GE Power & Water
Distributed Power

TM2500 GEN8

Mobile Gas Turbine Generator Set

Product Specification

Improvements and Changes
It is understood that GE has the right to make changes in product design and add improvements to products or services at any time without incurring any obligations to install the same on or in connection with the equipment or services identified in this document. DATE OF ISSUE 7/2015

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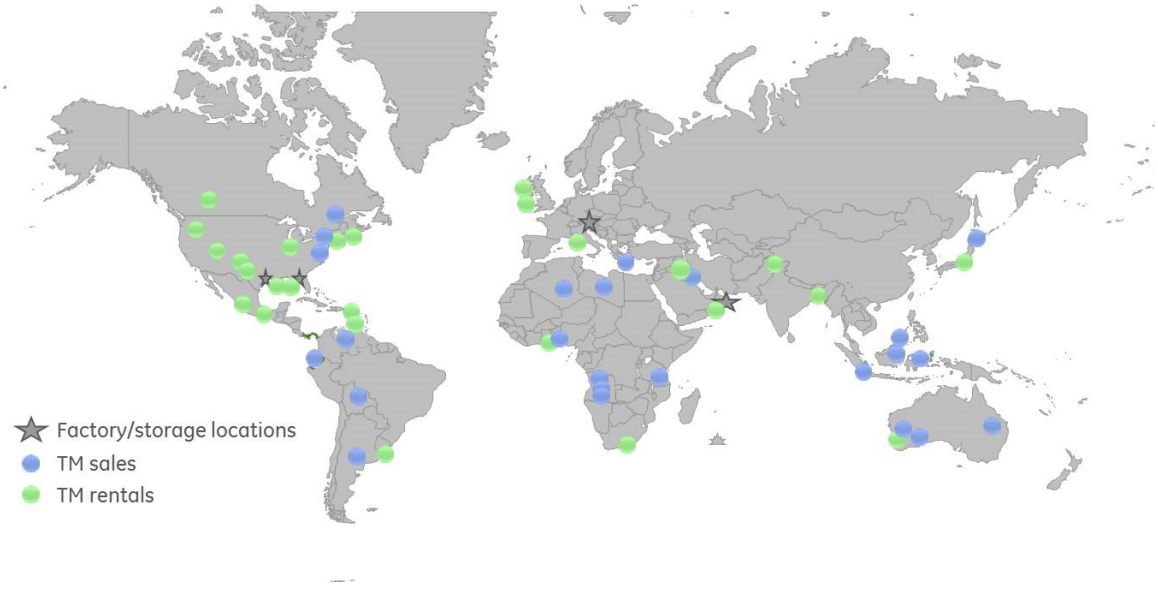
1. Introduction – TM2500 GEN8 Mobile Gas Turbine Generator Set

1.1 Packaging Concept

Known as GE's "Power Plant on Wheels", our TM2500 GEN8 mobile aeroderivative gas turbine generator set is ideal for providing a base-load bridge to permanent power installations or for generating backup power in support of natural disaster relief, plant shutdowns, or equipment maintenance, with the capacity to produce more than 35 megawatts of power—that's 13% more than its predecessor, the TM2500+™. Equipped with our proven LM2500+G4™ and engineered for flexibility and quick dispatch, the TM2500 GEN8 is the go to solution for fast, mobile power needs in almost any environment.

As the newest enhancement of GE Power & Water's trailer-mounted unit, the TM2500 GEN8 offers improved global mobility of the trailer package with its split trailer design. The split-trailer design has a shorter wheelbase resulting in a 20% improvement in the turning radius, as well as lowering the load per trailer. Another feature of this new design is the telescopic front and back trailer ends which can adjust to comply with global transportation requirements, as needed.

Global Experience



Features and Benefits

- Increased MW performance @ 50 Hz with the LM2500+G4™
- Smaller footprint compared to mobile unit competitors
- Laser Alignment System - simplified field alignment procedure and tooling
- 20% improvement in turning radius and lower weight per trailer axle
- Onboard Crane option allows for self-sufficiency
- Available for both 50 Hz and 60 Hz applications
- Aerosol Fire Suppression System
- Full power within 10 minutes or less
- Developed specifically to respond to fast and mobile power needs
- Flexible operation on either natural gas or distillate liquid fuels
- Quick conversion between 50 Hz and 60 Hz with no reduction gearbox
- Low emissions with demineralized water injection
- Quick dispatch and easy to operate and maintain
- Road legal trailers
- Trailer mounted air filters for increased accessibility and simplified installation
- Many options available
- Reduced system interconnects for faster installation

Class Certifications

The TM2500 GEN8 Mobile Gas Turbine Generator (MGTG) set design meets the requirements of UL/FM Class Certification, as well as CSA, CE/ATEX, and Australian standards.

1.2 Aeroderivative Engine

The cornerstone of this mobile unit's offering is GE's fourth generation upgrade of the LM2500® product line, the LM2500+G4™. It possesses technical features inherent to its design, which offer significant operational and economic advantages to the end user. This brochure presents an overall description of GE's TM2500 GEN8 mobile aeroderivative gas turbine generator set, with rated ISO shaft power output of 34.8 megawatts and 41% efficiency. It presents the value added to customers based on demonstrated high reliability and availability of the LM2500® gas turbine heritage.

The LM2500+G4™ shares in GE Aircraft Engine's research and development funding; which has surpassed one billion dollars each year for the past 16 years. Today, GE's entire gas turbine product line continues to benefit from this constant infusion of

research and development funding. Advances are constantly being incorporated to improve the benefits of GE's gas turbines to the customer.

Engine Heritage

The LM2500® product line is GE's most experienced aeroderivative engine. It is derived from the TF-39 engine used on DC-10 wide-bodied jets. More than 1,800 LM2500® engines are in service worldwide with more than 70 million hours of operational experience.

Simple Design

The LM2500+G4™ design includes a six-stage power turbine with a nominal speed of 3,600 rpm for 60 Hz applications and 3,000 rpm for 50 Hz applications.

Emissions Control

Most countries today are environmentally responsible and desire low emissions for new power plants. Even with the high firing temperatures and pressures, the LM2500+G4™ is capable of guaranteeing 25 ppm NOx level with Gas Fuel and 42 ppm NOx level with Liquid Fuel at 15% O_2 dry.

Fuel Flexibility

At GE, we understand flexibility in fuel choices is a high priority. Our Alternate Fuels Center of Excellence is leading the industry in identifying, designing, and delivering fuel flexibility options—all with the high reliability, availability, and maintainability standards you expect from GE.

The LM2500+G4™ dual fuel single annular combustor (SAC) gas turbine offers fuel flexibility. It is capable of operating with a variety of fuels such as:

- Natural Gas fuel
- #2 Diesel
- Kerosene
- Jet Fuel

Additional operating fuel options available with fuel retrofit kits include:

- Naptha
- Pentane
- Liquefied Petroleum Gas (LPG)
- Alcohol

High Availability and Reliability

By utilizing aircraft experience and design, our aeroderivative design approach incorporates features such as split casings, modular construction, individual replacement of internal and external parts, and GE's "lease pool" engine program. Our extensive use of high quality components common with parent aircraft engines validates engine reliability and offers reduced parts cost.

Various inspections and hot section repairs can be performed on the gas turbine at site within the turbine enclosure. The "Hot Section," HPT and combustor can be removed / replaced in the field within 72 hours, allowing for greater availability during planned maintenance. Greater availability is achieved by the on-condition maintenance program, which inspects and repairs only as necessary to desired operational condition.

1.3 Summary

This unit configuration, coupled with GE's most experienced aeroderivative engine, provides users with optimum value in reliability and cost of ownership.

The TM2500 GEN8 MGTG set delivers the following benefits over competitive designs:

- Increased power for 50 Hz market with the LM2500+G4™
- Smaller footprint vs competitor (2,417 sq. ft. vs 3,294 sq. ft.)
- Global mobility with split trailer design
- 20% improvement in turning radius; meets EU requirements
- 40% weight reduction of heaviest lift; onboard crane option
- Field engine alignment eliminated
- 90 dBA on liquid fuel or 87 dB(A) on gas fuel guarantee (standard)
- Seismic and Wind Rating is up to 0.35G and 100 mph (293 kg/m^2) (standard)

2. Performance Curves and Data

2.1 Turbine Performance

Gas turbine performance is affected by several factors, including:

- Ambient temperature
- Barometric pressure
- Relative humidity
- Elevation above sea level
- Inlet pressure losses
- Exhaust pressure losses
- Emission controls
- Fuel type

2.2 ISO Conditions

To assist buyers, the International Organization for Standardization (ISO) has defined the following standard conditions for rating and comparing gas turbine engines:

- Ambient Temperature - 59°F (15°C)
- Barometric Pressure - 14.7 psia (101.3 kPa)
- Relative Humidity - 60%
- Elevation - Sea Level
- Inlet and Exhaust Losses – None
- Emission Controls – None

2.3 ISO Performance Data

The charts, curves and data in this manual are shown at standard ISO conditions, except as specifically noted. Distributed Power will be glad to prepare performance data for customer's individual job site conditions.

	LM2500+G4™ SAC (NOx Control: None)			
	NPT: 3600 rpm	**NPT: 3000 rpm**	**NPT: 3600 rpm**	**NPT: 3000 rpm**
Fuel	**Natural Gas, per MID-TD-0000-1**		**Liquid, per MID-TD-0000-2**	
Power Output, SHP (kW) @ generator terminals	44757 (33375)	43189 (32206)	43303 (32291)	41947 (31280)
Heat Rate (Average), BTU/hp-hr. (KJ/kW-hr)	6532 (9241)	6863 (9711)	6599 (9336)	6909 (9775)
Exhaust Flow, lbs./sec (kg/sec)	201.9 (91.6)	204.8 (92.9)	199.5 (90.5)	202.4 (91.8)
Exhaust Temperature, °F (°C)	976 (524)	1004 (540)	981 (527)	1008 (542)
Power Turbine Speed, rpm	3600	3000	3600	3000
NOx @ 15% O_2, PPMvd (mg/Nm3)	302 (618)	311 (638)	454 (930)	470 (962)

Based on the following ISO conditions:				
Inlet Temperature, °F (°C)	59 (15)			
Altitude (Sea Level), ft. (m)	0 (0)			
Inlet & Exhaust Losses, inH_2O (mmHg)	Zero			
Relative Humidity	60%			
Bleed Air Extraction	0			
Accessory Power Extraction	0			
Generator Voltage, Power Factor, Frequency	13.8 kV, 0.9 PF, 60 Hz	11.5 kV, 0.9 PF, 50 Hz	13.8 kV, 0.9 PF, 60 Hz	11.5 kV, 0.9 PF, 50 Hz

