-start requirements, the start-up sequence, speed/load control, temperature control, combustion monitor, gas fuel operation, and liquid fuel operation. Discussions move from the determination of the control signal to the positioning of the valves. Content will also include detailed alarm response discussions.

Frame 6B Gas Turbine Protection
There are two versions of this topic, Mk-V and Mk-VI. Discussions include the trip header, the 20TV-1 and 20FG-1 solenoids, generation of trip signals to the gas and liquid fuel system and how the control cabinet communicates to the fuel valves. Then the discussion involves the generation of the master trip signals, L4, in the primary cores and the generation of trip signal in the protective cores. Alarm discussions are included; implications, probable causes, and actions to be taken.
(GE-LSTG) FOSSIL STEAM TURBINE

Steam Turbine Fundamentals
At the completion of this Learning-Doc the participant will better understand the purpose of a steam turbine and the basic theory of how energy is transformed from the inletting steam to torque within this steam turbine. Major topics include the thermal cycle, basic steam turbine theory, basic turbine construction, the classification of steam turbines, general design considerations, and the purpose of the steam valves.

Steam Turbine Construction
In this Learning-Doc the learner should be able describe the general construction of a GE-LSTG steam turbine. Topics include a description of the HP, IP and LP turbines; description of components in the steam path, shaft seals, journal bearings, the thrust bearing, turbine assembly, turning gear, MSV, Control Valves, CRVs, PA/FA Admission, Auxiliary Valves, and major code types.

Turbine Lube Oil System
Select from three different LDs, one for the MHC units, one for Mk-I and one for Mk-II designs. In each system the descriptions will include the oil tank construction / major components, the motor driven oil pumps, oil coolers, the main shaft driven oil pump, oil control valves, operating sequences (on turning gear, during start up, on-line, shutdowns), bearing header piping, periodic testing, and instrumentation. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Hydraulic System
Select from two different LDs, one for Mk-I and one for Mk-II designs. In each system the descriptions will include the reservoir construction / major components, the hydraulic pumping system, fluid actuating supply, the fluid to cooler drain, the transfer / fluid earth filtering unit, instrumentation and operating procedures. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Steam Sealing System
Select from two different LDs, one for mechanical and one for electronic control designs. In each system the descriptions will include HP and LP packing assemblies, operation of the steam seal header during startup and at high loads, the steam packing exhauster, and auxiliary systems. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Turbine Supervisory Instrumentation
This LD describes each of the turbine supervisory instruments; the keyphasor (or phase reference generator), eccentricity detector, speed, valve position, shell expansion, differential expansion, rotor expansion, thrust position, vibration, and steam/metal thermocouples. For each, both the original GE type and the newer Bently-Nevada type instrument are described. Also described is the purpose of the instrument, the interpretation of data, likely causes of operational problems and how to use the instrumentation for troubleshooting and decision making. All related alarms and alarm responses are included in this discussion.

Steam Turbine Control Concepts
Select from two different LDs, one for mechanical and one for electronic control designs. This learning doc describes the basic laws of steam turbine controls and the relative importance of valve positioning. Detailed discussions on speed control off line, speed load control while on-line, load limiters, pressure control (limiters), and positioning the turbine steam inlet valves. Topics will include operator interaction with the control system and unit reaction to grid conditions and how responses may be limited. All related alarms and alarm responses are included in this discussion.

Steam Turbine Operation
Select from two different LDs, one for mechanical and one for electronic control designs. Content beings with a discussion on stress management, then continues with thermal stress and distortion for hot and cold starts; life expenditure curves, full arc versus partial arc admission, instrumentation, and use of the starting and loading instructions (prewarming, acceleration rates, speed holds, and loading rates). Discussion continues with sequencing the unit through a startup, shutdown and a discussion of general precautions. Discussions include alarm response.

Steam Turbine Protection Systems
Select from five different LDs, one each for MHC, Mk-I, Mk-II, a Rexroth upgrade, and a D1600N upgrade. Discussion on the protective systems will include the generation of the trip signal within the controls (detection and actions taken) and how the turbine is physically tripped (action of the trip valves). Discussions include alarm response.
(GE) D-11 and A-10 COMBINED CYCLE STEAM TURBINES (topics are similar but detail differs)

Steam Turbine Fundamentals
At the completion of this Learning-Doc the participant will better understand the purpose of a steam turbine and the basic theory of how energy is transformed from the inletting steam to torque within this steam turbine. Major topics include the thermal cycle, basic steam turbine theory, basic turbine construction, general design considerations, and the purpose of the steam valves.

