

Solar[®] Turbines

A Caterpillar Company

TOTAL LIFE CYCLE SUPPORT

A CULTURE OF CUSTOMER CARE



TECHNICAL TRAINING
ELEARNING CATALOG

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SEPTEMBER 2020

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INTRODUCTION

ELEARNING METHODOLOGY

Through the conversion of instructor-led training (ILT) content to eLearning, the development of new content specifically designed for online delivery, and the improvement of digital content delivery services, Solar Turbines Technical Training is rapidly driving innovative digital services that build efficiency, flexibility, and autonomy in the delivery and management of training for their customers. Solar Turbines eLearning services provide learners an opportunity to receive equipment operation and maintenance training through flexible delivery in their time and their space.

Solar's current catalog of eLearning learning plans and units is expansive and continually growing.

LEARNING PLANS

Parallels will often be found between traditional instructor-led training (ILT) courses and the eLearning units available on Solar's learning management system (LMS). While a one-for-one equivalency does not exist between eLearning units and ILT courses or lessons, Solar has assembled learning plans that provide a similar balanced approach to learning. Learning Plans logically group related eLearning units together that compliment and build on one another. The result is a complete and balanced learning experience.

INDIVIDUAL TRAINING UNITS

While the available training units have been grouped into learning plans to help prospective students identify their training requirements, all training units may be purchased individually.

AVAILABLE LEARNING PLANS

TURBOTRONIC 5 CONTROL SYSTEM OPERATIONS

This learning plan is the online version of Solar’s 5-day instructor-led Turbotronic 5 Control System Operations course.

It is designed for package operators or maintenance technicians who are required to perform basic first line control system tasks with minimal guidance from Solar field service. The learning plan will cover the knowledge and skills required to help maintain the package in a serviceable state under several scenarios, including the following:

1. Using the control system program to determine the conditions for package alarms or shutdown
2. Reloading the control system program following a component replacement or system malfunction
3. Loading a revised control system program that may have been received from Solar
4. Modifying Tunable Program Constants
5. The use of the control system indications for basic troubleshooting (for example, the use of module LED’s to verify operation)

The following table lists the training units that comprise this learning plan. It is recommended that all training units are completed.

| | | | |
|---|--------------------------------------|----------|---------------------------------------|
| 1 | Turbotronic 5 Control System | 10211-1 | Control System Overview |
| | | 10211-2 | Control System Hardware |
| 2 | Control System Logic | 10211-3 | Boolean Logic |
| | | 10211-4 | Ladder Logic |
| 3 | Software Applications | 10211-5 | Introduction to Software Applications |
| | | 10211-6 | Offline Program Monitoring |
| 4 | Logix Project Framework | 10211-7 | Logix Project Familiarization |
| | | 10211-8 | Program Structure |
| | | 10211-9 | Tags and Databases |
| 5 | Turbotronic 5 Standards and Security | 10211-10 | Programming Conventions |
| | | 10211-11 | Control System Security |
| 6 | Troubleshooting Methods | 10211-12 | Hardware and Software Interface |
| | | 10211-13 | Troubleshooting Methods |
| | | 10211-14 | Online Functions |

PACKAGE OPERATING PRINCIPLES

This learning plan will provide a turbo-machinery package operator and maintenance technician with the knowledge and skills necessary to operate the package safely and efficiently. This requires a degree of background knowledge of the package systems and system components, the working relationship between the components, and their operating sequences. Therefore, the purpose and function of each of the package major components and support systems will be explained, as well as the components in each system, and the sequences of operation. Common malfunction conditions will be discussed, along with the significance of each, the probable causes, and the recommended action for each condition. The students will thus be able to recognize which abnormal conditions may be influenced and corrected by adjusting operational conditions, and which will require further investigation and "maintenance-based" corrective action.

COMPRESSOR SETS

| | | | |
|----|----------------------------|-------|--|
| 1 | Package Orientation | 50000 | Compressor Package Description |
| 2 | Gas Turbine Engine | 50004 | Gas Turbine Engine Principles and Construction |
| | | 50044 | Gas Turbine engine Control and Operation |
| 3 | Start System | 50005 | Direct AC Start System |
| | | 50007 | Pneumatic Start System |
| | | 50008 | Hydraulic Start System |
| 4 | Lube Oil System | 50008 | Lube Oil System Principles and Hardware |
| | | 50009 | Lube Oil System Operations |
| 5 | Gas Fuel System | 50012 | Gas Fuel Sytem Principles and Hardware |
| | | 50013 | Gas Fuel System Operations |
| 6 | Liquid Fuel System | 50031 | Liquid Fuel Sytem Principles and Hardware |
| | | 50032 | Liquid Fuel System Operations |
| 7 | SoLoNOx Fuel System | 50030 | SoLoNOx Basic Principles |
| 8 | Gas SoLoNOx Fuel System | 50035 | Gas SoLoNOx Fuel System Principles and Hardware |
| | | 50036 | Gas SoLoNOx Fuel System Operations |
| 9 | Liquid SoLoNOx Fuel System | 50037 | Liquid SoLoNOx Fuel System Principles and Hardware |
| | | 50038 | Liquid SoLoNOx Fuel System Operations |
| 10 | Control System | 50026 | Turbotronic Control System Overview |
| | | 50016 | Turbotronic 4 Control System Hardware |
| | | 50017 | Turbotronic 5 Control System Hardware |
| 11 | Compressor Operations | 50018 | Compressor Theory of Operation |
| | | 50021 | Compressor Operations |
| | | 50022 | Compressor Surge Fundamentals |
| 12 | Seal System | 50019 | Compressor Dry Seal System |
| | | 50020 | Compressor Wet Seal System |
| 13 | Maintenance | 50014 | Compressor Package Operating Procedures |
| | | 50025 | Package Maintenance Principles |