Table 2.1 - LM2500+G4™ SAC Combustor Performance at ISO Conditions

2.4 Motor Load List

ITEM	NAMEPLATE INFORMATION	TAG NAME	400/3P/50 Hz	480/3P/60 Hz
1	TURBINE LUBE OIL/HYDRAULIC OIL TANK HEATER	HE-1004	3.5 hp (2.6 kW)	4 hp (3 kW)
2	GENERATOR LUBE OIL TANK HEATER	HE-0005	3.7 hp (2.77 kW)	5.4 hp (4 kW)
3	GENERATOR STATOR / EXCITER SPACE HEATER	HE-4050/4051	3.7 hp (2.77 kW)	5.4 hp (4 kW)
4	TURBINE WATER WASH PUMP	MOT-5035	2 hp (1.5 kW)	2 hp (1.5 kW)
5	TURBINE ENCLOSURE VENT FAN	MOT-4017	80 hp (59.7 kW)	80 hp (59.7 kW)
6	TURBINE HYDRAULIC STARTER MOTOR	MOT-6015	200 hp (149 kW)	200 hp (149 kW)
7	TURBINE NOX WATER INJECTION PUMP	MOT-2075	41 hp (30.6 kW)	50 hp (37.3 kW)
8	TURBINE LIQUID FUEL PUMP	MOT-2022	41 hp (30.6 kW)	50 hp (37.3 kW)
9	TURBINE LUBE OIL/HYDRAULIC OIL HEAT EXCHANGER FAN	MOT-1078	7.5 hp (5.6 kW)	7.5 hp (5.6 kW)
10	GENERATOR LUBE OIL HEAT EXCHANGER FAN	MOT-0189	5 hp (3.7 kW)	5 hp (3.7 kW)
11	PULSE FILTER SKID COMPRESSOR	MOT-4297	20 hp (15 kW)	20 hp (15 kW)
12	LIGHTING AND DISTRIBUTION TRANSFORMER	45 kVA TRANSFORMER	48.2 hp (45 kVA)	48.2 hp (45 kVA)
13	LIGHTING AND DISTRIBUTION PANEL (230/133 3PH 4W 25 CKT)	LDP	10.7 hp (10 kVA)	10.7 hp (10 kVA)

Table 2.2 - Motor Load List

2.5 Typical Approximate Dimensions and Weights

	Approx. Weight (lbs.)	L x W x H (feet)
Turbine Trailer[1,2]		
Without Stinger	90,145	55' L x 9.8' W x 13.2' H
With Stinger	95,139	69.6' L x 9.8' W x 13.2' H
Generator Trailer[1,2]		
Extendable Stinger set to EU	157,380	68.6' L x 9.8' W x 12.4' H
Extendable Stinger to US	157,380	76' L x 9.8' W x 12.4' H
Extendable Stinger set to CAN	157,380	84' L x 9.8' W x 12.4' H
With Cold Steel Version	161,822	Dependent on Stinger Setup
Control House Trailer[1,2]	47,490	41.7' L x 9.2' W x 14' H
Transportation Trailer[1,2,3]	49,435	43.2' L x 9.8' W x 13.6' H
Air Filter Assembly (including support bracket)[2]	8,674	17.8' L x 8.3' W x 10.2' H
Switchgear	8,900	6' L x 9.4' W x 8.1' H
Generator 62-170ERT	84,878	19' L x 8.9' W x 7.2' H
Generator Ventilation	6,724	12.7' L x 8.4' W x 9.1' H
Control House	25,463	22.8' L x 8.3' W x 9.4' H
Ventilation Fan Assembly	4,530	10.3' L x 8.3' W x 7.9' H
Exhaust Stack	16,323	12.2' L x 8.3' W x 11' H
Crane[2]	9,140	5.3' L x 8.3' W x 8.75' H
Generator Air Filters[2]	1,600	4.4' L x 8.3' W x 8.75' H

[1] Trailer weights include mounted assemblies & skids
[2]Weights and Dimensions reflect amounts during transport
[3]Maximum values shown, varies with selected options

Table 2.3 Typical Approximate Dimensions and Weights

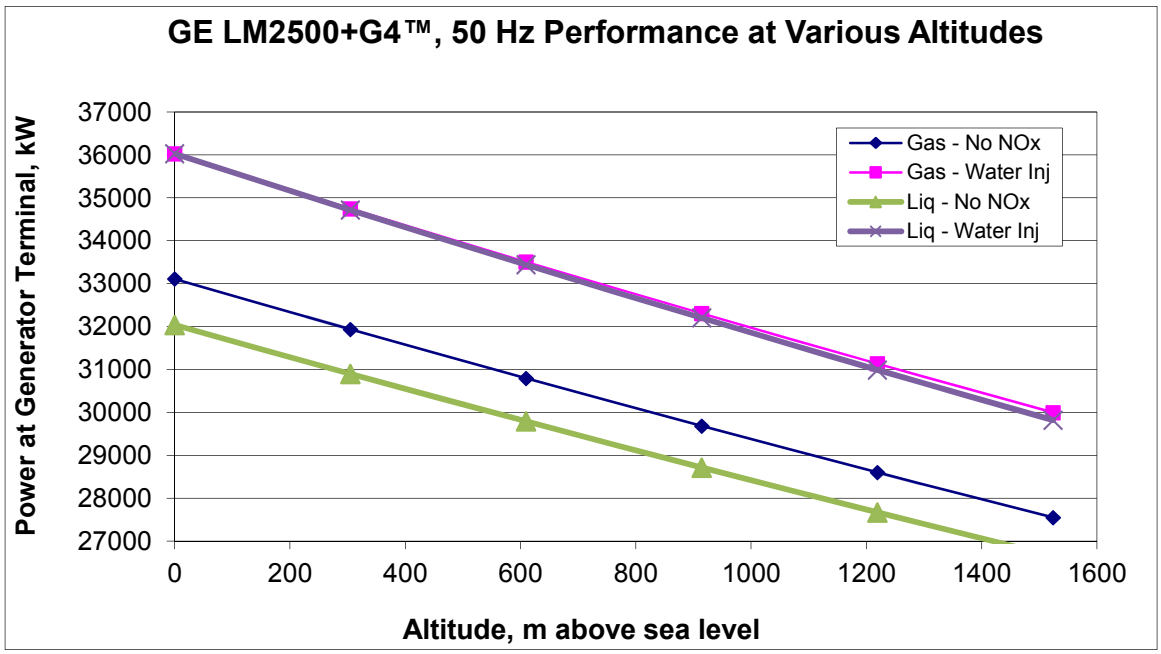
Note 1: Some equipment listed in this table may not be applicable to all projects.
Note 2: Main Unit is composed of the Turbine Trailer and Generator Trailed coupled together.

2.6 Performance Curves

From these curves it is possible to determine performance at ambient temperatures, altitudes, and conditions differing from those listed in the performance specifications.

- Power at Generator Terminal vs. Altitude above Sea Level
- Heat Rate vs. Ambient Temperature
- Power at Generator Terminal vs. Ambient Temperature
- Heat Rate, % of Base Load vs. % of Base Load
- Efficiency % vs. % of Base Load

2.6.1 LM2500+G4™, 50 Hz Curves



Basis of Performance: RH of 60% with 0imm H_20 inlet/0mm H_20 exhaust losses at 0ft MSL, Fuels: Natural Gas (44194 kJ/kg LHV) or Distillate (18400 Btu/lb LHV), 50 Hz, 11.5kV, 0.9PF. Not for guarantee. Gas Fuel NOx Water is to 51 mg/Nm3 @15% O_2; Liquid Fuel NOx Water is to 86 mg/Nm3 @15%O_2.

Figure 2.1 - Power at Generator Terminal vs. Altitude above Sea Level

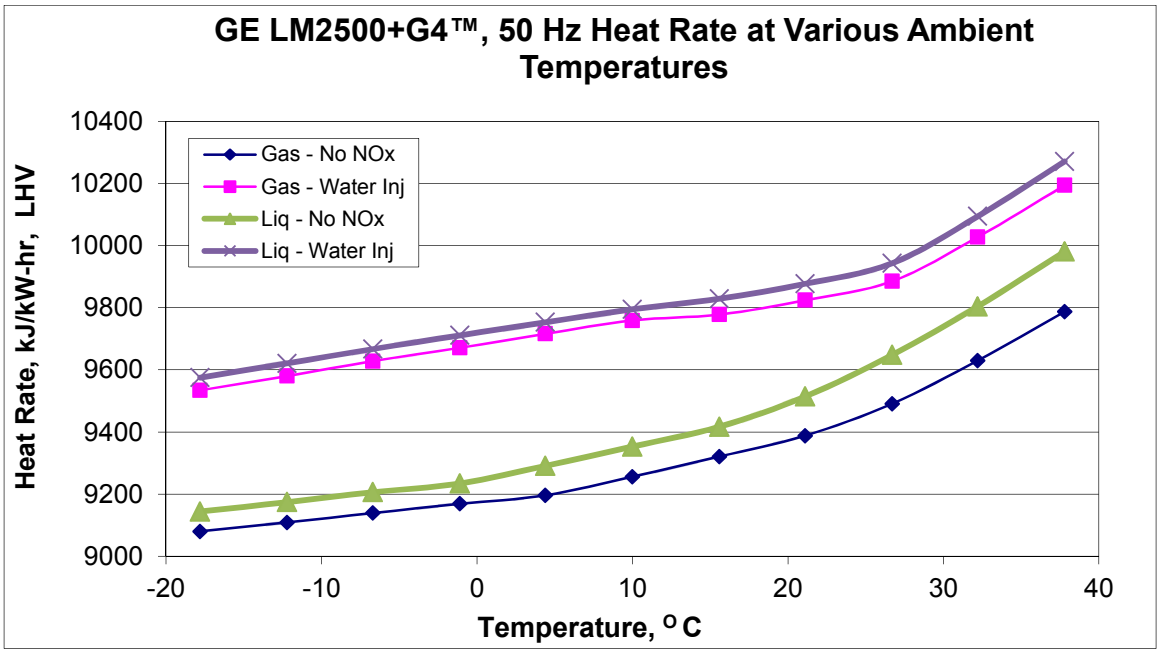


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Figure 2.2 - Heat Rate vs. Ambient Temperature

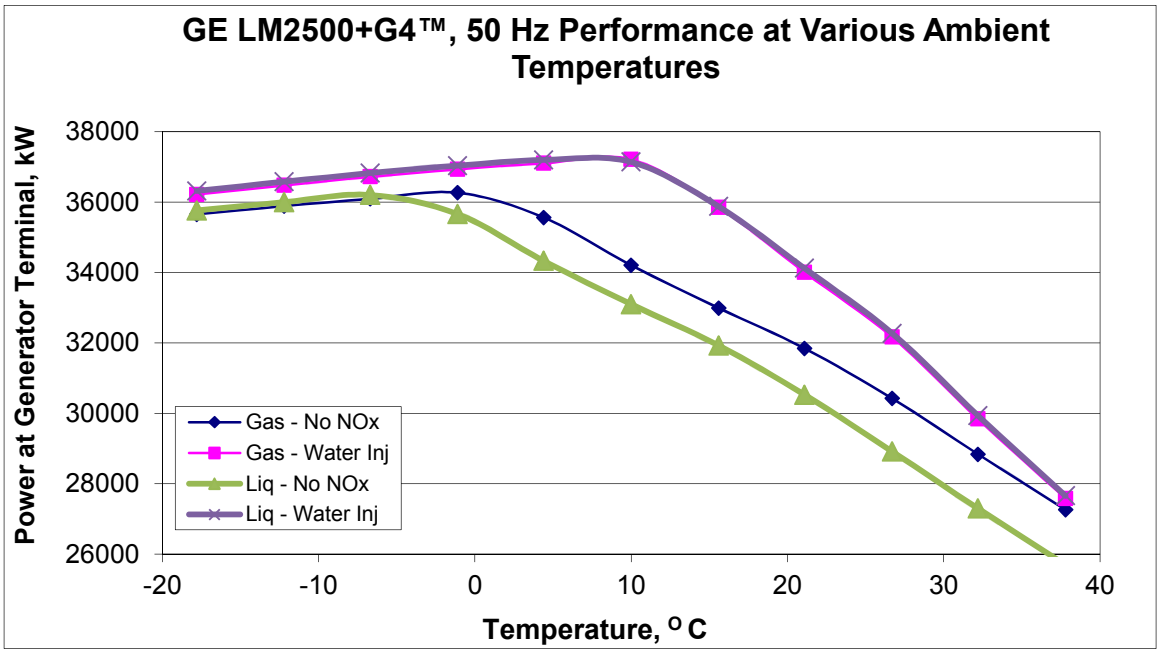

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Figure 2.3 - Power at Generator Terminal vs. Ambient Temperature