Steam Turbine Construction
In this Learning-Doc the learner should be able describe the general construction of a GE D-11 (or A-10) steam turbine. Topics include a description of the HP-IP and LP turbines; description of components in the steam path, turning gear, couplings, steam seals, bearings, expansion, the combined MSV/CVs, CRVs, LP Admission Valves, and the Auxiliary Valves.

Turbine Lube Oil System
Select from two different LDs, one for the separate skid, one for the integral skid designs. In each system the descriptions will include the oil tank construction / major components, the motor driven oil pumps, oil coolers, oil filters, operating sequences (on turning gear, during start up, on-line, shutdowns), bearing header piping, periodic testing, and instrumentation. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Hydraulic System
Select from two different LDs, one for the separate skid and one for integral skid designs. In each system the descriptions will include the reservoir construction / major components, the hydraulic pumping system, the common manifold, auto-start sequencing, accumulators, hydraulic & oil transfer filtering system, instrumentation and operating procedures. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Steam Sealing System
The LD descriptions will include HP and LP packing assemblies, operation of the steam seal header during startup and at high loads (use of the feed and dump valves), the steam packing exhauster, and auxiliary systems. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Turbine Supervisory Instrumentation
This LD describes the Bently-Nevada turbine supervisory instruments as used on the D11 steam turbine. Equipment includes the key-phasor, eccentricity detector, speed, valve position, shell expansion, differential expansion, rotor expansion, thrust position, vibration, and steam/metal thermocouples. Also described is the purpose of the instrument, the interpretation of data, likely causes of operational problems and how to use the instrumentation for troubleshooting and decision making. All related alarms and alarm responses are included in this discussion.

Steam Turbine Control Concepts
This learning doc describes the basic laws of steam turbine controls and the relative importance of valve positioning. Detailed discussions on speed control off line, speed load control while on-line, load limiters, LP admission, cascade bypass, and positioning the turbine steam inlet valves. Topics will include operator interaction with the control system and unit reaction to grid conditions and how responses may be limited. All related alarms and alarm responses are included in this discussion.

Steam Turbine Operation
Content begins with a discussion on stress management, then continues with thermal stress and distortion for hot and cold starts; life expenditure curves, instrumentation, and use of the starting and loading instructions (prewarming, acceleration rates, speed holds, and loading rates). Discussion continues with sequencing the unit through a startup, LP admission, cascade bypass, shutdown and a discussion of general precautions. Discussions include alarm response.

Steam Turbine Protection Systems
Discussion on the protective systems will include the generation of the trip signal within the controls (detection and actions taken), how the turbine is physically tripped (action of the trip valves), testing of the trip system, and use of the typical operating screens. Discussions include alarm response.
(GE-LSTG) NUCLEAR STEAM TURBINE (PWR and BWR versions)

Steam Turbine Fundamentals
At the completion of this Learning-Doc the participant will better understand the purpose of a steam turbine and the basic theory of how energy is transformed from the inletting steam to torque within this steam turbine. Major topics include the thermal cycle, basic steam turbine theory, basic turbine construction, general design considerations, and the purpose of the steam valves (includes the bypass valves on the BWR version).

Steam Turbine Construction
In this Learning-Doc the learner should be able describe the general construction of a GE-LSTG nuclear type steam turbine. Topics include a description of the HP (single and double flow) and LP turbines; description of components in the steam path, turning gear, couplings, steam seals, bearings, expansion, the MSVs, CVs, CIVs, BPVs (on the BWR units), and the Auxiliary Valves.

Turbine Lube Oil System
Select from three different LDs, one for the MHC units, one for Mk-I and one for Mk-II designs. In each system the descriptions will include the oil tank construction / major components, the motor driven oil pumps, oil coolers, the main shaft driven oil pump, oil control valves, operating sequences (on turning gear, during start up, on-line, shutdowns), bearing header piping, periodic testing, and instrumentation. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Hydraulic System
Select from two different LDs, one for Mk-I and one for Mk-II designs. In each system the descriptions will include the reservoir construction / major components, the hydraulic pumping system, fluid actuating supply, the fluid to cooler drain, the transfer / fluid earth filtering unit, instrumentation and operating procedures. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Steam Sealing System
Select from two different LDs, one for mechanical and one for electronic control designs. In each system the descriptions will include HP and LP packing assemblies, operation of the steam seal header during startup and at high loads, the steam packing exhauster, and auxiliary systems. For each typical alarm, discussions will include the alarm implications, probable causes, and actions to be taken.