GENERATOR SETS

| | | | |
|----|----------------------------|-------|--|
| 1 | Package Orientation | 50001 | Generator Package Description |
| 2 | Gas Turbine Engine | 50003 | Gas Turbine Engine Principles and Construction |
| | | 50043 | Gas Turbine engine Control and Operation |
| 3 | Start System | 50005 | Direct AC Start System |
| | | 50007 | Pneumatic Start System |
| | | 50008 | Hydraulic Start System |
| 4 | Lube Oil System | 50010 | Lube Oil System Principles and Hardware |
| | | 50011 | Lube Oil System Operations |
| 5 | Gas Fuel System | 50012 | Gas Fuel Sytem Principles and Hardware |
| | | 50013 | Gas Fuel System Operations |
| 6 | Liquid Fuel System | 50031 | Liquid Fuel Sytem Principles and Hardware |
| | | 50032 | Liquid Fuel System Operations |
| 7 | SoLoNOx Fuel System | 50030 | SoLoNOx Basic Principles |
| 8 | Gas SoLoNOx Fuel System | 50035 | Gas SoLoNOx Fuel System Principles and Hardware |
| | | 50036 | Gas SoLoNOx Fuel System Operations |
| 9 | Liquid SoLoNOx Fuel System | 50037 | Liquid SoLoNOx Fuel System Principles and Hardware |
| | | 50038 | Liquid SoLoNOx Fuel System Operations |
| 10 | Control System | 50026 | Turbotronic Control System Overview |
| | | 50016 | Turbotronic 4 Control System Hardware |
| | | 50017 | Turbotronic 5 Control System Hardware |
| 11 | Generator | 50045 | Generator Principles and Hardware |
| | | 50046 | Generator Operations |
| 12 | Maintenance | 50015 | Generator Package Operating Procedures |
| | | 50025 | Package Maintenance Principles |

TRAINING UNIT DESCRIPTIONS AND LEARNING OBJECTIVES

10611 – BASIC ELECTRICAL THEORY AND PRACTICES

This training course has been developed primarily as part of the Foundation Training Program for new field employees. It covers basic electrical theory and the application of that theory towards routine maintenance and troubleshooting of a Solar control system. The overall intent is to provide the knowledge and skills necessary to work safely and efficiently on a Solar control console and associated low voltage equipment. The course concludes with an introduction to AC power generation and transformers. This is the first in a series of five training modules.

LEARNING OBJECTIVES

1. Describe the fundamental principles of electricity, the methods of producing electricity, and the relationship between electricity and magnetism
2. Demonstrate the ability to solve problems for basic series DC circuits
3. Demonstrate the ability to solve problems for basic parallel DC circuits
4. Describe the use of common components in basic DC circuits
5. Describe the layout of a typical Solar control console
6. Describe the principles of AC power generation and the construction of a typical brushless generator
7. Describe the principles and typical Solar applications of a transformer

10612 – MOTORS

This training course covers an introduction to the principles, construction, operation, and maintenance of AC and DC motors. This is the second of five training modules that comprise the Electrical Core Training Program. The previous module covers Basic Electrical Theory and Practices, and later modules cover Motor Control Centers, Batteries, and Electrical Testing. Each lesson contains review questions that will help you verify your understanding of each sub-topic as you progress through the lesson. In addition, you should complete the graded end of course test in order to gain credit for the entire course.

LEARNING OBJECTIVES

1. Describe the principles of operation of a motor
2. Describe the construction of a motor
3. Describe the methods of motor starting and control
4. Describe common faults and basic inspection and testing procedures for a motor

10613 – MOTOR CONTROL CENTERS

This training course covers basic electrical theory and the application of that theory towards routine maintenance and troubleshooting of a Solar control system. The Overall intent is to provide the knowledge and skills necessary to work safely and efficiently on a Solar control console and associated low voltage equipment. The Electrical Core Training Program contains a series of Modules or Courses. This module - course # 10613 – covers Basic Theory of Motor Control Centers. Previous modules covered topics such as Basic Electrical Theory and Motors, while later modules cover topics such as

Batteries, and Electrical Testing. Each lesson contains review questions that will help you verify your understanding of each sub-topic as you progress through the lesson. In addition, you should complete the graded end of course test in order to gain credit for the entire course.