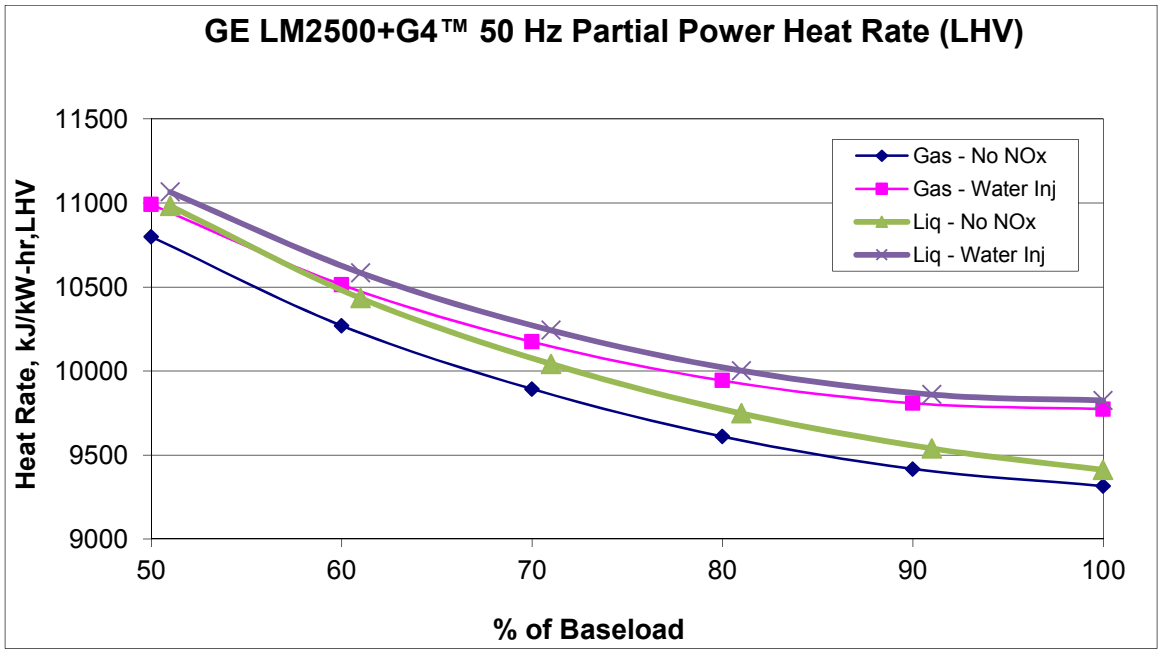

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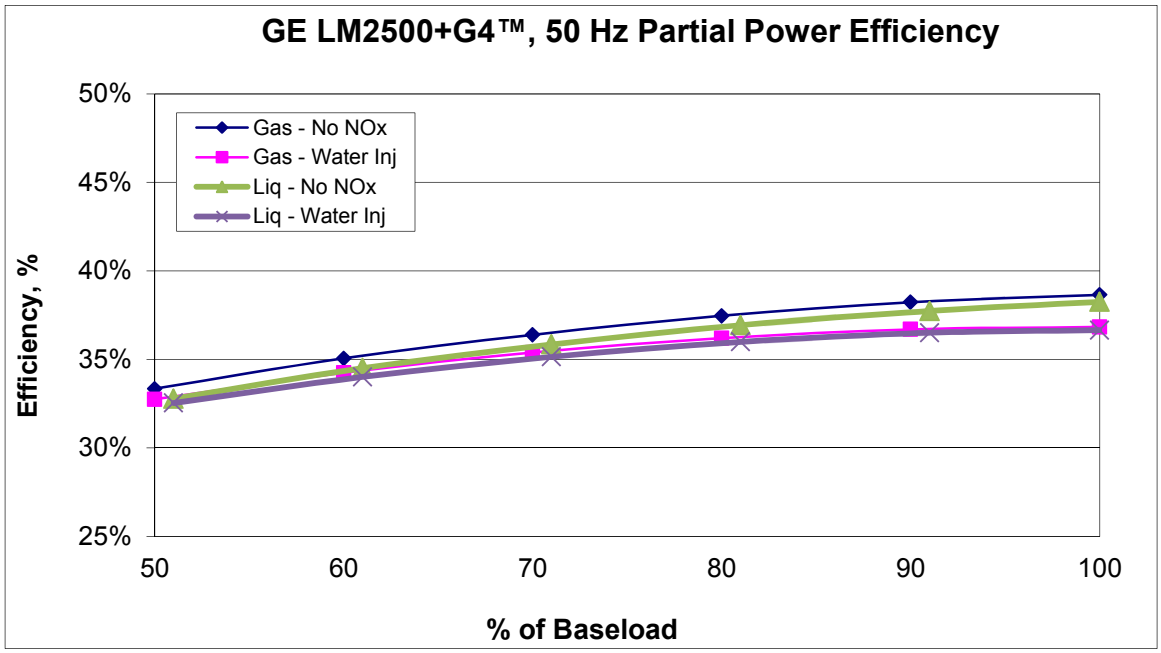
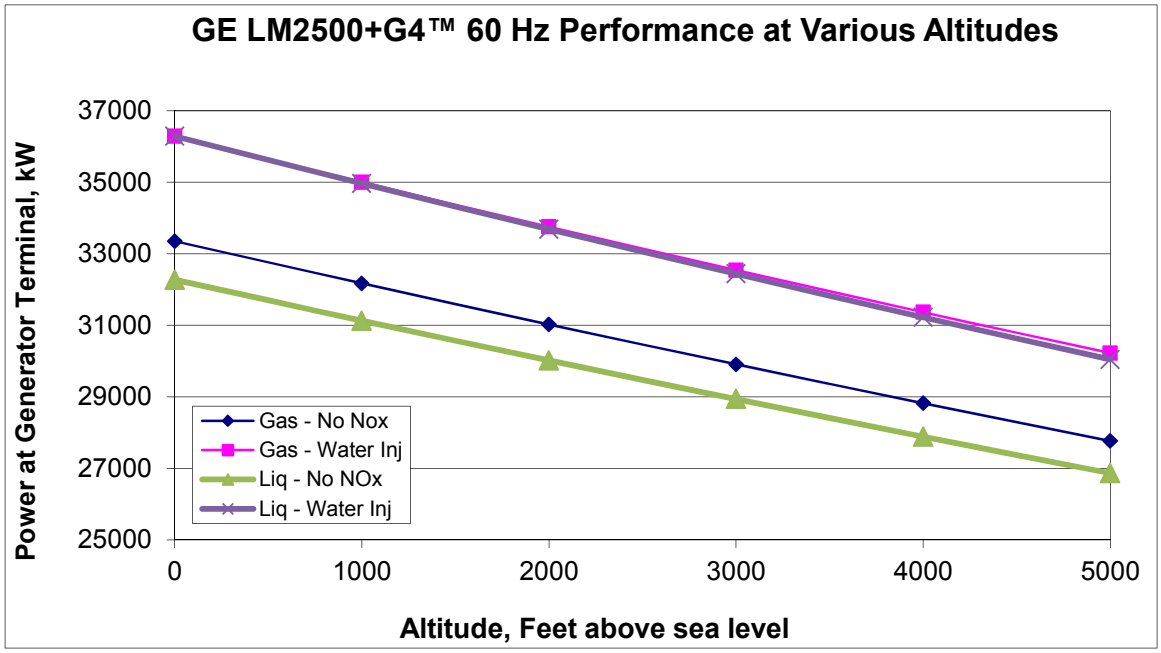
Figure 2.4 - Estimated Engine Heat Rate, % Base Load vs. Heat Rate kJ/Kw-hr, LHV



Basis of Performance: RH of 60% with 0imm H_20 inlet/0mm H_20 exhaust losses at 0ft MSL, Fuels: Natural Gas (44194 kJ/kg LHV) or Distillate (18400 Btu/lb LHV), 50 Hz, 11.5kV, 0.9PF. Not for guarantee. Gas Fuel NOx Water is to 51 mg/Nm3 @15% O_2; Liquid Fuel NOx Water is to 86 mg/Nm3 @15%O_2.

Figure 2.5 - Efficiency % vs. % of Base Load

2.6.2 LM2500+G4™, 60 Hz Curves



Basis of Performance: Amb 59°F RH of 60% with 0in H_20 inlet/0in H_20 exhaust losses at 0ft MSL, Fuel: Natural Gas (19000 Btu/lb LHV) or Distillate (18400 Btu/lb LHV), 60 Hz, 13.8kV, 0.9PF. Not for guarantee. Gas Fuel NOx Water is to 25 ppmvd @15% O_2; Liquid Fuel NOx Water is to 42 ppmvd @ 15% O_2.

