



500 Tallevast Road • Suite 101  
Sarasota, FL 34243 USA  
Tel: 941-747-7733 • Fax: 941-746-5374  
[www.hpcnet.com](http://www.hpcnet.com)

## Course Information Letter ---- TG401

### STEAM TURBINE MAINTENANCE FOR ENGINEERING TOPICS TG401

HPC's standard Steam Turbine Generator Maintenance course offering (TG301) deals with the routine aspects of a steam turbine generator outage. This course goes above and beyond. In this 'advanced' course HPC deals with the need to understand what goes on in a steam path audit, why it might be important, and how to proceed. Furthermore, we have found that too often maintenance personnel aren't prepared to deal with some relevant operations and controls issues. So in this course we present basic materials on steam turbine controls and the conditions under which thermal stress exists. Sometimes steam path alignment is not so routine. This course deals with abnormalities associated with steam path alignment, specifically distortion and how to measure the level of distortion as well as possible corrective (or compensating) actions. Balancing steam turbines is somewhat of an "art" and a "science", in this course we will take one-day and fully explain the "science" so the maintenance engineer is more capable to deal with vibration issues as they occur. Finally, decision making is often based upon the financial implication of the situation, so this course will better prepare the engineering staff to equate the mechanical difficulties to \$\$ and cents, through a brief overview of engineering economics.

**Are these issues important? If yes, this may be an opportunity to answer all these questions and more, in one setting.**

- Steam Turbine Performance Audit
- Steam Turbine Controls
- Thermal Stress
- Steam Path Alignment
- Steam Turbine Vibration Analysis & Balancing
- Decision Making Based Upon Financial Implications
- Report Writing

**Note:** An engineering degree is not a prerequisite to attendance, but experience is suggested. This course should be considered as a natural extension to our popular Steam Turbine Generator Maintenance Course, TG301, or our Steam Turbine Overhauls Course, TG316.

### COURSE DATES/LOCATION/FEE

For current dates / locations / prices, please see HPC's website, [www.hpcnet.com](http://www.hpcnet.com).

## OBJECTIVES:

1. Describe the design and operation of a turbine stage using thermodynamic principles.
2. Describe how stage performance can deteriorate and how this deterioration is detected and corrected.
3. Describe packing designs that provide variable clearances from start up to full load operations.
4. Describe two methods to determine leakage flow on opposed flow steam turbines.
5. Demonstrate a fundamental understanding of the erosion mechanisms in the steam path.
6. Describe thermal stress, how it is derived and what is the impact upon steam turbine components.
7. Describe how one can minimize the negative impact of thermal stress while minimizing start up times.
8. Describe the importance of Fracture Appearance Transition Temperature.
9. Demonstrate the ability to interpret the OEM starting and loading instructions.
10. Describe shell distortion and how it affects centerline alignment issues.
11. Describe two methods used to compensate for shell distortion during centerline component alignment.
12. Describe fundamental terms and concepts important to vibration analysis.
13. Demonstrate the ability to relate the use of vibration measuring instruments to your applications.
14. Describe normal conventions used during balancing and how they relate to your equipment.
15. Demonstrate the ability to calculate a “first-shot” using the “one-shot method” for calculating balance weight locations.
16. Demonstrate the ability to calculate a “second-shot” using the “measured effect method” for calculating balance weight locations.
17. Demonstrate the ability to translate calculated weight information to the actual installation of weights on any given rotor.
18. Demonstrate the ability to conduct a “low-speed balancing” program on a bowed rotor.
19. List those major components that have a direct bearing on the operations and/or reliability of steam turbine controls.
20. Describe how steam turbine governors function off-line.
21. Describe how steam turbine governors function on-line.
22. Describe how steam turbine governors function on-line and being responsive to grid conditions.
23. Describe how steam turbine governors function on-line when programmed to not be responsive to grid conditions.
24. Describe steam turbine governor response to overspeed conditions.
25. Describe operation of typical servomechanisms such as the Abex and Moog Servovalves.
26. Describe the relationships between steam flow and valve positioning.
27. Describe how to perform economic evaluations of the available repair/replace options in order to determine which will optimize maintenance expenditures and maximize return on investment.
28. Describe those elements important to the writing of an outage report.

## COURSE SYNOPSIS

### Monday

**Thermodynamic Review:** Properties of a fluid, Cycles, Sankey Diagram, Heat Balance Diagrams, Turbine Stage, Acceleration of Steam, Losses, LSB Designs, N2 Packing, Positive Pressure Variation Packing.

**Steam Path Analysis, Audit and Evaluation:** Causes of Loss of Efficiency, Evaluating Performance Loss, Restoring Thermal Performance, Diagnostics, Example Steam Path Audit.

### Tuesday

**Thermal Stress: Definitions, Starting & Loading Instructions, Decision Making re Starting/Shutdown Procedures.**

**Advanced Alignment Topics: Deviation** from Standard Practices, Joint Measurements, Data Collection as an Analysis for Distortion.