LEARNING OBJECTIVES

1. Identify common symbols found on electrical drawings and describe the various types of electrical drawings available for Motor Control Centers
2. State the purpose of a Motor Control Center (MCC) as well as identify and state the function of devices on a basic MCC

10614 – BATTERY SYSTEMS

This training course covers basic electrical theory and the application of that theory towards routine maintenance and troubleshooting of a Solar control system. The Overall intent is to provide the knowledge and skills necessary to work safely and efficiently on a Solar control console and associated low voltage equipment. The Electrical Core Training Program contains a series of Modules or Courses. This module - course # 10604 – covers Batteries and battery chargers. Previous modules covered topics such as Basic Electrical Theory, Motors and Motor Control Centers while the last module in the series will cover Electrical Testing. Each lesson contains review questions that will help you verify your understanding of each sub-topic as you progress through the lesson. In addition, you should complete the graded end of course test in order to gain credit for the entire course.

LEARNING OBJECTIVES

1. Describe the common types of batteries installed on Solar equipment
2. Describe the battery maintenance requirements
3. Describe the common types of battery chargers installed on Solar equipment
4. Describe the battery charger maintenance requirements

10211-1 - CONTROL SYSTEM OVERVIEW

This training unit covers the overall control system purpose and function, including how the control system uses a continuous loop of information transfer to monitor and control the operation of two realistic turbine package conditions. It also reviews the various field setups and arrangements dealing with where the controller is positioned and what support equipment is needed for each control system application. Overall, this training unit provides an understanding of the basic control process used to monitor, protect, and properly sequence the package events, plus some familiarity with the off-skid and on-skid control system configurations.

LEARNING OBJECTIVES

1. Describe the purpose and function of the Turbotronic 5 Control System
2. Describe the various configurations of the Control System

10211-2 - TURBOTRONIC 5 SYSTEM HARDWARE

This training unit provides an overview of the entire Turbotronic 5 system. This will include the ControlLogix Chassis, Ethernet DLR Network, HMI and optional connections, Flex I/O, vibration monitoring, and secondary networks.

LEARNING OBJECTIVES

1. Describe the function of the major components that comprise the Turbotronic 5 control system
2. Describe the communications paths between the components

10211-3 - BOOLEAN LOGIC

This training unit describes how simple logic to control a piece of industrial equipment is formed, essentially using what is known as Boolean Logic. This basic understanding of Boolean Logic will help later when the logic in the Turbotronic 5 system is discussed.

Boolean Logic, when applied to industrial equipment control, examines the status of parameters and makes decisions based on those parameters. This training unit also includes a discussion on the symbols that are used for different types of logic functions represented in graphical format.

LEARNING OBJECTIVES

1. Describe how the status of discrete and analog devices can be represented as binary logic symbols
2. Describe the various logic symbols used to represent turbine sequencing and control
3. Demonstrate the ability to interpret basic turbine control and sequencing functions

12011-4 - LADDER LOGIC

This training unit introduces the basic instructions used in the microprocessor-based controller, and the methods by which the instructions are assembled into a logical sequential program.

The instruction categories discussed include:

- Bit Instructions
- Timer and Counter Instructions
- Compare Instructions
- Compute or Math Instructions
- Move and Logical Instructions.

A functional description of each instruction is provided, and application examples of each are illustrated. To tie everything together, the training unit concludes with some application exercises, where you'll be given the opportunity to create some ladder logic based on functional requirements of turbine package control.

LEARNING OBJECTIVES

1. Demonstrate an understanding of the basic instructions used in the controller in a Turbotronic control system
2. Describe the execution sequence utilized by the controller in a ladder logic program
3. Create ladder logic to replicate specified control logic functions

12011-5 - INTRODUCTION TO SOFTWARE APPLICATIONS

Two main Rockwell Software applications will be discussed in this training unit. The first is Studio 5000 Logix Designer which was previously known as RSLogix 5000. This is the “programming software”, that contains the ladder logic and function block logic to monitor and control the turbine package. The second is RSLinx, which manages communications between the various devices on the network.

LEARNING OBJECTIVES

1. Describe the purpose of the software applications that support the Turbotronic 5 Control system
 - a. Studio 5000 Logix Designer (RSLogix 5000)
 - b. RSLinx

12011-6 - OFFLINE PROGRAM MONITORING

This training unit reviews the project file structure including locating and navigating the backup files and the ACD files. Additionally, the Logix toolbars and help menu will be briefly discussed.

LEARNING OBJECTIVES

2. Describe the process to distribute a Turbotronic 5 project to a programming terminal
3. Describe the process to open a Turbotronic 5 project
4. Describe the various screen sections of RSLogix 5000 / Logix Designer

12011-7 - LOGIX PROJECT FAMILIARIZATION

This training unit discusses the controller properties and general features. How to find logic elements, such as search, cross reference, Goto, and browse logic will also be covered.