Figure 2.6 - Power at Generator Terminal vs. Altitude above Sea Level

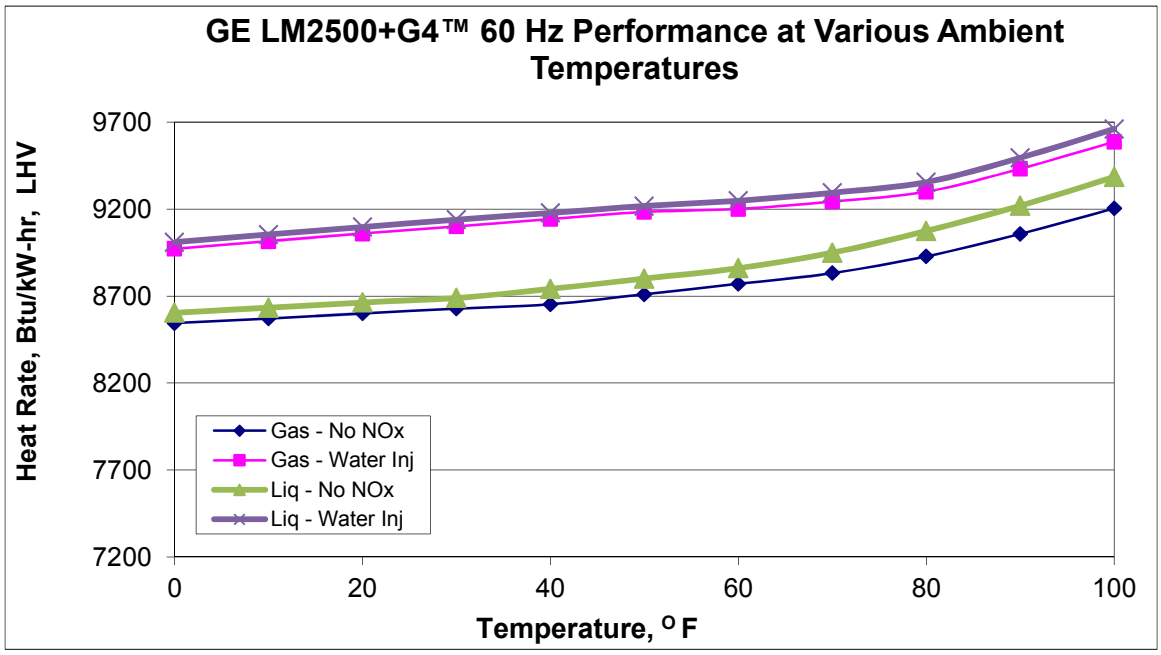


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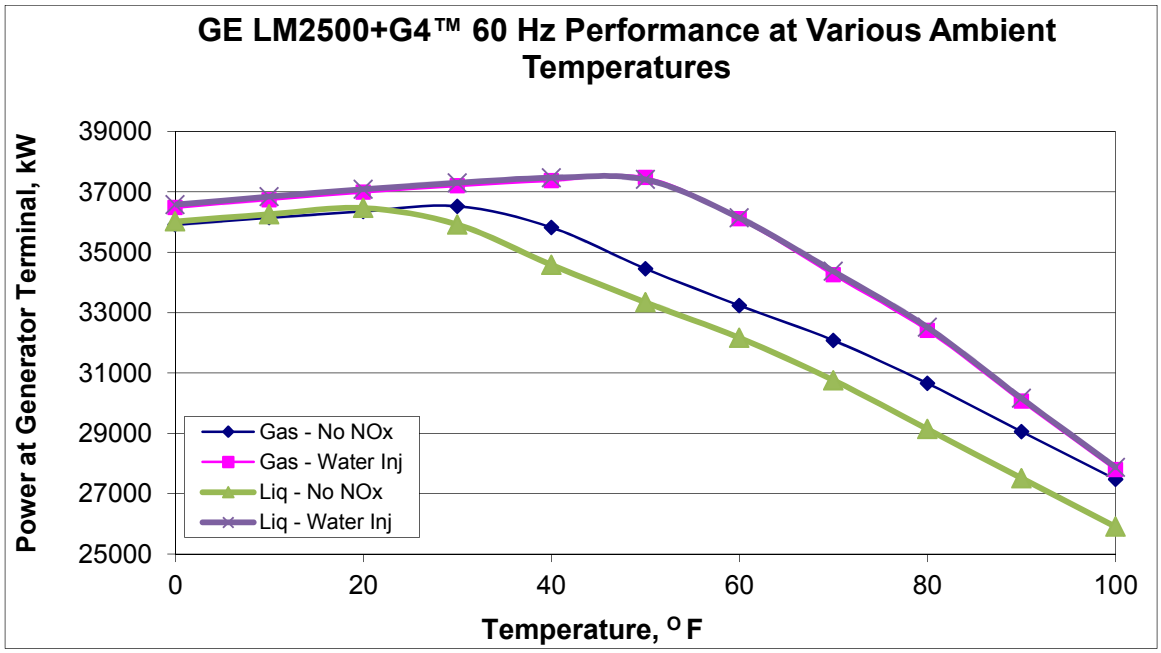
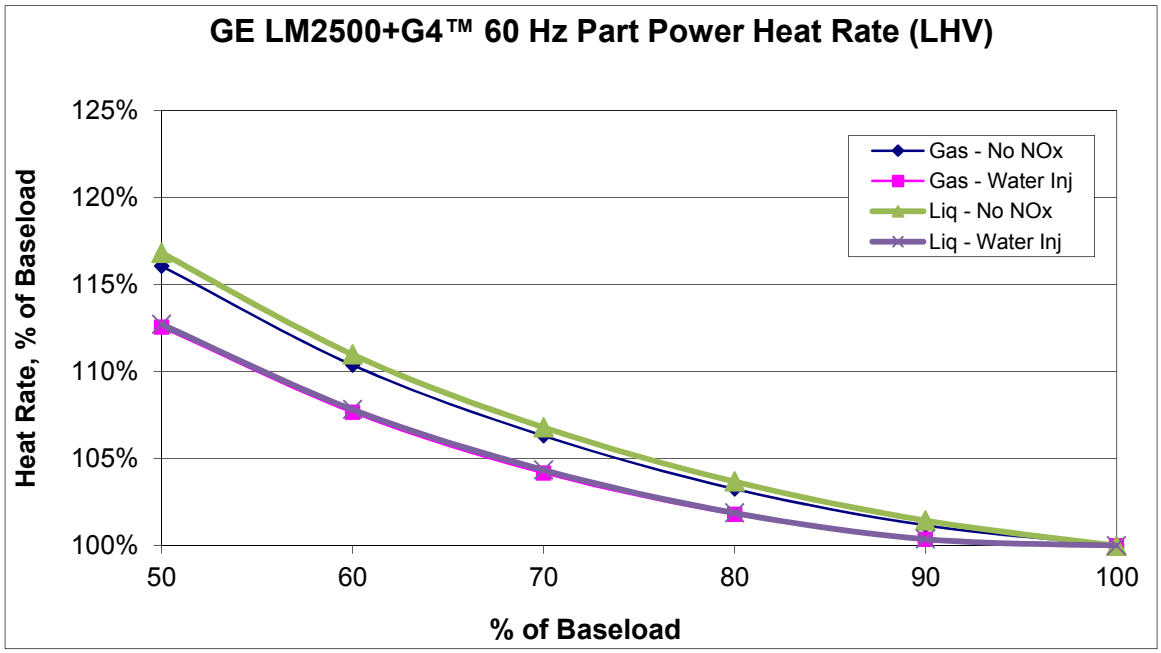
Figure 2.7 - Heat Rate vs. Ambient Temperature



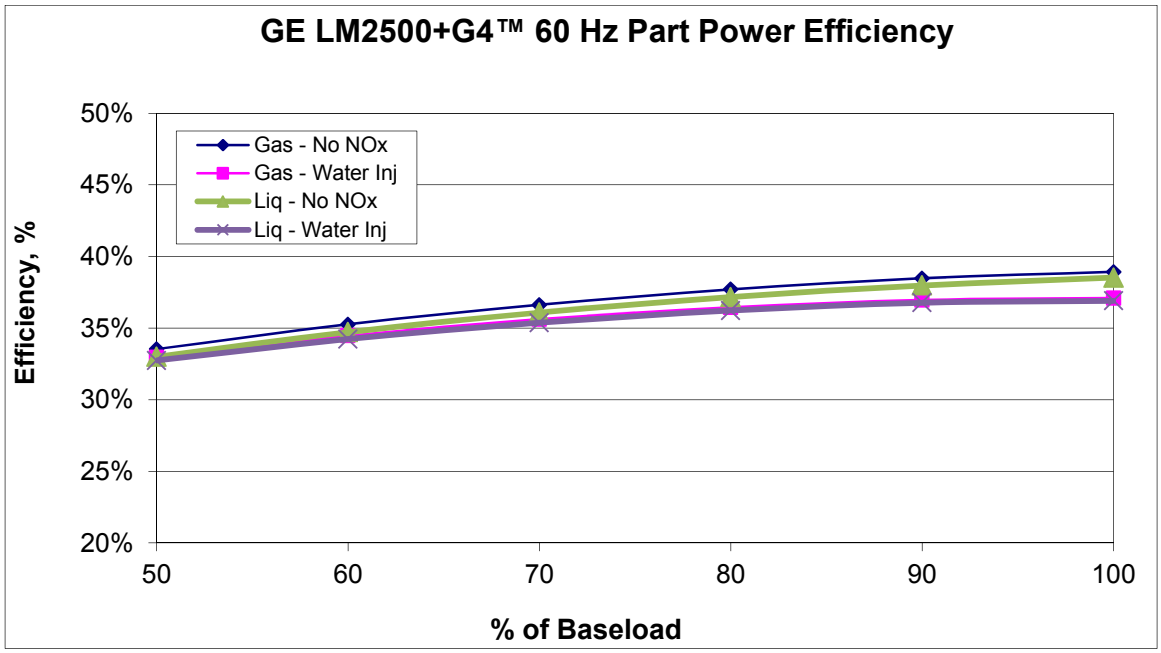
Basis of Performance: Amb 59°F RH of 60% with 0in H_20 inlet/0in H_20 exhaust losses at 0ft MSL, Fuel: Natural Gas (19000 Btu/lb LHV) or Distillate (18400 Btu/lb LHV), 60 Hz, 13.8kV, 0.9PF. Not for guarantee. Gas Fuel NOx Water is to 25 ppmvd @15% O_2; Liquid Fuel NOx Water is to 42 ppmvd @ 15% O_2.

Figure 2.8 - Power at Generator Terminal vs. Ambient Temperature



Basis of Performance: Amb 59°F RH of 60% with 0in H_20 inlet/0in H_20 exhaust losses at 0ft MSL, Fuel: Natural Gas (19000 Btu/lb LHV) or Distillate (18400 Btu/lb LHV), 60 Hz, 13.8kV, 0.9PF. Not for guarantee. Gas Fuel NOx Water is to 25 ppmvd @15% O_2; Liquid Fuel NOx Water is to 42 ppmvd @ 15% O_2.

Figure 2.9 - Heat Rate, % of Base Load vs. % of Base Load



Basis of Performance: Amb 59°F RH of 60% with 0in H_20 inlet/0in H_20 exhaust losses at 0ft MSL, Fuel: Natural Gas (19000 Btu/lb LHV) or Distillate (18400 Btu/lb LHV), 60 Hz, 13.8kV, 0.9PF. Not for guarantee. Gas Fuel NOx Water is to 25 ppmvd @15% O_2; Liquid Fuel NOx Water is to 42 ppmvd @ 15% O_2.

Figure 2.10 - Efficiency % vs. % of Base Load

2.7 Guarantee Basis

Performance guarantees are based upon local (ambient) conditions and overall cleanliness of the gas turbine with less than 200 fired hours. If more than 200 fired hours have elapsed before conducting a performance test, a General Electric representative has the right to inspect the unit to ensure condition and cleanliness standards have been met. Guarantees are based on a site test conducted in accordance with Distributed Power's standard practices and protocols as described in the Test Specifications. Distributed Power reserves the right to have a representative present during the performance test.

3. Codes and Standards

The applicable sections of the Global Codes and Standards listed are the most relevant standards for Distributed Power's manufactured gas turbine. GE designs and procedures are compliant with the applicable sections of the following listed standards. Applicability of listed standards, local specific standards and optional standards are applied within the specific project Transactional Compliance Plan. Revisions of the standards included below are based on at the time of publication of this document. Latest revisions as applicable are tracked and reviewed by Engineering and will be included during the next revision of this document.

Product Baseline Specifications (PBCSs) for your specific region will be provided upon request.

3.1 US and Canadian Codes and Standards

GE 60 Hz designs and procedures are compliant with the applicable sections of the following listed directives and standards. Canadian Standards applicable to Gas Turbines are equivalent to U.S. Codes and Standards.

