

TM2500

1. Scope of Supply

The TM2500 Mobile Gas Turbine Generator (MGTG) set is a trailer-mounted mobile power package. The trailer system allows for expedited transportation and set up of the package. The TM2500 MGTG typically consists of three trailers: The Turbine Trailer, the Generator Trailer, and the Control House Trailer. The basic scope of supply for each of these trailers is described in the following subsections.

2. Turbine

The main deck of the turbine trailer contains an inlet silencing system for the turbine and the turbine module. Located on the gooseneck of the trailer is the auxiliary skid, which contains the TCP (Turbine Control Panel) along with various package support systems. When the package is fully installed, the turbine trailer assembly is fitted with the air filter modules, the turbine exhaust silencer, and the ventilation fan assembly for the turbine enclosure.

Located at the rear of the turbine trailer is a docking station that provides the female interface required to connect the turbine and generator trailers together for the operational configuration. Located on the turbine trailer are the following components and assemblies:

- Gas Turbine Engine w/ Turbine Enclosure
- Turbine Gauge Panel (TGP)
- Fire Protection Aerosol Canisters
- Auxiliary Skid" including the following:
 - Turbine Control Panel (TCP)
 - Hydraulic Start System
 - Turbine Lube Oil (TLO) System (shared)
- Off-Line Water Wash System
- Air Inlet Silencer with enclosure
- Inlet Air Filter System (when package is fully assembled)
- Dual Fuel with Water Injection system
- Turbine Exhaust (when package is fully assembled)
- High Speed Coupling Shaft
- Ventilation Fan Assembly skid (when package is fully assembled)
- Alignment System

Trailer

A three-axle, air ride suspension trailer with two steerable axles is used to transport the turbine trailer components. At the Site, the turbine trailer is connected to the generator trailer. Landing legs are provided to support and level the equipment at the Site.

Turbine Enclosure

The turbine trailer is supplied with a weatherproof, acoustic enclosure for the turbine which provides ventilation and fire system containment.

The enclosure is designed for noise abatement to 90 dB(A). The enclosure is completely assembled and mounted over the equipment prior to testing and shipment. Provisions for turbine removal and personnel access are included.

Gas Turbine Engine

Located inside the turbine enclosure is a General Electric gas turbine engine (Model LM2500+G4T1), the turbine engine is equipped to operate on liquid fuel or natural gas with or without water injection. The turbine engine is mounted to the turbine trailer which is independent from the generator trailer.

This engine is a two-shaft design with the gas generator separate from the power turbine. This aerodynamically coupled design allows the power turbine to operate at a continuous speed of either 3,000 rpm (50Hz), regardless of the gas generator speed. Torque developed in the aerodynamically coupled power turbine is transferred to the rotor of the alternating current (AC) generator through a flexible diaphragm coupling. The AC generator operates at a synchronous speed of either 3,000 rpm (50Hz), eliminating the need for a speed reducing gearbox.

The inlet section, at the entrance of the silencer, is equipped with a stainless-steel mesh screen in the inlet air stream for protection against foreign object damage to the engine. The engine is shock mounted whenever shipped in position inside the package.

Turbine Gauge Panel (TGP)

The turbine gauge panel is located on the right-hand side of the turbine enclosure (with respect to the turbine aft looking forward) beside the turbine enclosure door. The turbine gauge panel provides an enclosure used to house various pressure transmitters.

Fire Protection Aerosol Canisters

Fire protection aerosol canisters are located on top of the turbine enclosure. These canisters are connected to the fire protection system located in the Generator Control Panel (GCP) and provide extinguishing agent in the event of a fire inside the enclosure.

Auxiliary Skid

The auxiliary skid is a compact installation of several systems and equipment and is positioned on the gooseneck of the turbine trailer. The major items on this skid include a TCP, the Hydraulic Start System with shared turbine lube oil reservoir, the Turbine Lube Oil System, and the Off-Line Water Wash System. Some of the systems on the skid contain transmitters that provide remote system monitoring. The pressure and pressure differential transmitters have instrument valves in their feed lines to simplify maintenance.

Mechanical interconnections between the auxiliary skid and turbine skid are made with hoses as required and come preassembled from the factory on the turbine trailer. Electrical interconnections are provided to allow the required interfacing between the auxiliary skid and the control house as needed, otherwise wiring is factory installed.

TCP-The Turbine Control Panel mounted on the auxiliary skid includes:

- RX3i
- VersaMax Controllers
- Bently Nevada 3701
- Woodward Digital Valve Positioners

Hydraulic Start System

The equipment package is supplied with a hydraulic starting system. The hydraulic start system turns the engine and is capable of rotating it for engine start, fuel purging, water wash cleaning, and conducting maintenance. The hydraulic starter system has components located on the auxiliary skid and inside the turbine enclosure. The DC hydraulic starter motor drives a hydraulic pump assembly consisting of a charge pump, pressurised filter, main pump, and variable SOV-actuated valve.