LEARNING OBJECTIVES

1. Describe the available information found in the Controller Properties dialog
2. Demonstrate the ability to use the following RSLogix 5000 / Logix Designer functions to locate information in and navigate through a Turbotronic 5 controller program
 - a. Controller Properties
 - b. Search
 - c. Cross Reference
 - d. Goto
 - e. Browse Logic

12011-8 - TURBOTRONIC PROGRAM STRUCTURE

This training unit provides an overview of project organization within the software. Safety critical control and add-on instructions are also discussed.

LEARNING OBJECTIVES

1. Describe the Logix project organization used by Solar
2. Describe Safety Critical Control Systems
3. Describe Add-On Instructions and Structured Text

12011-9 - TAGS AND DATABASES

This training unit covers Tags, with respect to tag scope (Controller-scoped or Program-scoped), types of tags, and data types.

LEARNING OBJECTIVES

1. Describe the use of Tag Databases in Logix programs
2. Define Base and Alias tags
3. List the typical data types used in Solar projects

12011-10 - TURBOTRONIC PROGRAMMING CONVENTIONS

This training unit builds on Logix instruction sets, program structure, and tag databases to illustrate several programming conventions Solar uses to accomplish needed functionality. This includes scaling analog values, annunciating alarms and shutdowns, and the use of program constants.

LEARNING OBJECTIVES

1. Describe the typical Solar programming conventions for analog scaling
2. Describe the typical Solar programming conventions for alarm and shutdown annunciation
3. Describe the Solar programming convention for HART analog scaling
4. Describe the use of Program Constants in a Solar Turbotronic project

12011-11 - TURBOTRONIC CONTROL SYSTEM SECURITY

This training unit discusses the FactoryTalk Security software by Rockwell. This includes permission sets, including how and why they are used. The discussion concludes the access permissions of various personnel, and how customers can utilize this software.

LEARNING OBJECTIVES

1. Describe the purpose of FactoryTalk Security as used with a Turbotronic 5 project
2. Describe the use of Permission Sets in a Solar project
3. Describe program access for Solar and non-Solar personnel

12011-12 - HARDWARE SOFTWARE INTERFACE

This training unit describes how logical functions control and sequence the package mounted devices.

LEARNING OBJECTIVES

1. Demonstrate the ability to cross-reference physical package devices to logix tags
2. Describe the basic function of typical turbine control and sequencing logic

12011-13 - TROUBLESHOOTING METHODS

This training unit covers troubleshooting skills, including the use of the display screens as a diagnostic tool. These display screens will include normal operations as well as Alarms and Historical data screens. Other troubleshooting tools that will be discussed include the use of technical drawings and circuit testing.

LEARNING OBJECTIVES

1. Identify the skills needed to troubleshoot a problem
2. Identify information sources or data that can assist troubleshooting a problem
3. Describe methods used to troubleshoot a problem using package drawings and control system indications
4. Describe basic DLR fault detection in a Turbotronic 5 control network

12011-14 - ONLINE FUNCTIONS

This training unit covers some of the online tasks that may be needed for operation and maintenance of the Solar package.

LEARNING OBJECTIVES

1. Configure communications drivers using RSLinx
2. Download, upload and go online with the controller
3. Make simple ladder logic edits for maintenance and test purposes
4. Set, enable and remove forces in the ladder logic for discrete and analog instructions
5. Modify tunable program constants in the software

50000 - COMPRESSOR PACKAGE DESCRIPTION

This training unit describes the purpose of a Solar Compressor Package; the major components and different configurations; and the various applications and compressor designs Solar have used over the years to meet those applications.

LEARNING OBJECTIVES

1. State the purpose of the compressor package
2. Describe package orientation
3. Identify compressor package major components and ancillary equipment
4. Identify and describe typical applications and uses of Solar compressor packages
5. Describe the alpha-numeric designations used to identify and differentiate Solar compressors

50001 – GENERATOR PACKAGE DESCRIPTION

This unit describes the purpose of a Solar Generator Package, the package major components, and the ancillary equipment needed to support the package operation.

LEARNING OBJECTIVES

1. State the purpose of the generator package.
2. Describe the package orientation referring to the forward and aft, and left and right designations.
3. Identify the major package components.
4. Identify the package ancillary equipment.

50002 - MECHANICAL DRIVE PACKAGE DESCRIPTION

This training unit describes the purpose of a Solar Mechanical Drive Package; the package major components; and the ancillary equipment needed to support the package operation.

LEARNING OBJECTIVES

1. State the purpose of the mechanical drive package
2. Describe the package orientation
3. Identify the package major components
4. Identify the package ancillary equipment

50003 – GAS TURBINE ENGINE PRINCIPLE AND CONSTRUCTION – 1 SHAFT

This training session discusses the purpose of the engine and how it operates and provides details about how the engine is internally constructed.

This training is specific for the single-shaft engine configuration that is used on Generator packages. Separate training is available for the two shaft engines that drive compressors, pumps, and in some cases generators.

LEARNING OBJECTIVES

1. Describe the purpose and basic operation of a Gas Turbine Engine
2. Describe the four operating stages of the Brayton Cycle
3. Identify and describe the function of the main engine sub-assemblies

50004 - GAS TURBINE ENGINE PRINCIPLES AND CONSTRUCTION – 2 SHAFT

This training unit discusses the purpose of the 2-shaft gas turbine engine; how it operates; and how the engine is internally constructed.