Standard	Edition	Title
ANSI/ABMA 9	90(R2008)	Load Ratings and Fatigue Life for Ball Bearings
ANSI/ABMA 11	90(R2008)	Load Ratings and Fatigue Life for Roller Bearings
ASCE 7-10	2010 SUPP 1 2013	Minimum Design Loads for Buildings and Other Structures
ASME B1.1	2003 (R2008)	Unified Inch Screw Threads
ASME B1.20.1	2013	Pipe Threads, General Purpose, Inch
ASME B16.5	2013	Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	2012	Factory-Made Wrought Butt Welding Fittings
ASME B16.21	2011	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B31.1	2014	Power Piping
ASME B133.8	2011	Gas Turbine Installation Sound Emissions
NFPA 70	2014 ERRATA 4 2014	National Electrical Code
IEEE 37.90	2005	Relays Associated with Electric Power Apparatus
API 614	5ED 2008 ERRATA 08	Lubrication, Shaft-Sealing and Oil-Control Systems and Auxiliaries
API 616	5ED 2011	Gas Turbines for Petroleum, Chemical, and Gas Industry Services
API 650	2013 ERRATA 2013	Storage Tanks

3.1 US and Canadian Codes and Standards (continued)

Standard	Edition	Title
API 670	4ED 2000(R2010)	Machinery Protection Systems
API 671	4ED 2007(R2010)	Special-Purpose Couplings for Petroleum, Chemical, and Gas Industry Services
ASME PTC22	2005	Performance Test Code On Gas Turbines
ASME PV Code 8 DIV 1	2013	ASME Boiler and Pressure Vessel Code
ASME PV Code 9	2013	ASME Boiler and Pressure Vessel Code
IEEE C37.2	2008	Electrical Power System Device Function Numbers, Acronyms, and Contact Designations
IEEE 100	7ED 2000	Authoritative Dictionary of IEEE Standards Terms
NEMA MG 1	2011	Motors and Generators
NEMA MG 2	2014	Safety Standard and Guide for Selection, Installation, and Use of Electric Motors and Generators
ANSI S12.51	2012	Acoustics - Determination Of Sound Power Levels And Sound Energy Levels Of Noise Sources Using Sound Pressure - Precision Methods For Reverberation Test Rooms
ANSI S1.4-1	2014	Specification for Sound Level Meters
ANSI S1.13	2005(R2010)	Measurement of Sound Pressure Levels In Air
ASHRAE 52.2	2012	Gravimetric and Dust Spot Procedures for Testing Air-cleaning Devices Used in General Ventilation for Removing Particulate Matter
SAE J 184	2014 STABILIZED	Qualifying a Sound Data Acquisition System
AGMA 6011	I2003	Standard Practice for High Speed Helical and Herringbone Gear Units
IBC	2012	International Building Code
IEEE 421.1	2007	Definitions for Excitation Systems for Synchronous Machines
ISO 4413	2010	Hydraulic Fluid Power - General Rules And Safety Requirements For Systems And Their Components
TIA 232	F1997(R2012)	Interface Between Data Terminal Equipment And Data Circuit Terminating Equipment Employing Serial Binary Data Interchange
UL 796	10ED REV SEP 2013	Printed-Wiring Boards
J-STD-001	F2014 ADDENDUM 14	Guidelines
EN 55011	2009 AMD 1 2010	Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement

3.2 European Directives and Standards

GE 50 Hz designs and procedures are compliant with the applicable sections of the following listed directives and standards. Several International Standards are equivalent to listed European Normative (EN) Standards. Directives and Standards are mandatory for projects installed in the European Union (EU) and recommended for non-EU countries that accept the standards in lieu of their own local standards.

Directive	Title
ATEX 94/9/EC	Equipment and Protective Systems intended for use in Potentially Explosive Atmospheres Directive
2013/59/EURATOM	Basic Safety Standards for Ionized Radiation
PED 97/23/EC	Pressure Equipment Directive
RoHS 2011/65/EU	Restriction of Hazardous Substances (RoHS) Directive
WEEE 2012/19/EU	Waste Electrical & Electronic Equipment (WEEE) Directive
EMC 2004/108/EC	Electromagnetic Compatibility Directive
REACH 1907/2006/EC	Registration, Evaluation, Authorization of Chemicals (REACH) Directive
MD 2006/42/EC	Machinery Safety Directive
2006/66/EC	Battery Directive
LVD 2006/95/EC	Low Voltage Directive
IED 2010/75/EU	Industrial Emissions Directive

TRS Category	Standard	Edition	Title	Harmonized/ Design Standard
Electromagnetic Compatibility/ Interference	EN 55011	2009 AMD 1 2010	Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement	Harmonized
Electromagnetic Compatibility/ Interference	IEC 61000-4-2	2ED 2008	Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test	Design
Electromagnetic Compatibility/ Interference	IEC 61000-4-3	2010 (CONED) 3.2	Electromagnetic Compatibility (EMC) - Part 4-3: Testing and Measurement Techniques - Radiated, Radio-Frequency, Electromagnetic Field Immunity Test	Design

3.2 European Directives and Standards (Continued)

TRS Category	Standard	Edition	Title	Harmonized/ Design Standard
Electromagnetic Compatibility/ Interference	IEC 61000-4-4	3ED 2012	Electromagnetic Compatibility (EMC) - Part 4-4: Testing and Measurement Techniques - Electrical Fast Transient/ Burst Immunity Test	Design
Electromagnetic Compatibility/ Interference	IEC 61000-4-5	3ED 2014	Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test	Design
Electromagnetic Compatibility/ Interference	IEC 61000-4-6	4ED 2013	Electromagnetic Compatibility (EMC) - Part 4-6: Testing and Measurement Techniques - Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields	Design
Electromagnetic Compatibility/ Interference	IEC 61000-4-11	2ED 2004	Electromagnetic Compatibility (EMC) - Part 4-11: Testing and Measurement Techniques - Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests	Design
Low Voltage Directive 2006/ 95/EC	IEC 60034-1	12ED 2010	Rotating Electrical Machines - Part 1: Rating and Performance	Harmonized
Low Voltage Directive	IEC 60034-3	6ED 2007	Rotating Electrical Machines - Part 3: Specific Requirements for Synchronous Generators Driven by Steam Turbines or	Harmonized
Electrical Safety	IEEE C37.90.1	2012	Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated With Electric Power Apparatus	Design
Electrical Safety	EN 61010-1	2010	Safety Requirements for Electrical Equipment for Measurement , Control and Laboratory Use, Part 1: General Requirements	Harmonized
Explosive Atmospheres	EN 60079-15	2010	Electrical apparatus for explosive gas atmospheres - Part 15: Construction, test and marking of type of protection "n" electrical apparatus	Harmonized

3.3 Optional Drafting Standards

The GE Gas Turbine Drafting Standards are based on the following Standards appropriated to the Gas Turbine. Please note that in several instances, symbols, etc. have been devised for GE's special needs (such as flow dividers and manifolds):

Standard	Edition	Title
ASME B46.1	2009	Surface Texture, Surface Roughness, Waviness, and Lay
ASME V14.36M	96(2008)	Surface Texture Symbols
IEEE 315	75(R1993)	Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Letters)
AWS D1.1	2010 ERRATA 2011	American Welding Specification
AWS A2.4	2012	Standard Symbols For Welding, Brazing, And Nondestructive Examination

3.4 Other Optional Codes and Standards

GE contracts may take exception to any unidentified codes or standards listed in this section or additional standards identified by a specification. Applicability and compliance through similarity comments can be prepared to such codes or standards. Type certification compliance requires additional business commitment and approval through PCB.

Product Baseline Specification (PBCS) additional standards and the compliance requirements will be provided upon request.

3.5 Compliance with Legislations and Regulatory Approvals

Engineering and manufacture of the Gas Turbine equipment is in accordance with GE Aviation design practices, manufacturing processes, procedures, and quality assurance programs, to comply with the applicable portions of the codes and standards listed in this section. Separate analysis for each project for compliance to the applicable national laws of a country that impact the design requires review and approval with PCB.

4. Major Equipment List

The TM2500 GEN8 MGTG set is a trailer mounted mobile power package. The trailer system allows for simplified transportation and set up of the package. The TM2500 GEN8 MGTG set typically consists of three trailers: the Turbine Trailer, Generator Trailer, Control House Trailer, as well as an optional Transportation Trailer. The basic scope of supply for each of these trailers is described in the following subsections and in Section 5 – Mechanical System Description.

4.1 Turbine Trailer

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, turbine exhaust silencer and 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:

- Turbine Trailer (with optional stinger for US and Canadian transport compliance)
- Gas Turbine Engine w/ Turbine Enclosure
- Turbine Gauge Panel (TGP)
- Fire Protection Aerosol Canisters
- Auxiliary Skid - contains the following:
  - Turbine Control Panel (TCP)
  - Turbine Lube Oil (TLO) System (shared)
  - Hydraulic Start System
  - 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

For transportation requirements in the United States and Canada, the turbine trailer has an optional stinger available.

Trailer and optional stinger

A three-axle, air ride suspension trailer with two steerable axles is used to transport the turbine trailer components. The optional stinger has a single-axle and is used to assist in weight distribution to meet U.S. and Canadian transport requirements. At the jobsite, the turbine trailer is connected to the generator trailer. Landing legs are provided to support and level the equipment at the jobsite.

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) for liquid fuel and 87 dB(A) for gas fuel. 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+G4™), 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. See Section 5.1 for more details.

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.

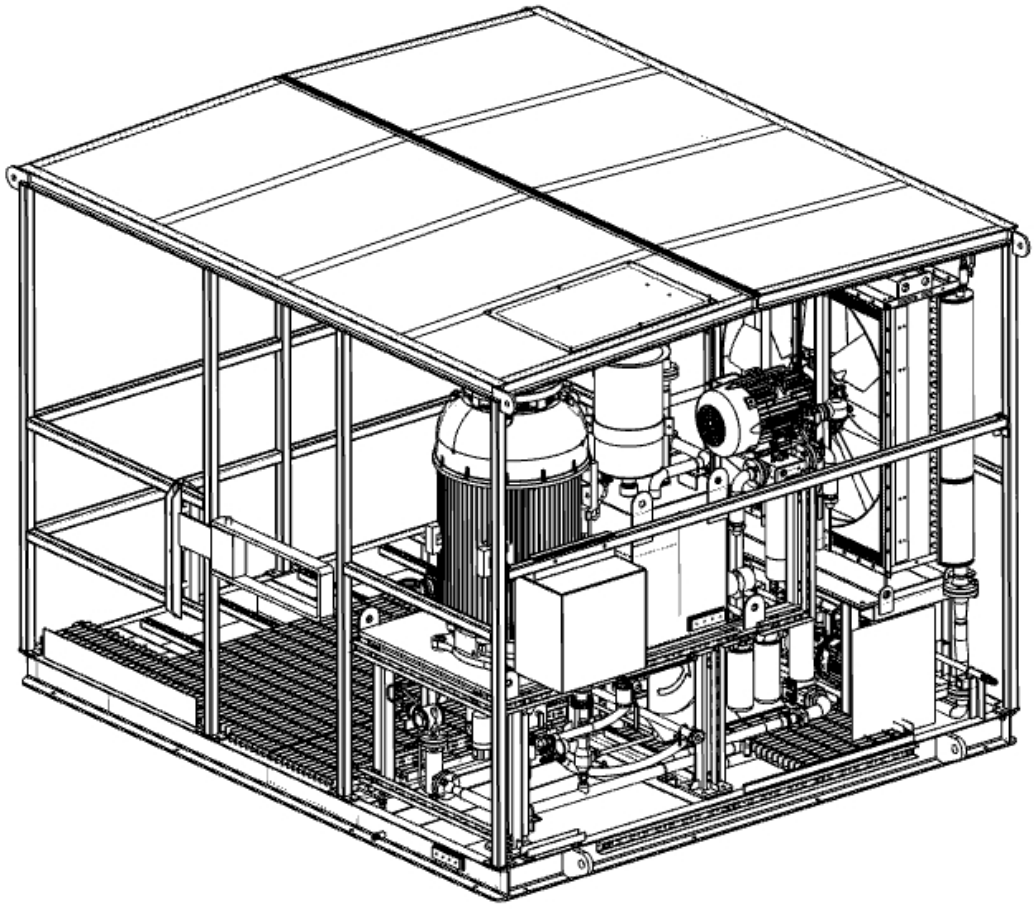
Fire Protection Aerosol Canisters

Fire protection aerosol canisters are located on top of the turbine enclosure, included as part of the ventilation fan assembly. These canisters are connected to the fire protection system located in the Generator Control Panel (GCP) and provide the

necessary extinguishing agent in the event of a fire inside the enclosure. See Section 5.10 for more details.