Turbine Supervisory Instrumentation
This LD describes each of the turbine supervisory instruments; the key-phasor (or phase reference generator), eccentricity detector, speed, valve position, shell expansion, differential expansion, rotor expansion, thrust position, vibration, and steam/metal thermocouples. For each, both the original GE type and the newer Bently-Nevada type instrument are described. Also described is the purpose of the instrument, the interpretation of data, likely causes of operational problems and how to use the instrumentation for troubleshooting and decision making. All related alarms and alarm responses are included in this discussion.

Steam Turbine Control Concepts
Select from three different LDs, one for mechanical and one for electronic control designs on a BWR unit and one for the electronic design on a PWR unit. This learning doc describes the basic laws of steam turbine controls and the relative importance of valve positioning. Detailed discussions on speed control off line, speed load control while on-line, load limiters, pressure control (BWR units), and positioning the turbine steam inlet valves. Topics will include operator interaction with the control system and unit reaction to grid conditions and how responses may be limited. All related alarms and alarm responses are included in this discussion.

Steam Turbine Operation
Select from three different LDs, one for mechanical and one for electronic control designs on a BWR unit and one for the electronic control design on a PWR unit. Content beings with a discussion on stress management, then continues with thermal stress and distortion for hot and cold starts; life expenditure curves, pressure control mode of operation (on BWR units), instrumentation, and use of the starting and loading instructions (prewarming, acceleration rates, speed holds, and loading rates). Discussion continues with sequencing the unit through a startup, shutdown and a discussion of general precautions. Discussions include alarm response.

Steam Turbine Protection Systems
Select from four different LDs, one each for MHC, Mk-I, Mk-II, and a D1600N upgrade. Discussion on the protective systems will include the generation of the trip signal within the controls (detection and actions taken) and how the turbine is physically tripped (action of the trip valves). Discussions include alarm response.
(GE-LSTG) NUCLEAR 4-POLE GENERATORS

Generator Fundamentals
At the completion of this Learning-Doc the participant will better understand the purpose of a generator and how the mechanical energy input to the generator is transformed to electrical power. The learner will also learn about kW and kVARs; how they are demanded, how they are generated and how they are transmitted. Content includes an overview discussion, a description of a 4-pole field winding and magnetic field, a description of the stator windings, the creation of a stator winding magnetic field, interaction of the magnetic fields, effect of different load types (resistive, inductive, and capacitive), VAR definitions, power triangle, and an introduction to the capability curve contents.

4-Pole Generator Construction
In this Learning-Doc the learner should be able describe the general construction of a GE-LSTG 4-pole generator construction. Topics include introductory discussions on the nameplate and purpose of the generator, descriptions of the stationary components (core, stationary windings, assembly, an overview of electrical testing, end shields, bearings, hydrogen seals, and instrumentation), descriptions of the rotating components (forging, field windings, hydrogen cooling, collector rings and an overview of electrical testing), and the use of special application instruments.

