



LM6000 Generator Set Familiarization/Basic Operator Course – 02/03/00

Purpose

This proposal defines the objective, scope of work and agenda for the SSEP Engine Familiarization/Basic Operator Course, to be specifically developed for the customer's LM6000 Gas Turbine Generator Set. The training will cover the LM6000 Engine Familiarization and Generator Set basic Operations. This proposal is not intended to be a complete and final training program. It is however, a proposal to provide training services for customer requirements, as they were understood at the time of publication.

Scope of Work

SSEP will provide the necessary training instructor, student manual, and visual aids to perform the Operator training. The course can be presented either at the SSEP facility in Houston, Texas or at the client facility. SSEP Training Specialist will use the customers' equipment drawings & technical manuals to develop specialized lesson plans in support of the customers' equipment.

Student Qualifications and Experience

For the purpose of this training proposal, students are assumed to have at least a journeyman's knowledge of electrical generating plant operation. Also the students are assumed to be proficient in reading piping flow and instrument drawings, mechanical drawings, and have a working knowledge of electrical generators, and gas turbine engines.

Responsibilities

SSEP will be responsible for the development, scheduling, and coordination of the class. SSEP will also be responsible to provide all necessary training equipment (classroom, 35mm projectors, overhead projectors, VHS or PAL format video player, dryboards, chalkboard, etc) if the class is held at the SSEP facility in Houston, Texas. If the class is held at the client facility the client will be responsible to provide all necessary training equipment (air conditioned classroom, 35mm projector, VHS or PAL format video player, overhead projector, dryboards, chalkboards, etc).

Training Aids and Manuals

Each major topic will be supported by training literature, which will include detail descriptions, associated one-line diagrams, simplified schematics and engineering drawings. A student-training manual will be given to each student and one copy will be given for the client file. Color and black and white 35mm projection slides and/or overhead projection transparencies will be used to present the materials.

Course Presentation Method

The SSEP trainer conducts the course in a lecture/seminar format. The client's Turbine-Generator System will be used for hands-on training to supplement the classroom instruction. Each topic is presented to the student by the trainer and a trainer/student discussion on the topic follows. Student attending the Basic Operators Course will be given examinations. At the completion of several related topics the students are given a progressive examination. The instructor to measure the effectiveness of the presentation and as a tool to identify any student that is not grasping the course material uses these progressive examinations. At the completion of the course a final examination is given to the students. This final examination covers the entire course material and is used as a measure of the course effectiveness and students performance.

Course Length

The courses convene for eight hours per day with a one-hour lunch break and fifteen-minute breaks every one and one half-hours. The start time for the class is normally eight AM and finishes for the day at four PM. The actual course length and time can be extended to meet the client's needs.

- 5-Days – LM6000 Engine Familiarization/Basic Operators Course

Training Completion Report and Certificates

At the end of the training course, a "Training Completion Report" will be given to the client. This report provides key information about the class, including special problems, test results, and instructor comments. Upon successful completion of the course, students will be issued "Certificates of Completion" containing S&S seal and signature.

Engine Familiarization/Basic Operator Course Objectives

The course objective is to provide the plant operating personnel the necessary fundamental information to:

- Introduce the students to the LM6000 gas turbine and its components. Provide students with a basic knowledge of the system design, theory of operation and operating procedures.
- Understand the function of each gas turbine generator system components, its computerized control and its relationship to the overall operation of the Turbine generator package.
- Perform startup, shutdown and system monitoring operations.
- Understand turbo-generator system operating parameters and maintain the operating parameters for maximum turbine generator efficiency.

NOTE: The proposed Operator training course does not include, and is not intended to include maintenance, troubleshooting or repair of the Gas Turbine Generator system or components.

Basic Operators Course Topics

For the purpose of this training proposal, the following is a list of course topics for the LM6000 Engine Familiarization/Basic Operator Course,

DAY 1

- **INTRODUCTION**

- **GAS TURBINE ENGINE**

- Gas Turbine Theory of Operation
- LM6000 Details of Construction

- **GAS TURBINE SUPPORT SYSTEMS**

- **Equipment Drawings** – Discuss dwg. symbols for Electrical and Mechanical type dwgs. Review abbreviations and system Reference dwgs.
 - **Turbine Lube Oil System** – Discuss system theory of operation and flow logic. Review System physical configuration using F&ID dwg. Discuss operator interface and system monitoring screens. Review Exams and material covered.
 - **Hydraulic Start System** – Discuss system theory of operation and component flow logic. Review system configuration using F&ID drawings. Discuss operator monitoring screens and controls.
 - **Hydraulic System** – Discuss IGV's, VSV's, VBV's and Fuel Valves operation and flow logic. Discuss system monitoring of I/O and Feedback Signals.
 - **Fuel System** – Discuss Fuel Valve positioning and Feedback signals. Fuel Flow Logic for Liquid and Gas fuel systems. Fuel Transfer capabilities. And system components (i.e. Shutoff Valves, Temperature and Pressure sensors, Fuel Nozzles, Fuel Manifolds, CDP Purge system, etc.).
 - **Compressor Water Wash System** – Discuss requirements for compressor Water Washing. Flow logic for "On-Line" and "Off-Line" wash cycles. Component components identified with system F&ID drawing.
- **SITE VISIT** and review system configuration using F&ID drawings and actual component tag system.
 - **ADMINISTER PROGRESSIVE EXAMS**
 - Exam #1 – Turbine Fundamentals
 - Exam #2 – Turbine Lube Oil system
 - Exam #3 – Hydraulic Start System
 - Exam #4 – Hydraulic System
 - Exam #5 – Fuel System
- Review exams and material covered.**