The hydraulic start system mounted on the auxiliary skid includes:

- Hydraulic Pump & Motor
- Oil Reservoir (shared with Turbine Lube Oil))
- Various Temperature Elements, Pressure Gauges, and Hydraulic filters

Turbine Lube Oil (TLO) System

The purpose of the TLO system is to provide clean, cool oil to lubricate bearings, and also to provide pressurized oil for operation of the turbine's variable geometry (VG) actuators.

The turbine lube oil system has two separate circuits:

- Supply System - Provides clean, cool oil to the turbine bearings
- Scavenge System-Recovers (scavenges) the lube oil from the bearing drain-sumps, filters and cools the oil, then returns it to the reservoir.

The synthetic lube oil system mounted on the auxiliary skid includes:

- Tank Flame Arrestor
- Turbine and Hydraulic Lube Oil Reservoir
- Tank Demister
- Turbine/ Hydraulic Start Fin-Fan Heat Exchanger

Off-Line Water Wash System

The equipment package is supplied with an 11off-line11 cleaning system, with a water wash reservoir and all necessary filters and instrumentation supplied. Customer is required to provide purified water to meet Water Wash (MID-TD-0000-4)

The water wash system mounted on the auxiliary skid includes:

- Polyethylene Tank
- Water Inlet Shut-Off Valve
- Pump and Strainer

Air Filter Assembly and Silencer Enclosure

The air filter assembly contains combustion and ventilation air filtration equipment including pre-filters, high-efficiency filters, a ventilation fan assembly, and a concentric intake silencer in an enclosure. The turbine compartment is fully ventilated by a ventilation fan which draws filtered air from the silencer enclosure. After initial operation using this static type filter, the Units will be retrofitted with Pulse Filter Units inclusive of Air Compressor package and control system for pulsing elements.

Dual Fuel with Water Injection System

The GTG offers dual fuel (gas and liquid) capabilities for (Single Annular Combustor) SAC combustor through the full load operations and are sequenced and controlled automatically by the control system. The GTG is designed to start up on either gas or liquid fuel.

A natural gas fuel system with electronically controlled fuel-metering valve(s) is supplied in the basic package. For full-load operation, the gaseous fuel must be supplied to the main skid unit at an acceptable range depending on engine model and combustor option. Maximum flow and temperature of the customer-supplied gas fuel is monitored and required to be acceptable. Buyer shall provide Gas Fuel in accordance with Gaseous Fuels (IVLTD-TD-0000-1).

The package is also equipped with a liquid fuel system. For full-load operation, the liquid fuel must be supplied to the package at the specified range. Liquid fuel must arrive filtered to 5 microns.

Buyer shall provide clean and filtered Liquid fuel in accordance with Liquid Fuels (MID-TD-0000-2).

With the exception of the gas fuel skid, all components for the dual fuel system with water injection are located on the turbine trailer. All components come preassembled from the factory. Mechanical interconnect locations for liquid fuel and water are provided for Buyer connection just below the turbine gauge panel.

Gas fuel system major components include:

- Gas Fuel Duplex Filter Assembly
- Gas Fuel Vent Valve
- Gas Fuel Purge & Bleed Ball Valve
- Woodward Gas Fuel Valve
- Gas Fuel Purge Check Valve
- Purge Valve

Liquid fuel system major components include:

- Liquid Fuel Y -strainer
- Purge & Bleed Valve
- Liquid Fuel Pump/Motor
- Primary & Secondary Shut-off Valve
- Liquid Fuel Ball Valve
- Fuel Manifold
- Liquid Fuel Relief Valve
- 30 Fuel Nozzles
- Liquid Fuel Duplex Filter Assembly
- Return Check Valve
- Liquid Fuel Control Valve

Water Injection System:

Seller provides the necessary controls, metering equipment, and interconnecting piping within the turbine enclosure. All piping is stainless steel, and the valves are trimmed with stainless steel. Water injection can reduce NOx emissions to 25 ppm (51 mg/Nm³) for gaseous fuel and to 42 ppm (86 mg/Nm³) for liquid fuel (see Performance Section, for Site specific emissions data). The Buyer shall provide a supply of pressurized water in accordance with the Injection Water Quality Specification (MID-TD-0000-3).

Gas Fuel Skid

The gas fuel skid is transported on the gooseneck of the generator trailer and provides the final filtration of gas fuel to the package. When in operation the gas fuel skid is connected to the turbine trailer with a Seller-provided mechanical interconnect to the package.

Turbine Exhaust

The LM2500G4TM gas turbine exhaust flows through an exhaust collector and roof mounted exhaust silencer. The standard TM2500 exhaust collector exit is oriented in the upright position. The exhaust collector provides a direct path into the turbine exhaust silencer. The exhaust collector consists of an inner and outer duct forming a diffusing passage from the power turbine rear frame.