Generator Vacuum-Type Seal Oil System
In this Learning-Doc the learner should be able describe the major components, operations of the GE-LSTG generator seal oil system, and be able to navigate the system drawings. Topics include description of the seal rings, the seal oil vacuum tank, main seal oil pump, recirculation seal oil pump, emergency seal oil pump, regulation of differential pressures, hydrogen detraining tank, float trap, and the air detraining tank. Discussions include starting the system, normal operations, temporary modes of operation, emergency operations, use of instrumentation. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Hydrogen Control System
In this Learning-Doc the learner should be able describe the major components, operations of the GE-LSTG hydrogen control system, and be able to navigate the system drawings. Topics include introductory discussions on why hydrogen, the hydrogen coolers, hydrogen supply, CO2 supply, and instrumentation. Procedural discussions adding CO2 and removing air, adding H2, removing H2 with CO2, and removing the CO2 with air. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Stator Cooling Water System
In this Learning-Doc the learner should be able describe the major components, operations of the GE-LSTG stator cooling water system, and be able to navigate the system drawings. Topics include an introduction to water flow in the system, detailed discussions of the stator cooling water system skid, the deionizer, descriptions of water flow to the generator, instrumentation, filling the reservoir, changing the resin, purpose of the HIT skid, and use of the stator leak monitoring system. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Control Concepts & the Alterrex Exciter
In this Learning-Doc the learner should be able describe the major components making up the Alterrex and how power is controlled within the generator. Content begins with introductory statements as to the purpose and theory of operation, and continues with the construction of the exciter, the brush rigging, and power rectifiers. Material then continues with descriptions of the excitation controls, describing the major components, thyristor regulation, AC Regulator, DC Regulator, and some related protective devices. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Operation
In this Learning-Doc the learner should be able describe operation of the generator under differing conditions. Discussions include start up pre-checks, procedures for manual and automatic synchronizing, instrumentation, description of the generator reactive capability curves, description of the “V” curves, and use of the saturation and synchronization impedance curves. Discussions will include considerations for loading, unloading and shutdown. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator One-Line Diagram and Protection
In this Learning-Doc the learner should be able describe use of the one-line diagram, functionality of the protective relays and how the generator may be at risk. Discussions include discussions of the information contained on a one-line diagram, use of the R-X diagram, and shutdown considerations. Abnormal conditions described include stator over-current, over voltage, a stator ground, phase-to-phase fault protection, volt-per-hertz protection, field over-excitation, field ground, loss of excitation, negative phase sequence currents, loss of synchronism, abnormal frequency operation, inadvertent energization, reverse power, and use of a distance relay. Each abnormal condition description includes the risk to the generator, instrumentation used, description of the protective relay function, and actions to be taken.
(GE-LSTG) FOSSIL 2-POLE GENERATORS

Generator Fundamentals
At the completion of this Learning-Doc the participant will better understand the purpose of a generator and how the mechanical energy input to the generator is transformed to electrical power. The learner will also learn about kW and kVARs; how they are demanded, how they are generated and how they are transmitted. Content includes an overview discussion, a description of a 2-pole field winding and magnetic field, a description of the stator windings, the creation of a stator winding magnetic field, interaction of the magnetic fields, effect of different load types (resistive, inductive, and capacitive), VAR definitions, power triangle, and an introduction to the capability curve contents.

2-Pole Generator Construction
In this Learning-Doc the learner should be able describe the general construction of a GE-LSTG 2-pole generator construction. Topics include introductory discussions on the nameplate and purpose of the generator, descriptions of the stationary components (core, stationary windings, assembly, an overview of electrical testing, end shields, bearings, hydrogen seals, and instrumentation), descriptions of the rotating components (forging, field windings, hydrogen cooling, collector rings and an overview of electrical testing), and the use of special application instruments.

