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.
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
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.
(GE) FRAME 7FA GAS TURBINE

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, wheelspac e, 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 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) FRAME 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 Lubricating 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.
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 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 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 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 begins 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 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 beings 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.
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 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, voltpere-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 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, 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 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 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.