### Wednesday

**Turbine Generator Vibration Analysis & Balancing:** Definitions, Conventions, Data Collection, High Spot Rotation, Analysis of HS Rotation, Static / Couple Components, Balancing Decision Making, 1st Shot Calculation, Measured Effect Balancing, Shot Resolution

**Types of Turbine Vibrations, Symptoms, Causes & Solutions:** Rubbing, Coupling, Alignment, Oil Whip, Thermal Sensitivity, Non-Synchronous Frequencies

**Low Speed Balancing:** Bowed Rotors, Detection, Analysis, Equipment Setup, Avoiding Mistakes, Centerspan Calculation

### Thursday

**Steam Turbine Control Concepts:** Turbine Control Components, 3-Laws of Steam Turbine Controls, Speed Control Concepts, Load Control Concepts, Pressure Control Concepts, Overspeed Protection Concepts, Need for Incremental Regulation, Upgrade Considerations

### Friday

**Engineering Economics:** Basic Concepts of the Evaluation of Money, Fixed Outage Charges, Payback Analysis re Replace/Repair/Reuse Decisions, Outage Cost Considerations, Recoverable versus Non-Recoverable Outage Costs.

**Report Writing:** A reminder of the value and costs of a valuable outage report.

## FREQUENTLY ASKED QUESTIONS

- Will HPC Technical Services bring this course to our location for our personnel only? YES, call or email Stephen Parker, [stparker@hpcnet.com](mailto:stparker@hpcnet.com) for a price quotation.
- Will HPC Technical Services customize the presentation at our site to suit our particular needs? Yes.
- Is HPC Technical Services' textbook available for purchase as a reference document? Yes. \$195 + S&H.
- What is the cost for HPC Technical Service to deliver this course at our location? Well, of course that can vary, but generally speaking, if you're planning on having 6+ attend, when considering your T&L, it is to your advantage to perform the course at your plant (office). You gain from the customization and price.
- Can HPC Technical Services provide "Technical Assistance" in troubleshooting vibration problems on your equipment? In providing technical assistance in balance weight location? Yes we can. Call or contact Harold Parker, [hparker@hpcnet.com](mailto:hparker@hpcnet.com) for our rate sheets and any further information required.

## WHAT YOU WILL RECEIVE:

1. 1 copy of HPC Technical Services' textbook, Advanced Steam Turbine Maintenance, a \$195 value, as written by Harold Parker.
2. A "Certificate of Completion" with 2.3 CEUs, authorized for issue by the International Associate of Continuing Education/Training.

## STEAM TURBINE MAINTENANCE CERTIFICATION:

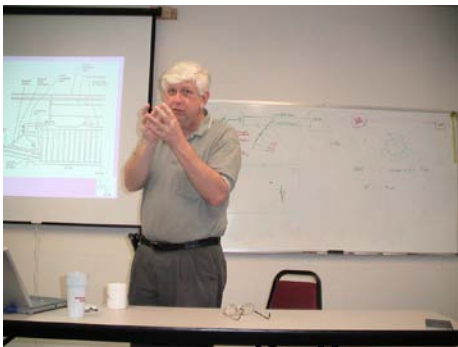
There are two levels of certification (Both levels require this course):

1. Engineer
2. Mechanical Technician

Those who attend this course are automatically qualified to take HPC Technical Services' Certification Examination. This examination is offered at no additional expense to the participant. An 80% passing grade is required. The examination length will not exceed 2-hours. Those who complete this examination will receive a revised "certificate of completion" that recognizes this accomplishment along with two-copies of a "To Whom It May Concern" letter that states their accomplishment. (Two copies are provided, one for the participants' employer and one for the participants' personal file.)

Consult HPC's website, [www.hpcnet.com](http://www.hpcnet.com), for detail on this certification program.

## INSTRUCTOR (S):



**Harold Parker** is the founder & President of H Parker & Company, Inc. Mr. Parker, along with Mr. Douglas Lemmo (see below) were significant contributors to the development of the Steam Turbine Generator Maintenance training program used by GE for the "advanced" training of their field engineering force. Mr. Parker has worked in the "Power Generation" industry for 36 years, 14-years with GE as a Field Engineer, Start-Up Engineer, Technical Training Specialist and Manager. In 1983 Mr. Parker resigned from GE and started a training company, Schenectady Learning Systems, in Schenectady NY, which evolved into H Parker & Company, Inc. today. During this post-GE period, Mr. Parker was briefly employed as Manager Turbine-Generator Services with General Physics (2-years) and as a Field Engineer with Mechanical Dynamics & Analysis (2-years). Mr. Parker is the primary contributor to the development of the text used in this course presentation. Mr. Parker holds a BSME ('69 from Lawrence Institute of Technology), a MBA ('81 from the State University of New York @ Albany) and is a member of ASME.