Generator Vacumm-Type Seal Oil System
In this Learning-Doc the learner should be able describe the major components, operations of the GE-LSTG generator seal oil system, and be able to navigate the system drawings. Topics include description of the seal rings, the seal oil vacuum tank, main seal oil pump, recirculation seal oil pump, emergency seal oil pump, regulation of differential pressures, hydrogen detraining tank, float trap, and the air detraining tank. Discussions include starting the system, normal operations, temporary modes of operation, emergency operations, and use of instrumentation. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Hydrogen Control System
In this Learning-Doc the learner should be able describe the major components, operations of the GE-LSTG hydrogen control system, and be able to navigate the system drawings. Topics include an introduction discussions on why hydrogen, the hydrogen coolers, hydrogen supply, CO2 supply, and instrumentation. Procedural discussions adding CO2 and removing air, adding H2, removing H2 with CO2, and removing the CO2 with air. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Stator Cooling Water System
In this Learning-Doc the learner should be able describe the major components, operations of the GE-LSTG stator cooling water system, and be able to navigate the system drawings. Topics include an introduction to water flow in the system, detailed discussions of the stator cooling water system skid, the deionizer, descriptions of water flow to the generator, instrumentation, filling the reservoir, changing the resin, purpose of the HIT skid, and use of the stator leak monitoring system. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Control Concepts & the Alterrex Exciter
In this Learning-Doc the learner should be able describe the major components making up the Alterrex and how power is controlled within the generator. Content begins with introductory statements as to the purpose and theory of operation, and continues with the construction of the exciter, the brush rigging, and power rectifiers. Material then continues with descriptions of the excitation controls, describing the major components, thyristor regulation, AC Regulator, DC Regulator, and some related protective devices. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Operation
In this Learning-Doc the learner should be able describe operation of the generator under differing conditions. Discussions include start up pre-checks, procedures for manual and automatic synchronizing, instrumentation, description of the generator reactive capability curves, description of the "V" curves, and use of the saturation and synchronization impedance curves. Discussions will include considerations for loading, unloading and shutdown. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator One-Line Diagram and Protection
In this Learning-Doc the learner should be able describe use of the one-line diagram, functionality of the protective relays and how the generator may be at risk. Discussions include discussions of the information contained on a one-line diagram, use of the R-X diagram, and shutdown considerations. Abnormal conditions described include stator over-current, over voltage, a stator ground, phase-to-phase fault protection, volts-per-hertz protection, field over-excitation, field ground, loss of excitation, negative phase sequence currents, loss of synchronism, abnormal frequency operation, inadvertent energization, reverse power, and use of a distance relay. Each abnormal condition description includes the risk to the generator, instrumentation used, description of the protective relay function, and actions to be taken.
**Generator Fundamentals**
At the completion of this Learning-Doc the participant will better understand the purpose of a generator and how the mechanical energy input to the generator is transformed to electrical power. The learner will also learn about kW and kVARs; how they are demanded, how they are generated and how they are transmitted. Content includes an overview discussion, a description of a 2-pole field winding and magnetic field, a description of the stator windings, the creation of a stator winding magnetic field, interaction of the magnetic fields, effect of different load types (resistive, inductive, and capacitive), VAR definitions, power triangle, and an introduction to the capability curve content.

**7FH2 Type Generator Construction**
In this Learning-Doc the learner should be able describe the general construction of a GE 7FH2 type 2-pole generator. Topics include introductory discussions on the nameplate and purpose of the generator, descriptions of the stationary components (core, stationary windings, assembly, an overview of electrical testing, end shields, bearings, hydrogen seals, and instrumentation), descriptions of the rotating components (forging, field windings, hydrogen cooling, collector rings, and an overview of electrical testing), and the use of special application instruments.

**Generator Seal Oil System**
In this Learning-Doc the learner should be able describe the major components, operations of the GE 7FH2 generator seal oil system, and be able to navigate the system drawings. Topics include description of the seal rings, regulation of differential pressures, hydrogen detraining tank, float trap, and the air detraining tank. Discussions include starting the system, normal operations, temporary modes of operation, emergency operations, and use of instrumentation. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

**Generator Hydrogen Control System**
In this Learning-Doc the learner should be able describe the major components, operations of the GE 7FH2 hydrogen control system, and be able to navigate the system drawings. Topics include discussions on why hydrogen, the hydrogen coolers, hydrogen supply, CO2 supply, and instrumentation. Procedural discussions adding CO2 and removing air, adding H2, removing H2 with CO2, and removing the CO2 with air. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

**Generator Control Concepts & Excitation**
In this Learning-Doc the learner should be able describe the major components making up the exciter and how power is controlled within the generator. Content begins with introductory statements as to the purpose and theory of operation, and continues with the construction of the exciter, the brush rigging, and power rectifiers. Material then continues with descriptions of the excitation controls, describing the major components, AC Regulator, DC Regulator, and some related protective devices. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

**Generator Operation**
In this Learning-Doc the learner should be able describe operation of the generator under differing conditions. Discussions include start up pre-checks, procedures for manual and automatic synchronizing, instrumentation, description of the generator reactive capability curves, description of the “V” curves, and use of the saturation and synchronization impedance curves. Discussions will include considerations for loading, unloading and shutdown. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

**Generator One-Line Diagram and Protection**
In this Learning-Doc the learner should be able describe use of the one-line diagram, functionality of the protective relays and how the generator may be at risk. Discussions include discussions of the information contained on a one-line diagram, use of the R-X diagram, and shutdown considerations. Abnormal conditions described include stator over-current, over voltage, a stator ground, phase-to-phase fault protection, volts-per-hertz protection, field over-excitation, field ground, loss of excitation, negative phase sequence currents, loss of synchronism, abnormal frequency operation, inadvertent energization, reverse power, and use of a distance relay. Each abnormal condition description includes the risk to the generator, instrumentation used, description of the protective relay function, and actions to be taken.
(GE) AIR COOLED GENERATORS (as found coupled to 7EA gas turbines and A10 steam turbines)