Auxiliary Skid

The auxiliary skid is a compact installation of several systems and equipment and is positioned on the gooseneck of the turbine trailer. This skid contains a variety of support equipment including a TCP, the Hydraulic Start System with shared turbine lube oil reservoir, 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.



Auxiliary Skid (TCP not shown)

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 will include:

- RX3i
- VersaMax Controllers
- Bently Nevada 3701
- Jaquet T401
- Servo Position Controllers (For variable geometry and compressor discharge)

Hydraulic Start System – The hydraulic start system mounted on the auxiliary skid will include:

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

See Section 5.8 for more details.

Turbine Lube Oil (TLO) System – The synthetic lube oil system mounted on the auxiliary skid will include:

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

See Section 5.7 for more details.

Off-Line Water Wash System – The water wash system mounted on the auxiliary skid will include:

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

See Section 5.9 for more details.

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. See Section 5.2 for more details.

Dual Fuel with Water Injection System

All components for the dual fuel system with water injection, with the exception of the gas fuel skid, are located on the turbine trailer. All components come preassembled from the factory. Mechanical interconnect locations for liquid fuel and water are provided for customer connection just below the turbine gauge panel. See Section 5.6 for more details.

Gas fuel system major components include:

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

Liquid fuel system major components include:

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

Water Injection System:

GE 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. The customer must 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 the only GE mechanical interconnect provided with the package.

Turbine Exhaust

The LM2500+G4™ gas turbine exhaust flows through an exhaust collector and roof mounted exhaust silencer. The standard TM2500 GEN8 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. See Section 5.5 for more details.

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 in-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)
- Laser (Green)
- Light
- Power Switch
- Tablet (Microsoft Surface™)

4.2 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 overall 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 with stinger for transportation
- Generator
- Generator Lube Oil Skid
- Generator Ventilation (when package is fully assembled)
- Switchgear

For transportation purposes, the generator trailer has a stinger with hydraulic steering. **The stinger must be connected when transporting the generator trailer at all times.**

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 jobsite, the generator trailer is connected to the turbine trailer. Landing legs are provided to support and level the equipment at the jobsite.

Generator

The AC generator operates at a synchronous speed of 3,600 rpm (60-Hz applications) or 3,000 rpm (50-Hz applications), eliminating the need for a speed-reducing gearbox during simple-cycle operation. The TM2500 GEN8 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 GLO skid contains the generator lube oil air/oil separator, GLO tank, DC lube pump and GLO filter.

The skid contains transmitters that provide remote system monitoring. The pressure transmitters have instrument valves in their feed lines to simplify maintenance.

The mineral lube oil system for the generator will include:

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

Switchgear

The TM2500 GEN8 has a self-contained, metal clad switchgear; it is located on the front portion of the generator trailer.

The switchgear houses the following components:

- Generator breaker
- Buses
- Current Transformers
- 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.

4.3 Control House Trailer

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

The control house trailer consists of the following components:

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

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

Control House Trailer

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

Control House

The control house trailer contains the control house, which houses the Human-Machine Interface (HMI), Generator Control Panel (GCP) and the MCC (Motor Control Center). Additionally, an externally accessed room is provided for the system batteries.

The control house packaged equipment is described below:

HMI - The human machine interface which 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 and chair 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 Beckwith Integrated Generator Protection System (IGPS) for monitoring the operation of the turbine engine and generator. 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 as needed. 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 also includes a 30 kVA lighting and distribution transformer.

Batteries and Chargers - The TM2500 GEN8 has a 24 VDC control system battery system and charger, a 24 VDC fire system battery system and charger, and a 125 VDC switchgear and backup generator lube pump motor battery system and charger. The battery systems are fully wired and mounted in racks located in a separate ventilated compartment in the control house. The standup charger unit for all these components is located inside the control house trailer for easy accessibility. The 24

VDC distribution circuit breakers for the fire and gas protection system are located in the battery chargers cabinet.

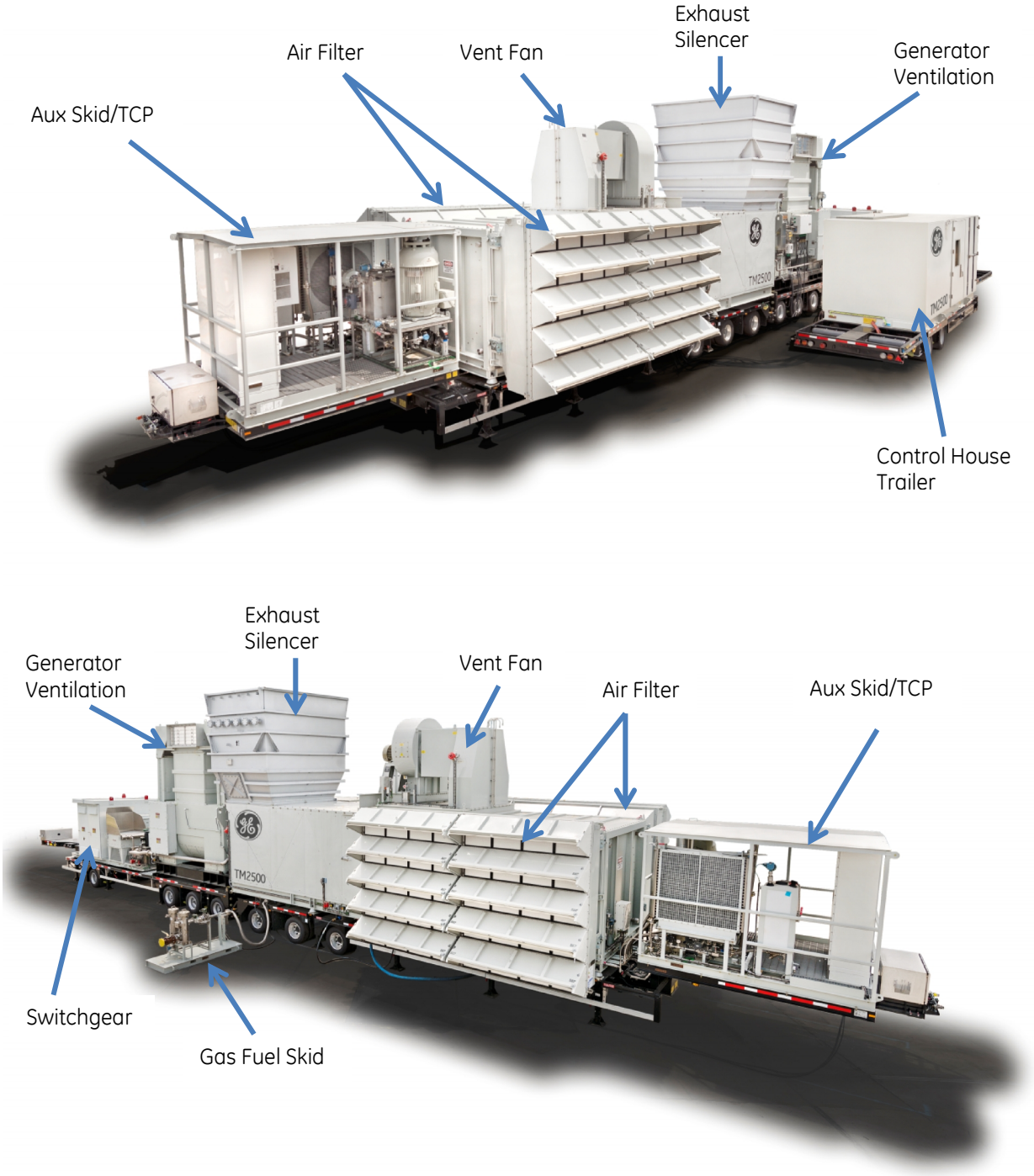


Figure 1 – TM2500 GEN8 Operational Configuration

4.4 Transportation Trailer (optional)

The TM2500 GEN8 MGTG offers the option of ordering a transportation trailer. Additionally, the transport trailer can be factory fitted with a crane to enable the owner/operator the ability to have a self-sufficient package that can be assembled and disassembled with only factory provided components.

The optional transportation trailer is a two-axle air rid suspension trailer. This trailer, if ordered, is used to transport the turbine air filter modules, turbine exhaust silencer, generator filter modules and optional crane.

4.5 Factory Miscellaneous

In addition to the supply of the equipment, for each unit Distributed Power will:

- Conduct standard factory tests of the equipment and conform to carefully established QA practices.
- Test the turbine package and control system, including flushing, and verification of safety alarm and shutdown set points.
- Coordinate drafting, manufacturing, and shipping schedules to meet contractual requirements.
- Prepare the equipment for shipment.
- Ship the equipment, ex-works from Houston, Texas and other manufacturing facility locations.

4.6 Drawing, Documentation and Training

For the site, the documentation provided is:

- Buyer's drawings and six (6) copies of the Operation and Maintenance (O&M) manuals in CD form.
- The Installation and Commissioning (I&C) manual is a one volume publication. Three copies of this manual are shipped to the site at least one month prior to MGTG unit shipment.

  Note: A recommended installation schedule will be prepared by GE, which will define the manpower loading, and classification of the supervisors provided, as well as the schedule of events.

- Three (3) copies of the Renewal Parts manual, which contains lists of recommended parts.
- Field technical direction for performance tests per GE standard test procedures.

(See Section 14 for further details on Customer Drawings and other documentation)

Site personnel training:

- Hosting a Gas Turbine Familiarization and Operator's Training Course for customer personnel at the Distributed Power Jacintoport facility.

(See Section 16 for further details on training)

4.7 Factory Testing

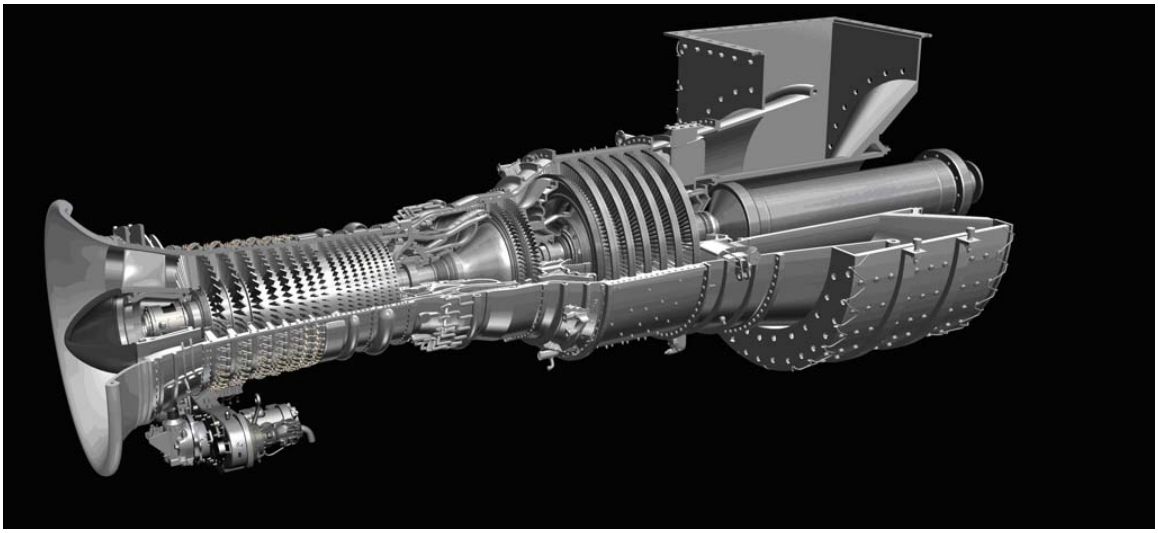
Over the last 20 years, the petroleum industry has saved millions in capital investment costs and field startup time by preassembling and testing equipment modules before shipment to the customer site. Distributed Power has adopted this "factory packaging concept" for our complete line of gas turbine products. Static testing is the base of our standard offering consisting of a rigorous 400-point test. Following minimal disassembly, the unit is crated and prepared for shipment (or customer pickup).