LEARNING OBJECTIVES

1. Describe the purpose and basic operation of a Gas Turbine Engine
2. Describe the four operating stages of the Brayton Cycle
3. Identify and describe the function of the main engine sub-assemblies

50005 - DIRECT AC START SYSTEM

This training describes the Direct AC Start System used on Solar turbomachinery packages.

LEARNING OBJECTIVES

1. State the purpose of the Direct-Drive AC Start System Identify and describe the function of the major system components
2. Describe the operational sequences of the start system
3. Describe the interface with the control and display systems
4. Describe typical start system malfunctions
5. Describe the DAC Start System general maintenance requirements

50006 - HYDRAULIC START SYSTEM

This training describes the Hydraulic Start System used on Solar turbomachinery packages.

LEARNING OBJECTIVES

1. State the purpose of the Hydraulic Start System
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the start system
4. Describe the interface with the control and display systems
5. Describe typical start system malfunctions
6. Describe the general maintenance requirements

50007 - PNEUMATIC START SYSTEM

This training describes the Pneumatic Start System used on Solar turbomachinery packages.

LEARNING OBJECTIVES

1. State the purpose of the Pneumatic Start System
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the start system
4. Describe the interface with the control and display systems
5. Describe typical start system malfunctions
6. Describe the general maintenance requirements

50008 - LUBE OIL SYSTEM PRINCIPLES AND HARDWARE

This training unit describes the Lube Oil System used on Solar compressor packages. This includes the purpose and function of the system; the hardware needed to support them; and the operational sequences.

A separate training unit – Lube Oil System Operations - will then describe the operational monitoring in more detail, including potential malfunctions and maintenance requirements.

LEARNING OBJECTIVES

1. State the purpose of the Lube oil system
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the Lube Oil Fuel System

50009 - LUBE OIL SYSTEM OPERATIONS

This training describes the Lube Oil System used on Solar compressor packages, with an emphasis on the operational aspects including the system sequencing; operator interface; typical malfunctions; and general maintenance requirements.

LEARNING OBJECTIVES

1. Describe the operational sequences of the Lube Oil System
2. Describe the interface with the control and display systems
3. Describe typical Lube Oil System malfunctions
4. Describe the Lube Oil System general maintenance requirements
5. Describe the lube oil specification, and also the oil analysis process

50010 – LUBE OIL SYSTEM PRINCIPLES AND HARDWARE – GS

This training unit describes the Lube Oil System used on Solar generator packages. This includes the purpose and function of the system; the hardware needed to support them; and the operational sequences.

A separate training unit – Lube Oil System Operations - will then describe the operational monitoring in more detail, including potential malfunctions and maintenance requirements.

LEARNING OBJECTIVES

1. State the purpose of the Lube oil system
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the Lube Oil Fuel System

50011 – LUBE OIL SYSTEM OPERATIONS – GS

This training describes the Lube Oil System used on Solar generator packages, with an emphasis on the operational aspects including the system sequencing; operator interface; typical malfunctions; and general maintenance requirements.

LEARNING OBJECTIVES

1. Describe the operational sequences of the Lube Oil System
2. Describe the interface with the control and display systems
3. Describe typical Lube Oil System malfunctions
4. Describe the Lube Oil System general maintenance requirements
5. Describe the lube oil specification, and also the oil analysis process.

50012 - GAS FUEL SYSTEM PRINCIPLES AND HARDWARE

This training unit describes the standard combustion Gas Fuel System used on Solar turbomachinery packages. This includes the purpose and function of the system; the hardware needed to support them; and the operational sequences.

LEARNING OBJECTIVES

1. State the purpose of the Gas Fuel System
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the Gas Fuel System

50013 - GAS FUEL SYSTEM OPERATIONS

This training describes the Gas Fuel System used on Solar turbomachinery packages, with an emphasis on the operational aspects including the system sequencing; operator interface; typical malfunctions; and general maintenance requirements.

LEARNING OBJECTIVES

1. Describe the operational sequences of the Gas Fuel System
2. Describe the interface with the control and display systems
3. Describe typical Gas Fuel System malfunctions
4. Describe the Gas Fuel System general maintenance requirements

50014 - COMPRESSOR PACKAGE OPERATING PROCEDURES

This training unit will describe the Operating Procedures for a typical Solar compressor package.

LEARNING OBJECTIVES

1. Describe the commands and indications available on the Human Machine Interface (HMI).
2. List the prestart configuration and precautions that should be followed for safe operation.
3. Describe the procedures to start the unit and put the unit online.
4. List the operating parameters that should be monitored during normal operation.
5. Describe the different shutdown categories.

50015 – GENERATOR OPERATING PROCEDURES

This training unit will describe the Operating Procedures for a typical Solar generator package.

LEARNING OBJECTIVES

1. Describe the commands and indications available on the Human Machine Interface, or HMI.
2. List the prestart configuration and precautions that should be followed for safe operation.
3. Describe the procedures to start the unit and put the unit online.
4. List the operating parameters that should be monitored during normal operation.
5. Describe the different shutdown categories.