Generator Fundamentals
At the completion of this Learning-Doc the participant will better understand the purpose of a generator and how the mechanical energy input to the generator is transformed to electrical power. The learner will also learn about kW and kVARs; how they are demanded, how they are generated and how they are transmitted. Content includes an overview discussion, a description of a 2-pole field winding and magnetic field, a description of the stator windings, the creation of a stator winding magnetic field, interaction of the magnetic fields, effect of different load types (resistive, inductive, and capacitive), VAR definitions, power triangle, and an introduction to the capability curve contents.

TEWAC Generator Construction
In this Learning-Doc the learner should be able describe the general construction of a GE totally enclosed water to air cooled 2-pole generator. Topics include introductory discussions on the nameplate and purpose of the generator, descriptions of the stationary components (core, stationary windings, assembly, an overview of electrical testing, end shields, bearings, hydrogen seals, and instrumentation), descriptions of the rotating components (forging, field windings, hydrogen cooling, collector rings and an overview of electrical testing), and the use of special application instruments.

Generator Control Concepts & Excitation
In this Learning-Doc the learner should be able describe the major components making up the exciter and how power is controlled within the generator. Content begins with introductory statements as to the purpose and theory of operation, and continues with the construction of the exciter, the brush rigging, and power rectifiers. Material then continues with descriptions of the excitation controls, describing the major components, AC Regulator, DC Regulator, and some related protective devices. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator Operation
In this Learning-Doc the learner should be able describe operation of the generator under differing conditions. Discussions include start up pre-checks, procedures for manual and automatic synchronizing, instrumentation, description of the generator reactive capability curves, description of the “V” curves, and use of the saturation and synchronizaton impedance curves. Discussions will include considerations for loading, unloading and shutdown. Common alarm discussions include the implication of each alarm, probable causes, instrumentation, and actions to be taken.

Generator One-Line Diagram and Protection
In this Learning-Doc the learner should be able describe use of the one-line diagram, functionality of the protective relays and how the generator may be at risk. Discussions include discussions of the information contained on a one-line diagram, use of the R-X diagram, and shutdown considerations. Abnormal conditions described include stator over-current, over voltage, a stator ground, phase-to-phase fault protection, volts-per-hertz protection, field over-excitation, field ground, loss of excitation, negative phase sequence currents, loss of synchronism, abnormal frequency operation, inadvertent energization, reverse power, and use of a distance relay. Each abnormal condition description includes the risk to the generator, instrumentation used, description of the protective relay function, and actions to be taken.
TRAINING MANUALS

UNDERSTANDING GENERATORS................................................................. US$49
Authored by Harold Parker

Learn what armature reaction is. Learn how armature reaction affects unit terminal voltage. Learn how armature reaction affects unit frequency. Learn how electrical power is generated. In the 1990's HPC instructors started to become frustrated over how many personnel in the power generation industry do not understand basic electrical generation. So this book was authored, authored by a Mechanical Engineer so he can understand, so everyone can understand.

TOPICAL OUTLINE: Rotor Windings • Field Current • Magnetism • Stator Windings • Generator Voltage • Terminal Voltage • Armature Reaction • Armature Reaction versus Torque • Rotor Angle • Different Loads • Voltage Drops • Demagnetizing Fields • Magnetizing Fields • Role of the Speed Governor • Role of the Auto Voltage Regulator.

GENERATORS: NORMAL/ABNORMAL OPERATIONS.................................. US$159
Authored by Harold Parker

Learn proper procedures for generator operation, the purpose of auxiliary systems, the use of capability and “V” curves, how generators are monitored and proper response to frequency and voltage deviations. For each alarm condition there will be discussions on likely damage, protective relaying, proper annunciation, alarm validation (where possible) and the most correct action. Discussions are applicable for hydro, gas, diesel, and steam turbine drives.

TOPICAL OUTLINE: Generator Theory (Lite) • Power System Operations • Generator Construction • Generator Operation • Synchronizing • Generator Abnormal Operations such as Over Temperature • Voltage Deviation • Frequency Deviation • Loss of Excitation • Negative Phase Sequence • Grounds • Short Circuits • Differential Currents • Accidental Energization • Motoring.