5. Mechanical System Description

5.1 Turbine Engine

The LM2500+G4™ gas turbine is the prime driver of the MGTG set. This engine is a two shaft design with the gas generator separate from the power turbine. This mechanically decoupled design allows the power turbine to operate at a continuous speed of 3,000 rpm (50-Hz applications) or 3,600 rpm (60-Hz applications), 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 3,000 rpm or 3,600 rpm, eliminating the need for a speed reducing gearbox.

The main components of the LM2500+G4™ gas turbine assembly consist of a gas generator, a power turbine, a coupling, and inlet and exhaust components.

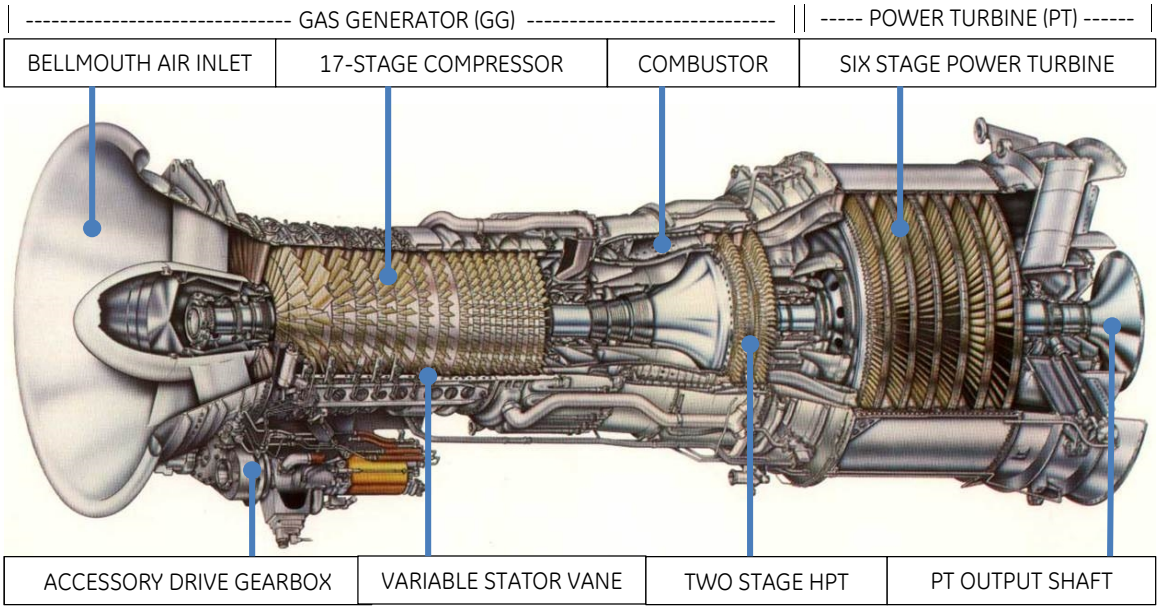


The LM2500+G4™ SAC GG/GT engine comes fully assembled with the following standard equipment installed and tested at the factory:

- GG with 17-stage high pressure compressor (HPC), SAC combustor, and 2-stage high pressure turbine (HPT)
- Six-stage PT (GT only)
- Inlet duct and centerbody (except spare engine)
- Accessory gearbox (AGB), consisting of the transfer gearbox (TGB) assembly and the inlet gearbox assembly (IGB)
- AGB driven lube pump, scavenge pump, hydraulic pump/variable stator vane (VSV) servo valve, and air/oil separator
- Variable-geometry (VG) control system for the VSV system

- Dual fuel system nozzles and manifolds
- Ignition system (igniter and exciter)
- Engine lubrication system (less oil tank, cooler, and filters)
- Set of instrumentation sensors
- Forward adapter (for connecting with flex coupling and driven equipment [GT])

The inlet duct and center body are referred to as the engine inlet components. The gas generator is composed of a variable geometry compressor, an annular combustor, a high-pressure turbine, an accessory drive system, controls and accessories. The power turbine is composed of a six-stage low-pressure turbine rotor, a low-pressure turbine stator, and a turbine rear frame. The high-speed coupling shaft adapter is connected to the power turbine rotor and provides shaft power to drive the generator. The exhaust duct, outer cone, and inner deflector are considered the engine exhaust components.



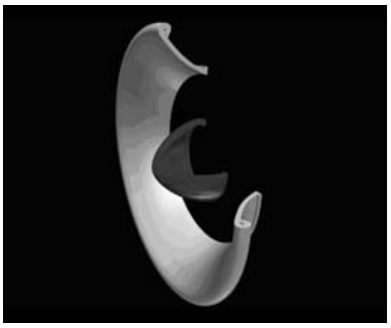
Mating splines connect the HPC and the HPT rotors. The HP rotor turns clockwise when viewed from aft, looking forward. The inlet duct and center body are the engine inlet components mounted to the compressor front frame (CFF). The structural frames provide support for the HPC rotor, bearings, compressor stator, HPT rotor, and the power turbine (PT) rotor. These include the CFF, compressor rear frame (CRF), and the turbine mid frame (TMF) in the gas generator (GG), and the turbine rear frame (TRF) in the power turbine (PT). The PT connects to the GG via a joining kit to produce the gas turbine assembly.

The LM2500+G4™ gas turbine uses the low-pressure turbine (LPT) to power the output shaft. By eliminating the separate compressor found in many other gas turbines, the LM2500+G4™ design simplifies the engine, improves fuel efficiency and permits coupling, through a flexible dry type coupling connected to the end of the LPT shaft.

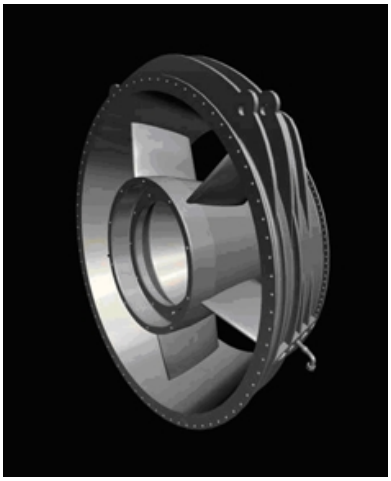
Turbine Cycle

- Filtered air enters the bellmouth and flows through guide vanes to the compressor and then travels through the HPC
- The air is compressed in a 24:2 ratio
- Combustor swirlers and fuel nozzles mix air and fuel at the nozzle tip
- Hot combustion gases expand through HPT
- HPT drives HPC
- Flanged end of LPT shaft drives electric generator load
- Exhaust gasses exit engine/package at exhaust flange

The gas turbine engine is comprised of the following major sections:



Air Inlet and Inlet Guide Vane (IGV) Section
The air inlet section consists of a bellmouth and bullet nose, which produce a smooth, non-turbulent flow of air into the compressor. Movable guide vanes at the inlet (IGV) control airflow through the engine for any given core speed.



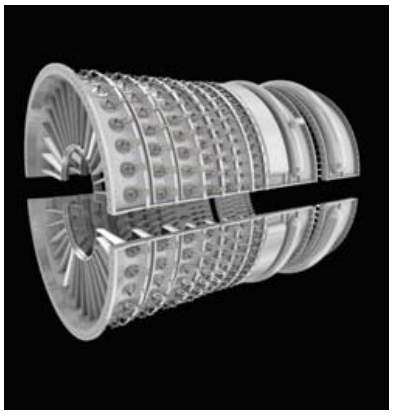
Compressor Front Frame (CFF)
The steel front frame assembly forms a flow path for compressor inlet air, and houses the #3 roller bearing. Struts between the hub and outer case contain lubrication supply and gravity lines. The front frame provides mounting or attachment provisions for the gas turbine front mounts, handling mounts, compressor inlet temperature sensor, and transfer gearbox mounts. Air passages in the frame provide sump and seal pressurization and cooling. The lower frame strut houses a radial drive shaft that transfers power from the inlet gearbox to the accessory gearbox mounted on the bottom of the frame.

High Pressure Compressor (HPC)

The LM2500+G4™ HPC is a 17-stage, axial flow design. Major components include the high pressure compressor rotor (HPCR), high pressure compressor stator (HPCS), and CRF. The purpose of the compressor is to compress air for combustion. Some of the compressed air is also extracted for engine cooling and pressurization.

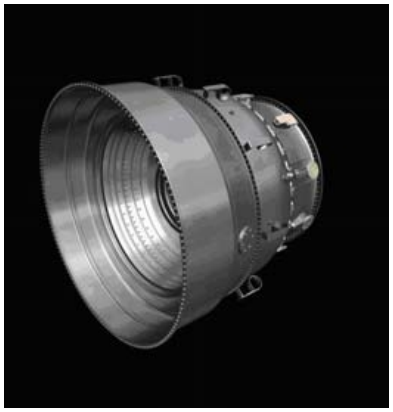
High Pressure Compressor Rotor (HPCR)

The HPCR is a spool-and-disk bolted joint structure. The rotor is supported at the forward end by a roller bearing in the CFF, and the aft end of the rotor is supported by a roller bearing in the CRF. Close clearances are obtained with metal spray rub coating. Thin squealer tips on the blades and vanes contact the sprayed material. Abrasive action on the tips prevents excessive rub while obtaining minimum clearance.



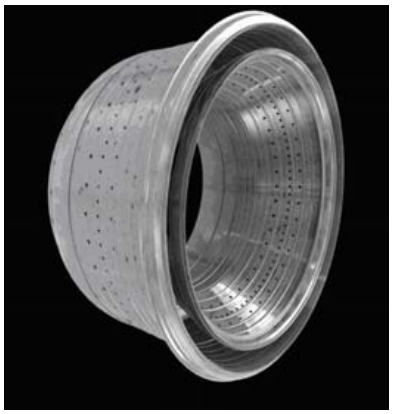
High Pressure Compressor Stator (HPCS)

The HPCS consists of two forward casing halves and two aft casing halves, each split horizontally and bolted together. They house variable and fixed vanes, and provide a structural shell between the CFF and the CRF. Inlet guide vanes (IGVs) and stages 0 through 6 are variable. Their angular positions change as a function of turbine temperature and speed. This gives the vane airfoil the optimum angle of attack for efficient operation without compressor stall.



Compressor Rear Frame (CRF)

The CRF consists of an outer case, struts, hub, and the B-sump housing. Its outer case supports fuel pre-mixers and an igniter plug. The CRF, in conjunction with the combustor cowl assembly, serves as a diffuser and distributor of compressor discharge air to the combustor.



Combustor

The standard combustor is a single-annular design consisting of four major components: cowl (diffuser) assembly, dome, inner liner, and outer liner. The cowl assembly, in conjunction with the compressor rear frame, serves as a diffuser and distributor for the compressor discharge air. It furnishes uniform airflow to the combustor throughout the operating range, providing uniform combustion and even temperature distribution to the turbine.