50016 - TURBOTRONIC 4 CONTROL SYSTEM HARDWARE

This training unit will familiarize you with the various hardware components that make up the Turbotronic 4 control system. These components are mounted at various locations and are interconnected by a communications network that relays information to and from the RSLogix Controller and the turbine package. Additionally, the system performs communications with other specialized control devices, such as the Variable Frequency Device, or VFD, the Fire System, and Vibration system.

LEARNING OBJECTIVES

1. Define the Turbotronic 4 system
2. Describe the features of the ControlLogix Chassis
3. Describe the features of the Logix 5000 Controller
4. State the function of the communications modules
5. Define Flex I/O
6. Describe the various devices connected to the ControlNet network
7. State how the Programming Terminal is integrated into the system

50017 - TURBOTRONIC 5 CONTROL SYSTEM HARDWARE

This training unit will familiarize you with the various hardware components that make up the Turbotronic 5 control system. These components are mounted at various locations and are interconnected by a communications network that relays information to and from the RSLogix Controller and the turbine package. Additionally, the system performs communications with other specialized control devices, such as the Variable Frequency Device, or VFD, the Fire System, and Vibration system.

LEARNING OBJECTIVES

1. Describe the function of the major components that comprise the Turbotronic 5 control system
2. Describe the communications paths between the components

50018 - COMPRESSOR THEORY OF OPERATION

This training unit describes the operational theory of a centrifugal gas compressor; identifies the main internal components; and describes the functions of those components.

LEARNING OBJECTIVES

1. Describe the operational theory of a centrifugal gas compressor
2. Identify the main internal components installed within a centrifugal gas compressor
3. Describe how the major internal compressor components function

50019 - COMPRESSOR WET SEAL SYSTEM

This training unit will describe purpose, function, major components, and operation of the seal oil, or “wet seal”, system used to retain the process gas inside the compressor body on Solar compressor packages.

LEARNING OBJECTIVES

1. State the purpose of the compressor wet seal system
2. Describe the principles of operation of the compressor buffer gas and seal oil systems
3. Identify and describe the function of the main components of the wet seal system
4. Describe the various wet seal configurations available
5. Describe the sequence of operation of the seal system during package startup, normal operation, and shutdown conditions
6. Describe the typical wet seal information available on the HMI screens
7. List and describe possible wet seal system malfunctions

50020 - COMPRESSOR DRY SEAL SYSTEM

This training unit will describe purpose, function, major components, and operation of the dry gas seal system used to retain the process gas inside the compressor body on Solar compressor packages.

LEARNING OBJECTIVES

1. State the function of the dry gas seal system
2. Describe the operating principles of the dry gas seal system
3. Describe the function of the buffer air / nitrogen supply
4. Identify and describe the function of the seal system major components
5. Describe the operational sequences of the seal system during startup, normal operation, and shutdown
6. Identify the seal system data displayed on the HMI screens
7. List and describe some common seal system malfunctions

50021 - COMPRESSOR OPERATIONS

This training unit addresses operational details related to the safe and proper operation of a compressor within the facility's process gas system. Specifically, we'll discuss instrumentation to monitor the compressor operation; conduct a review of the various process valves, whose sequencing is very critical in preparing the compressor for operation; and discuss the principles behind compressor process control.

LEARNING OBJECTIVES

1. Identify and state the function of the compressor instrumentation
2. Identify and state the function of the process valves
3. Describe the operation and sequencing of the process valves
4. Describe the basic principles of compressor process control

50022 - COMPRESSOR SURGE FUNDAMENTALS

Compressor manufacturers, including Solar, have developed systems to avoid surge, to detect surge if it does occur, and take immediate action to prevent the problem becoming serious. This training unit will discuss the basic principles of surge; the systems used to avoid and detect surge; and the surge-related information available to the package operator.

LEARNING OBJECTIVES

1. Describe centrifugal compressor head versus flow characteristics
2. Define the term “Surge” as it applies to the centrifugal compressor
3. List the symptoms, effects, and causes of surge
4. Describe the basic principle of a surge avoidance system
5. Describe the basic principle of a surge detection system
6. Describe the features of the HMI Surge Display Screen

50025 - PACKAGE MAINTENANCE PRINCIPLES

This training unit will describe the methods, requirements, and resources needed to perform routine maintenance on Solar turbomachinery packages.

LEARNING OBJECTIVES

1. Describe various methods and approaches of maintaining turbo-machinery
2. Describe the advantages of Solar’s recommended method of maintaining turbo-machinery
3. Describe methods of trending operational data for routine maintenance planning
4. List and describe special tooling, equipment, and typical spare parts required for routine maintenance activities on Solar turbo-machinery
5. List and describe the available technical information sources used to support routine maintenance activities
6. Identify typical routine maintenance data and requirements for various sub-system components

50026 - TURBOTRONIC CONTROL SYSTEM OVERVIEW

This training unit will acquaint you with the overall purpose of Solar’s Turbotronic Control System. We’ll discuss each of the five basic control loop elements, as well as describe the typical on and off-skid configuration setups of turbine installed systems.