## Steam Turbine Maintenance for Engineering Topics – TG401

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**Robert Doughty**. Mr. Doughty has more than 30 years of experience in start up, maintenance and operation of both large and small turbine-generators. Bob started his career as a power plant instrumentation technician while he completed his BS degree in Engineering Technology (1976) at the University of Houston. He has worked as a start up and field engineer for one of the major turbine-generator OEM's and as a consulting engineer, supporting the initial operation of two nuclear fueled power plants. He also was the field-engineering supervisor with overall responsibility for construction testing, initial start up and operations of a 600 MW coal fired generating plant. Later, as an employee of one of the larger independent turbine-generator service corporations, he worked as a start up and maintenance engineer on turbine-generators of all sizes from nearly all the major manufacturers. His most recent position (1999) as the President of Turbine Services, Inc., has allowed him to continue to provide on site technical direction, start up and controls adjustments for several major turbine inspections in the range of 35 to 835 MW. He is experienced in electro-hydraulic and mechanical governor control systems and turbine valve and control system up-grades. Bob is a member of ASME (18 years) and has worked closely with HPC on multiple projects, training as well as field service.



**Douglas Lemmo, PE**. Mr. Lemmo has 35 years experience in the power generation industry, 31 of them with GE. Within GE he was initially employed as a field engineer (1971-1976). Here he was responsible for the installation and startup of a number of large and medium steam turbine generators and the feed pump turbines. In addition to this installation work, Mr. Lemmo also performed maintenance service on a variety of nuclear, fossil and marine turbine units. After leaving the field, Mr. Lemmo taught in GE's Field Engineering Development Center. Here his specialty was steam turbine generators, installation, alignment and maintenance. After a couple years instructing, he accepted a position selling maintenance and repair services. In 1982, Mr. Lemmo was the Project Manager for a Waste-to-Energy site. Later projects included a modernization of a hydroelectric facility and the management of the installation of a few combined cycle sites. In 2002, Doug left GE and founded Power Generation Consulting Services, which focuses primarily on the operation, maintenance and repair of steam turbine generators. In this last position, Doug has been closely aligned with HPC as he has instructed many of our courses and provided site-engineering support on HPC contracts.



**John Mitchell**. John Mitchell is a multi-talented leader with over 33 years management, engineering, installation and maintenance experience in thermoelectric power plants. He is especially an expert in steam turbines, generators and their controls. Prior to June 2003 (when he accepted an early retirement package from GE), John was a Customer Training Specialist with the GE International Department. Other past responsibilities included being Manager, Engineering Services, Senior Application Engineer, Senior Service Engineer, Lead Training Specialist, Program Support Engineer, Instructor Technical Training, and Field Engineer. All of this on operation & maintenance of steam turbine generator hardware and controls. John resides in Schenectady NY.

**Bob Johndrow** hired into GE as a field engineer in 1969. That was 36-years ago. Since that date, Bob Johndrow has been a GE Field Engineer specializing in many disciplines including Generator Maintenance and Testing. Bob completed GE's Generator Specialist Training Program early in his career. Since then he has been involved in the commissioning of several steam turbine generators where he was responsible for the turbine controls, auxiliaries, startup sequence and the generator. Bob earned a BS in Industrial Distribution from Clarkson University in Potsdam NY and also has GE Six Sigma Green Belt Certification. Bob accepted an early retirement package late 2003 and has worked as an independent as well as being associated with HPC Technical Services since then. He resides in Rhode Island.

**Joe Byrd**. Joseph Byrd has over 29 years of experience in the power industry, concentrating in the area of turbine-generator controls and operations. He graduated from North Carolina State University in December 1978 with BS in Mechanical Engineering. He began his career in January 1979 as a Field Engineer, and subsequently a Start-Up Engineer with GE and was lead Start-up Engineer on five turbine-generator installations. He left GE in 1986 to consult directly to utilities on control systems calibration and maintenance with MD&A. In June 2008, he ended his relationship with MD&A and became available to HPC to instruct. His primary areas of expertise are GE manufactured Large Steam and Mechanical Drive Turbine MHC control systems as well as EHC systems. Joe resides near Raleigh NC.

**HPC TECHNICAL SERVICES**  
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**Website: [www.hpcnet.com](http://www.hpcnet.com)**

**REGISTRATION FORM**

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: \_\_\_\_\_

Student #2: \_\_\_\_\_

**Taking advantage of HPC's 3-4-2 Policy: Send 3, Pay for 2 when paying in advance.**

Student #3: \_\_\_\_\_

**Enrolled by:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**METHOD OF PAYMENT**

Check to Follow: \_\_\_\_\_

Check Enclosed #: \_\_\_\_\_

MC/Visa/AMEX #: \_\_\_\_\_

Expiration Date: \_\_\_\_\_ CV Code: \_\_\_\_\_

Purchase Order #: \_\_\_\_\_

**HOW DID YOU LEARN OF THIS COURSE?**

Attended HPC courses before

Received an email

Received a fax

Received an update mailing

Internet search

Other: \_\_\_\_\_