TURBINE-DRIVEN GENERATORS: THEORY, CONTROLS, OPERATION, MAINTENANCE & TESTING................................................... US$289
Authored by Harold Parker with significant input from AGT Services and others

This text supports a course, of the same name, that is intended to provide those answers to the many tough questions surrounding generator O&M. This course covers all aspects of generator O&M like no other course offered (by the OEM or otherwise). This course practices two of HPC's beliefs: (1) When it comes to maintenance, the generator is a mechanical thing (learn why and how). (2) There are no small problems on the generator (all are major and we needed to be prepared to deal with them).

TOPICAL OUTLINE: Generator Theory • Generator Theory (Lite) • Systems Operation • Generator Auxiliaries • Generator Excitation Systems & Controls • Normal Operations • Abnormal Operations • Generator Construction • Planning and Scheduling Generator Outages • Disassembly • Visual Inspection • Reassembly • Resistance Testing • Dielectric • Absorption Testing • DC Current Leakage Test • Dissipation Factor Test • Radio Noise Test • High Potential Testing • Ring Test • Polarization Index • EL-CID.

STEAM TURBINES

STEAM TURBINE GENERATOR FUNDAMENTALS...................................... US$149
Authored by Dan Anderson, Ray Militello and Harold Parker

Learn the fundamentals of steam turbine generator operations and maintenance. Emphasis is on construction and the purpose/function of individual major components.

TOPICAL OUTLINE: Power Plant Cycles • Turbine Theory • Components • Inlet Valves • Controls • Generator Theory • Generator Components • an Introduction to Voltage Regulator • an Intro to Auxiliary Systems • Operating Parameters.

STEAM TURBINE GENERATOR MAINTENANCE....................................... US$249
Authored by Harold Parker, revised by Ray Militello with input from Bob Doughty and Doug Lemmo

Prepare for steam turbine generator outages by having a thorough understanding of the equipment and what maintenance activities need to be performed. Reduce outage length, reduce extensions, minimize work duplication or rework. Increase intervals between outages, reliability, availability and productivity.

TOPICAL OUTLINE: Planning and Scheduling • Turbine Shell/Casing/Rotor Maintenance • Journal and Thrust Bearing Maintenance • Coupling Maintenance • Steam Valve Maintenance • Generator Maintenance • Alignment • Job Wrap Up.
STEAM TURBINE OPERATION PRACTICES & ALARM RESPONSE

When things go wrong, with respect to steam turbine operations, they go wrong quickly! Learn fundamental operations, what is considered to be normal, and preventive operating practices. Knowing this, we can now better assess alarm conditions by understanding the alarm source, the probable results and actions to be taken.


STEAM TURBINE ADVANCED MAINTENANCE TOPICS

In any major outage, beyond routine decision making regarding disassembly/reassembly/inspection, there are those decisions that require significant thought or outside evaluation. These decisions are typically associated with steam path performance, steam path distortion, crack evaluation decisions, vibration related issues, control system issues, and making/reporting decisions based upon cost data. It is our intent to make decision making more effective on these topics.

TOPICAL OUTLINE: Review of Steam Turbine Thermodynamics • Performance Analysis • Steam Path Audits • Thermal Stress • Steam Path Crack Causes, Evaluation & Repair • Steam Path Upgrade Decision Making • Vibration Analysis High Spot Theory • Types of Turbine Vibration Symptoms, Causes and Solutions • Balancing Techniques • Low Speed Balancing • Concepts of Turbine Speed, Load and Pressure Control • Turbine Protection • Incremental Regulation • Engineering Economic Evaluation of Upgrades/Repair Decisions.

(GE) MHC STEAM TURBINE CONTROLS

This text describes operations but emphasizes maintenance, calibration procedures, techniques used during troubleshooting.

TOPICAL OUTLINE: Mechanical Hydraulic Amplifiers • Speed/Load Control • Limiters • Reheat Controls • Extraction Pressure Controls • Emergency Trip System • Troubleshooting • Procedures.

GAS TURBINES

COMBINED CYCLE PLANT FUNDAMENTALS

This text is directed toward personnel new to a combined cycle power plant. Learn about the combined cycle process (from fuel to electrical power) as well as the purpose and function of each major component within the combined cycle power plant.