Exhaust system components include:

- Exhaust Collector
- Exhaust

Silencer High Speed

Coupling Shaft

A high-speed flexible coupling shaft connects the low-pressure turbine/power turbine to the generator. It consists of a forward adapter which mates with the power turbine, two flexible couplings, a distance piece, and an aft adapter which mates with the connected load. The flexibility in the coupling allows for minor deviations between the turbine and generator shafts, this flexibility aids in successful connection between the turbine and the generator.

Alignment System

The Laser Alignment System consists of the following components:

- IP Camera (2)
- Power Switch
- Laser
- Tablet (Microsoft Surface™)
- Light

2. Generator Trailer

The main deck of the generator trailer contains the generator, generator ventilation, generator lube oil system, and switchgear. The gooseneck of the generator trailer may be optionally removed in operational configurations to reduce the overall installed footprint.

Located at the rear of the generator trailer is a docking station that provides the male interface required to connect the turbine and generator trailers together for the operational configuration.

The Generator Trailer consists of the following components:

- Generator Trailer
- Generator Ventilation
- Generator
- Switchgear
- Generator Lube Oil Skid

For transportation purposes, the generator trailer has a hydraulically steered stinger intended to be connected during any type of trailer move.

Generator Trailer with Stinger

A four-axle, air ride suspension trailer with two tracking axles and a three-axle steerable stinger is used to transport the generator trailer components. At the Site, the generator trailer is connected to the turbine trailer. Landing legs are provided to support and level the equipment at the Site.

Generator

The AC generator operates at a synchronous speed of 3,000 rpm (50-Hz applications), eliminating the need for a speed-reducing gearbox during simple-cycle operation. The TM2500 generator is an air-cooled Brush generator (Model BDAX62-170ERT) with an air filter assembly and exhaust assembly.

Dry coupled to the engine, the generator is mounted directly to the generator trailer. This arrangement enables engine/generator shaft alignment to be adjusted with the turbine trailer with the suspension system of the turbine trailer, while the generator remains fixed.

Generator Lube Oil (GLO) Skid

The GLO skid is a compact installation of generator lube system equipment on the generator trailer and is positioned on the generator end of the generator trailer. The skid contains transmitters that provide remote system monitoring. The pressure transmitters have instrument valves in their feed lines to

The mineral lube oil system for the generator will include:

- GLO Filter
- GLO Tank
- DC Lube Oil Pump
- Generator Cooler Vent Valve
- Shaft-driven Lube Pump
- GLO Fin-Fan Heat Exchanger
- GLO Air/Oil Separator
- GLO Pressure Control Valve

Switchgear

The TM2500 has self-contained, metal clad switchgear which is located on the front portion of the generator trailer. The switchgear houses the following components:

- Generator breaker
- Current Transformers
- Buses
- Voltage Transformers

Generator Ventilation

The generator is supplied with its own ventilation components to provide cooling air solely for the generator. Shaft mounted fans direct cooling air through the generator- unit. The cooling air is then exhausted out of the generator through the exhaust silencer located on top of the generator

3. Control House Trailer

The control house trailer includes a lighted and insulated control house. The control house is equipped with an access door and air conditioner/heater.

The control house trailer consists of the following components:

- Control House Trailer
- Control House - which includes:
 - Human-Machine Interface (HMI)
 - Motor Control Center (MCC)
 - Generator Control Panel (GCP)
 - Batteries and Chargers

When in the transport configuration, the control house goose neck provides the storage location for the turbine enclosure ventilation fan while the rear platform of the trailer is storage for the generator exhaust silencer.

It is a two-axle, air ride suspension trailer. At the Site, it is inter-connected electrically to the turbine and generator trailers. Landing legs are provided to support and level the equipment at the Site.

Control House

The control house packaged equipment is described below:

HMI - The human machine interface allows operator interaction to operate and control the package. The HMI is integrated with the control system PLC located in the TCP. A computer with separate workstation is provided for HMI control. Alarm and shutdown events are displayed on the HMI automatically.

GCP - The GCP contains the voltage regulator and switches for controlling generator operation. This panel also contains local controls, the Beck with Integrated Generator Protection System (IGPS) for monitoring the operation of the turbine engine and generator and the fire protection panel and VersaMax modules integrated with the control system PLC. The GCP also houses DC circuit breakers for the distribution of DC voltage

throughout the package. The framework of interconnects required for complete package communications are distributed through this panel via interconnect cables.

MCC - The MCC (motor control center) is a free-standing metal cubicle that houses various low-voltage circuit breakers, motor starters, and their controls. It is installed in the control house and includes a 45 kV A lighting and distribution transformer.