LEARNING OBJECTIVES

1. Describe the purpose and function of the Turbotronic Control System
2. Describe the various configurations of the Control System

50030 - SOLONOX BASIC PRINCIPLES

This training unit covers the basic principles of Solar’s low emissions technology – known as “SoLoNOx”.

LEARNING OBJECTIVES

1. Describe what NOx and CO emissions are, and how they impact our environment
2. Describe the combustion conditions under which NOx and CO are formed
3. Describe how the SoLoNOx system reduces exhaust emissions
4. List the typical emissions guarantees
5. State the purpose of the Pilot Fuel system and describe its operation

6. Describe how Variable Geometry is used to control emissions
7. Describe what is known as the BAM system, and state why it is needed
8. Describe the basic operational sequences of the SoLoNOx system

50031 – LIQUID FUEL PRINCIPLES AND HARDWARE

This training will describe the standard combustion Liquid Fuel System used on Solar turbomachinery packages. This includes the purpose and function of the system, the hardware needed to support them, and the operational sequences.

A separate training unit – Liquid Fuel System Operations - will then describe the operational monitoring in more detail, including potential malfunctions and maintenance requirements.

LEARNING OBJECTIVES

1. State the purpose of the Liquid Fuel System
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the Liquid Fuel System

50032 – LIQUID FUEL OPERATIONS

This training describes the Liquid Fuel System used on Solar turbomachinery packages, with an emphasis on the operational aspects including the system sequencing; operator interface; typical malfunctions; and general maintenance requirements.

LEARNING OBJECTIVES

1. Describe the operational sequences of the Liquid Fuel System
2. Describe the interface with the control and display systems
3. Describe typical Liquid Fuel System malfunctions
4. Describe the Liquid Fuel System general maintenance requirements

50035 - GAS SOLONOX FUEL SYSTEM PRINCIPLES AND HARDWARE

This training unit describes the SoLoNOx Gas Fuel System used on Solar turbomachinery packages. This includes the purpose and function of the system; the hardware needed to support them; and the operational sequences.

A separate training unit – SoLoNOx Gas Fuel System Operations - will then describe the operational monitoring in more detail, including potential malfunctions and maintenance requirements.

LEARNING OBJECTIVES

1. State the purpose of the SoLoNOx Gas Fuel System
2. Identify and describe the function of the major system components
3. Describe the basic principles of Solar's SoLoNOx technology for emissions control
4. Describe the operational sequences of the SoLoNOx Gas Fuel System

50036 - GAS SOLONOX FUEL SYSTEM OPERATIONS

This training describes the SoLoNOx Gas Fuel System used on Solar turbomachinery packages, with an emphasis on the operational aspects including the system sequencing; operator interface; typical malfunctions; and general maintenance requirements.

LEARNING OBJECTIVES

1. Describe the operational sequences of the SoLoNOx Gas Fuel System
2. Describe the interface with the control and display systems
3. Describe typical SoLoNOx Gas Fuel System malfunctions
4. Describe the SoLoNOx Gas Fuel System general maintenance requirements

50037 – SOLONOX LIQUID FUEL PRINCIPLES AND HARDWARE

This training will describe the SoLoNox Liquid Fuel System used on Solar turbomachinery packages. It will cover the purpose and function of the system, and the hardware needed to support them, and the operational sequences.

LEARNING OBJECTIVES

1. State the purpose of the Solonox Liquid Fuel System
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the Solonox Liquid Fuel System

50038 – SOLONOX LIQUID FUEL OPERATIONS

This training is a follow on from the Liquid Fuel Solonox Principles and Hardware training unit. It describes the operational sequences and operational monitoring, including potential malfunctions and maintenance requirements.

LEARNING OBJECTIVES

1. Describe the operational sequences of the Solonox Liquid Fuel System
2. Describe the interface with the control and display systems
3. Describe typical Solonox Liquid Fuel System malfunctions
4. Describe the Solonox Liquid Fuel System general maintenance requirements

50043 – GAS TURBINE ENGINE CONTROL AND OPERATIONS – 1 SHAFT

This training unit discusses the monitoring and control aspects of the 1-shaft engine, including problems that might be encountered and general maintenance requirements for the engine.

You should note that this training is specific for the single-shaft engine configuration that is used on Generator packages. Separate training is available for the two shaft engines that drive compressors, pumps, and in some cases generators.

LEARNING OBJECTIVES

1. Describe typical engine instrumentation
2. Describe the engine operational sequences
3. Identify and describe the engine-related data on the HMI display screens
4. Describe typical engine problems and their possible causes

5. Describe the general engine maintenance requirements

50044 - GAS TURBINE ENGINE CONTROL AND OPERATION – 2 SHAFT

This training unit discusses the monitoring and control aspects of the 2-shaft engine, including problems that might be encountered and general maintenance requirements for the engine.