**Basic Operators Course
Topics (Cont)**

DAY 2

- **TURBINE AND GENERATOR SUPPORT SYSTEMS**
 - **Ventilation and Combustion Air System** - Discuss flow logic for Turbine Combustion Air and Enclosure cooling air. Discuss flow logic of Generator Cooling Air system. Review system configuration and components using F&ID drawing.
 - **Fire Protection System** – System configuration, detection components, sensor placement and system response logic. Operator system precautions, checks and component resets after CO₂ discharge.
 - **Vibration Monitoring System**- System configuration, interpretation of displayed data for diagnostics purposes, sensor descriptions and placement, theory of vibration principles and system response to “Alarm” and “Shutdown” limits.
- **SITE VISIT** control room and observe how fire protection system and vibration system interface with system controls. In turbine and generator enclosure use F&ID dwgs. To familiarize operators with system configuration. Demonstrate precautions, pre-checks and return a system to operation following a fire system CO₂ release.
- **ADMINISTER PROGRESSIVE EXAMS**
 - Exam #6 – Ventilation and Combustion Air System
 - Exam #7 – Fire Protection System
 - Exam #8 – Vibration Monitoring System**Review exams and material covered**

DAY 3

- **ELECTRICAL SYSTEM**
 - **Electric Generator Theory of Operation** – Discuss Magnetic fields, current flow, single and three phase generators, and speed Vs frequency relationship.
 - **Electric Generator Details of Construction** – Show system illustrations of generators internal component configuration. Discuss major component assemblies, i.e. Main Rotor, Exciter and Diode Assembly, Bearing Seal System and temperature sensors.
 - **Generator Lube Oil System** – Discuss Flow Logic and operation of Lube Oil System. Cooling and lubrication requirements. Interpretation of bearing temperatures for trouble detection diagnostics. Component configuration and System Instrumentation.
 - **Power Control and Synchronization** – Discuss power Distribution, Transformers, Circuit Breakers, Equipment interfaces, Generator Controls, Excitation Controls, and Voltage Regulator.

Basic Operators Course Topics (Cont)

- **SITE VISIT** generator enclosure and operator control room. Use F&ID drawings and locate instrumentation components and lube oil system components. Have students determine lube oil flow in system. In control room review operator screens for monitoring generator-operating status, discuss components of voltage regulator, and system MCC panel configuration.
- **ADMINISTER PROGRESSIVE EXAMS**
Exam #9 – Electric Generator Theory and Details of Construction.
Exam #10 – Generator Lube Oil System.
Exam #11 – Generator Control and Synchronization.
Exam #12 – Synchronization.
Review exams and discuss material covered

DAY 4

- **GENERATOR CONTROLS**
 - **Generator Protective Relay System** – Discuss Theory of Operation and system requirements for protection. Using system's One-Line Electrical Diagram, Identification of major system components and how they interface to main control panel. Review of DGP controls and instrumentation.
 - **Motor Control Panel (MCC)** – Discuss layout of a typical Motor Control Center and its purpose. Components of circuit breaker front panel. Review of how a circuit breaker works.
- **AIR COMPRESSOR / AIR DRYER SYSTEM**
 - **Air Compressor / Air Dryer** – Theory of operation and major system components.
- **SITE VISIT** control room and review controls for protective relay panel and motor control center
- **ADMINISTER PROGRESSIVE EXAMS**
Exam #14 – Generator Protective Relay System.
Exam #15 – Motor Control Center.
Exam #16 – Air Compressor / Air Dryer System
Review exams and discuss material

**Basic Operators Course
Topics (Cont)**

DAY 5

- **TURBINE CONTROL SYSTEM**

System Operator Interface – Observe layout of Control Panel sections and discuss operation of all switches, indicator lights and system monitors.

- **Operator Screens** - Demonstration of how to navigate through the multi-layered Operator Screens, for observation of system status and parameter characteristics.
- **Fuel Management System** –Discuss Fuel management System Valve Actuator Interface and Feedback control. Other topics will include the review of the Fuel Control System Schematic, XN25 and XNSD Speed Reference Logic, T48, PS3 and T3 Limiting Control logic, Startup Limiting, Deceleration Limiting, and Fuel Flow Limiting Control Logic.
- **Sequencing Logic** – Using Logic Flow Chart, students cover a Normal Start Sequence and a Normal Stop Sequence. Logic charts indicate system operating parameter and characteristics during sequencing cycle.
- **Operator Overview** – Students are given system-operating scenarios, which they are required to demonstrate correct system response in acknowledging a given condition or correcting the problem.

- **SITE VISIT** control room and get hands-on for control panel switches, indicators and system monitors. Instruct students on how to navigate through operator screens to obtain status and operating conditions of unit.

- **ADMINISTER PROGRESSIVE EXAMS**

Exam #17 – Fuel Management System.

Exam #18 – Operator interface

Review exams and discuss material

- **ADMINISTER FINAL EXAM**

- **COURSE AND FINAL EXAM REVIEW EXAM WITH STUDENTS**