COMBUSTION TURBINE GENERATOR FUNDAMENTALS

The text addresses the basic theory of gas turbine operation, the construction of a typical gas turbine, and basic operation. This text serves as an excellent introduction to operations and maintenance.

TOPICAL OUTLINE: Thermodynamic Principles, Turbine Fundamentals, Compressor, Combustion Section, Turbine, Exhaust, Support Systems, and an Intro to Gas Turbine Controls.

COMBINED CYCLE TURBINE GENERATOR FUNDAMENTALS

The text addresses the basic theory of gas turbine operation, the construction of a typical gas turbine, and basic operation. The text further addresses basic theory and construction of those steam turbines found in combined cycle applications. This text serves as an excellent introduction to operations and maintenance.

HYDROELECTRIC

HYDRO TURBINE GENERATOR O&M

Learn effective and safe operating procedures, turbine maintenance, generator maintenance and alignment.

TOPICAL OUTLINE: Power System • Hydraulic Turbines • Turbine Controls • Generators • Maintenance Principles • Visual Inspection • Alignment Considerations • Alignment of Vertical Shafts • Coupling Alignment.

ELECTRICITY FOR NON-ENGINEERS

This text is designed for all that need to better understand how to work around and with electrical systems. Do you need to work around or on electrical systems at your industrial plant or building (owners/maintenance personnel of apartment buildings included)? If you do, you should learn to work wisely and safely.

TOPICAL OUTLINE: Electrical Fundamentals • Safety Issues • Test Equipment • Use of Test Meters • Understanding Building Electrical Systems • National Electric Code • Wire Selection • Running Wire • Installing and Wiring Equipment • Intro to Troubleshooting and Maintenance.

ELECTRICAL TROUBLESHOOTING & PREVENTIVE MAINTENANCE

This text is designed to provide the minimum knowledge required in the development of troubleshooting effectively. Additionally, to hone your knowledge of troubleshooting, a myriad of circuits will be used that represent the ones that you will most likely come in contact with.

TRAINING REGISTRATION FORM

HPC TECHNICAL SERVICES
406 43rd Street West
Bradenton, FL 34209
Telephone: 941-747-7733
FAX: 941-746-5374
Website: www.hpcnet.com

Company: ____________________________
Plant: ____________________________
Address: ____________________________
City/State/Zip: ____________________________
Telephone: __________________ Fax: __________________
Course Number/Title: __________________
Course Dates: ___/___/___ thru ___/___/___
Course Location: __________________ Course Fee: __________________

PLEASE ENROLL THE FOLLOWING INDIVIDUAL(S) LISTED BELOW:

Student #1: ____________________________ E-mail: __________________
Student #2: ____________________________ E-mail: __________________
☐ Taking advantage of HPC’s 3-4-2 Policy: Send 3, Pay for 2 when paying in advance.
Student #3: ____________________________ E-mail: __________________
Enrolled by: ____________________________ E-mail: __________________
Date: ____________________________

METHOD OF PAYMENT

☐ Check to Follow: ____________________________
☐ Check Enclosed #: ____________________________
☐ MC/Visa/AMEX #: ____________________________
 Examiration Date: __________________ CV Code: __________________
☐ Purchase Order #: ____________________________
TRAINING MANUAL ORDER FORM

Company: 
Plant: 
Address: 
City/State/Zip: 
Telephone: 
Fax: 

METHOD OF PAYMENT

☐ Check to Follow: 
☐ Check Enclosed #: 
☐ MC/Visa/AMEX #: 
   Expiration Date: 
   CV Code: 
☐ Purchase Order #: 

Catalog Number        Unit Price   Qty      Amount
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Subtotal: ______________________
Florida Residents Add Sales Tax
Sales Tax: ____________________
Plus Shipping & Handling
S&H: _________________________
Total Due: ____________________
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# 2019 Open Enrollment Training Schedule

(Sorted by Course Topic)

*** Course Dates/Prices/Locations subject to change without notice ***

<table>
<thead>
<tr>
<th>Course #</th>
<th>Course Name</th>
<th>Start Date</th>
<th>Length</th>
<th>Location</th>
<th>Price (US$)</th>
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</tbody>
</table>
Where is HPC located?

HPC Technical Services

406 43rd Street West
Bradenton, Florida 34209
USA