LEARNING OBJECTIVES

1. Describe typical engine instrumentation
2. Describe engine operational sequences
3. Identify and describe the engine-related data on the HMI display screens
4. Describe typical engine problems and their possible causes
5. Describe the general engine maintenance requirements

50045 – GENERATOR PRINCIPLES AND HARDWARE

This training unit discusses the principles and hardware associated with electromagnetic generation.

LEARNING OBJECTIVES

1. Describe the principles of electro-magnetic induction
2. Describe 3-phase electrical characteristics and how a 3-phase electrical signal is generated using electro-magnetic induction
3. Explain transformer operation and how transformers are used in 3-phase electrical power generation
4. List and describe the function of typical 3-phase electrical generator major components, and
5. Explain the characteristics of real, reactive, and apparent power

50046 – GENERATOR OPERATIONS

This training unit discusses the operation of the generator package, including the various configuration options that may be selected to maximize the operating efficiency, especially when the generator is operated in parallel with other generator packages, or the grid.

LEARNING OBJECTIVES

1. Describe basic generator synchronizing principles
2. Describe the generator synchronizing process
3. Describe basic generator load sharing principles
4. Classify power system operational modes using industry and Solar terminology
5. Determine the control system configuration options for various operational scenarios

50051 – SMT60 PACKAGE DESCRIPTION

This training unit will identify the SMT60 major package components and state their function.

LEARNING OBJECTIVES

1. State the purpose of the SMT 60 package
2. Identify the location of the major package components
3. Describe the enclosure ventilation airflow,
4. Describe the features and functions of the HMI Enclosure Display screen

50052 – SMT60 ENGINE

Welcome to this training unit on the engine installed in the SMT60 package.

LEARNING OBJECTIVES

1. Describe the purpose and basic operation of a Gas Turbine Engine
2. Describe typical engine instrumentation
3. Identify and describe the engine-related data on the HMI display screens.
4. Describe the engine operational sequences

50053 – SMT60 START

Welcome to this training unit on the start system installed on Solar's SMT60 packages.

LEARNING OBJECTIVES

1. State the purpose of the Direct-Drive AC Start System
2. Identify and describe the function of the major system components
3. Describe the operational sequences of the start system
4. Describe the interface with the control and display systems
5. Describe typical start system malfunctions.

50054 – SMT60 LUBE OIL SYSTEM

This training unit will discuss the SMT60 lube oil system.

LEARNING OBJECTIVES

1. State the purpose of the Lube Oil System
2. Identify and describe the function of the major system components
3. Describe the information found on the HMI Lube Details Screen
4. Describe the operational sequences of the Lube Oil System
5. State some common causes of typical Lube System malfunctions

50055 – SMT60 GAS FUEL SOLONOX

This training unit will discuss the Solonox gas fuel system on the SMT60

LEARNING OBJECTIVES

1. State the purpose of the Fuel System
2. Identify and describe the function of the major components
3. Identify the Fuel System data displayed on the HMI screens.
4. Describe the operational sequences of the system.

50056 – SMT60 CONTROL SYSTEM

This training unit will describe the control system installed on the SMT60

LEARNING OBJECTIVES

1. Describe the overall purpose and function of the Turbotronic control system, and
2. Describe the system hardware that comprises the Turbotronic control system
3. Describe the operator interface with the control system
4. State the software that would be required if system maintenance needs to be carried out.

50057 – SMT60 MEDIUM VOLTAGE SYSTEM

Operators of the SMT60 should be familiar with the various voltages present on the equipment. This lesson will discuss the electrical distribution throughout the SMT60 and review the medium voltage drawings.

LEARNING OBJECTIVES

1. State the purpose of the various voltage systems on the SMT60,
2. Describe the electrical power flow path from the generator to the MCC and customer connection,
3. Identify the components on the medium voltage drawings,
4. List the voltages present at various locations on the SMT60

50058 – SMT60 GENERATOR OPERATIONS

In this training we'll discuss the operation of the generator package, including the various configuration options that may be selected to maximize the operating efficiency, especially when the generator is operated in parallel with other generator packages, or the grid.

LEARNING OBJECTIVES

1. Describe basic generator synchronizing principles
2. Describe the generator synchronizing process
3. Classify power system operational modes using industry and Solar terminology
4. Determine the control system configuration options for various operational scenarios

50059 – SMT60 OPERATING PROCEDURES

This training unit will discuss the operating procedures of the SMT60

LEARNING OBJECTIVES

1. Describe the commands and indications available on the Human Machine Interface, or HMI.
2. List the prestart configuration and precautions that should be followed for safe operation.
3. Describe the procedures to start the unit and put the unit online.
4. List the operating parameters that should be monitored during normal operation.
5. Describe the different shutdown categories.

50060 – SMT60 ASSEMBLY AND DISASSEMBLY

This training unit will describe the basic process for the assembly and disassembly of the SMT60, to be completed before and after each transportation.

LEARNING OBJECTIVES

1. List the Solar documentation required proper specifications and procedures
2. Describe the requirements for placement and set up of the SMT60
3. List the steps of the mechanical set up procedures
4. List the steps of the electrical set up procedures
5. Describe the procedures to disassemble and prepare the SMT60 for transportation