High Pressure Turbine (HPT)

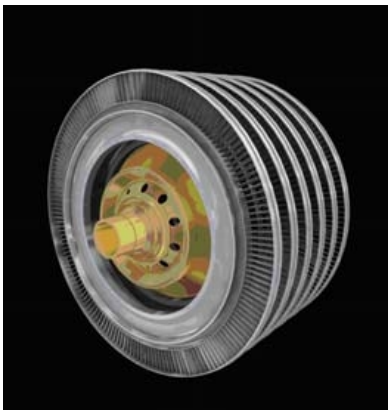
The HPT is an air-cooled, two-stage power turbine that consists of a rotor and two stages of nozzles. The nozzles direct the hot gas from the combustor on to the high pressure turbine rotor (HPTR) blades at the optimum angle and velocity. The HPTR extracts energy from the exhaust gas to drive the HPCR, to which it is mechanically coupled.

Turbine Mid-Frame (TMF)

The turbine mid-frame supports the aft end of the high pressure turbine rotor and the forward end of the power turbine rotor. The frame diffuser provides a smooth flow path for air flowing into the power turbine.

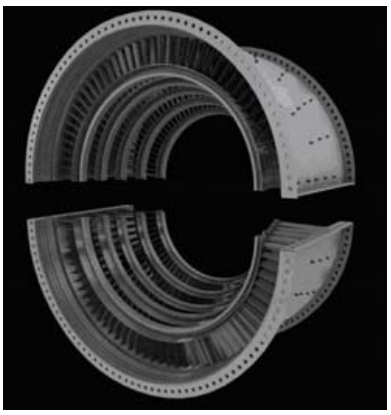
Power Turbine (PT)

The power turbine is a 6-stage aeroderivative design, suited for 3,000-3,600 rpm output speeds. The PT assembly consists of a turbine rotor, stator, rear frame, and drive shaft adapter.



Power Turbine Rotor

The PT rotor is a 6-stage low-pressure turbine rotor. It consists of six disks, each having two integral spacers. Each disk spacer is attached to the adjacent disk spacer by close-fitting bolts. Blades of all six stages contain interlocking tip shrouds for low vibration, and are retained in the disks by dovetails.



Power Turbine Stator

The PT stator consists of two casing halves split horizontally, stages 2 through 6 turbine nozzles, and six stages of blade shrouds. Stages 2 to 3 nozzles have welded segments of six vanes each. Vanes are coated for corrosion and oxidation protection where applicable.

Turbine Rear Frame (TRF)

The TRF consists of an outer casing, eight radial struts, and a stainless steel hub. It forms the PT exhaust flow path and supports the aft end of the PT stator case. It also provides a mounting point for the outer cone of the exhaust system and GT rear supports. The struts contain service lines for lubrication and sump scavenging and venting.

Accessory Drive Section

The accessory drive section consists of an inlet gearbox (IGB), a radial drive shaft, a transfer gearbox (TGB), and an accessory gearbox (AGB). The hydraulic starter, lube and scavenge pump, air-oil separator and hydraulic pump are mounted on the AGB.

Inlet Gearbox (IGB)

Power to drive accessories is extracted from the compressor rotor through a large diameter hollow shaft, which is spline-connected to the turbine rotor. A set of bevel gears in the IGB transfers power to the radial drive shaft, which transmits the power to another set of bevel gears in the TGB. A short horizontal drive shaft transmits the power to the AGB. Internal gears drive various accessory adapters in the AGB.

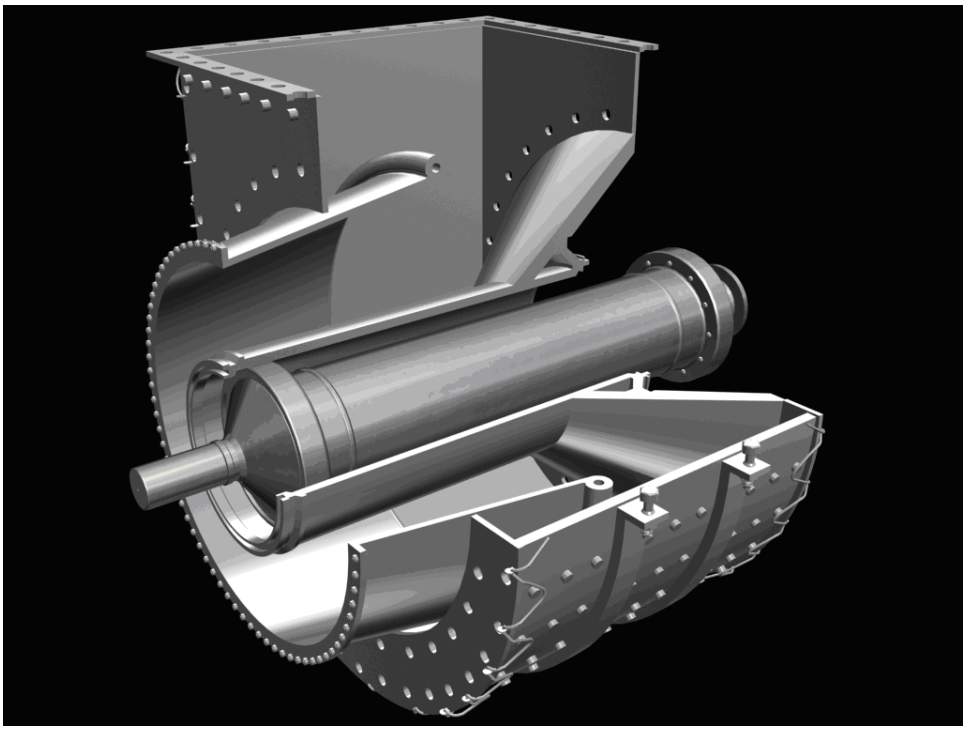
Exhaust System

The exhaust flows through an exhaust collector and a 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
- Radial exhaust collector system



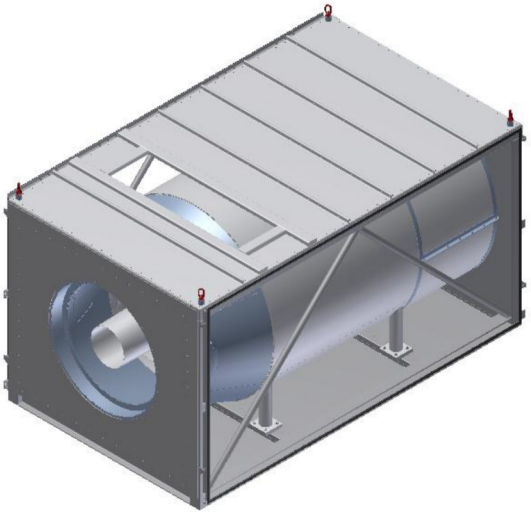
Flexible Coupling

A high-speed flexible coupling shaft connects the low-pressure turbine/power turbine to 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 generator.

5.2 Clean Air Filters and Silencer Assembly

The air intake system for the TM2500 GEN8 MGTG is a compact, dual aspect filtration system, mounted to a central silencer enclosure, designed to meet the technical requirements of the GE LM2500+G4™ gas turbine. The complete filtration system, for combustion and ventilation air, is a high efficiency package designed to reduce a wide range of airborne contaminants to within specified limits. Typical airborne contaminants include; high concentrations of dust, un-burnt hydrocarbons, and sand.

The combined turbine combustion and ventilation supply air is supplied by silencer enclosure mounted with filter housing panels on each side. The silencer enclosure is a structural, open-sided chamber, permanently mounted to the trailer bed directly upstream of the GT enclosure. An annular silencer is centrally mounted within the chamber to direct airflow towards the turbine inlet, whilst reducing noise break-out to required levels. The silencer enclosure has no serviceable parts and, once installed on the trailer bed, is not intended to be removed. The silencer enclosure is comprised of an enclosure, a FOD (foreign object damage) screen with a nylon FOD sock, and concentric silencer, high efficiency filter elements and controls.

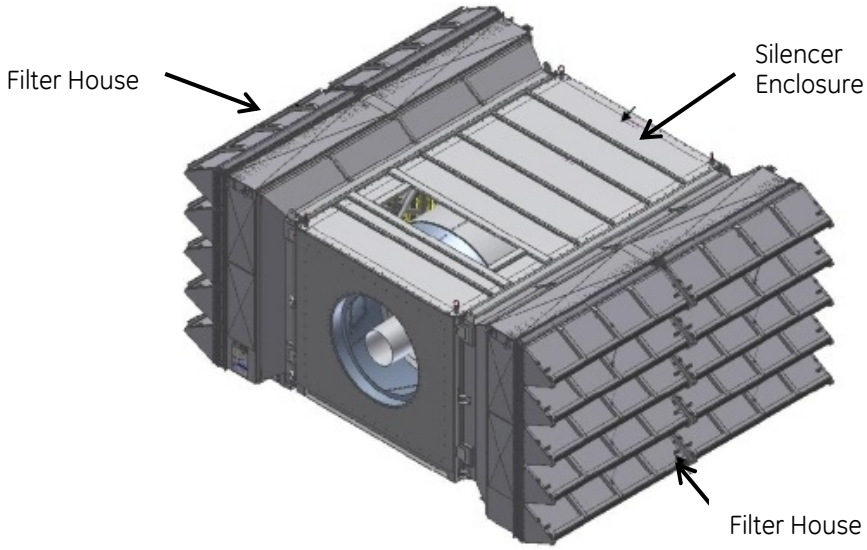


Annular Silencer & Enclosure

Filter House Panels

Filtered air for combustion is provided through the filter house and inlet silencer prior to entering to the inlet of the turbine. Combustion air flows at a nominal rate of 150,000 scfm (4,248 scmm) from the filter elements. The clean air passes through a FOD screen with a nylon FOD sock and through the concentric silencer. From the exit of the concentric silencer, the clean air enters the turbine bell mouth of the turbine engine where it is mixed with fuel and burned in the combustor.

Additionally an external drain valve is located below, in the bottom of the silencer enclosure.



5.3 Enclosure

The basic equipment package is supplied with a weatherproof acoustic enclosure for the turbine. The enclosure is completely assembled and mounted over the equipment prior to testing and shipment. The turbine compartment is fully ventilated and includes access doors.

Turbine Ventilation

Ventilation air for the cooling of the turbine is drawn into the turbine room by one direct driven ventilation fan mounted on the roof structure; Ventilation airflow is drawn by the ventilation fan at a nominal rate of 35,000 scfm (992 scmm), enters the turbine compartment where it circulates around and cools mechanical components. This direct driven ventilation fan assembly draws filtered air from inside the silencer enclosure. Ventilation air is routed through a silencer and back draft fire damper into the turbine enclosure. The backdraft fire damper (on the turbine enclosure roof) is gravity operated and open when the fan is running. The back draft fire dampers are normally closed when the gas turbine is not operating.

Generator Ventilation

The generator is equipped with a separate air treatment module that includes inlet filters, inlet/outlet silencer assemblies, and pressure and temperature sensors. The generator rotor is equipped with fan blades to produce a flow of cooling air through the interior of the generator. The blades draw cool, filtered ambient air into the generator and circulate it around internal parts before expelling the now heated air through the generator exhaust vent.

5.4 Noise Control

The standard equipment enclosure and air inlet silencers reduce the average near-field noise to an average 90 dBA at three feet from the enclosure (five feet above grade).

5.5 Turbine Exhaust

The LM2500+G4™ exhaust flows through an exhaust collector and roof mounted exhaust silencer. The standard TM2500 GEN8 exhaust collector exit is oriented in the upright position.

5.6 Fuel System

The TM2500 GEN8 MGTG set offers dual fuel (gas + liquid) capabilities for SAC combustor through the full load operations and are sequenced and controlled automatically by the control system. TM2500 GEN8 trailer unit is designed to start up on either gas fuel or liquid fuel. The operator's role is to monitor the system during startup and operation, as well as responding to any abnormal conditions or alarms.

Gas Fuel System

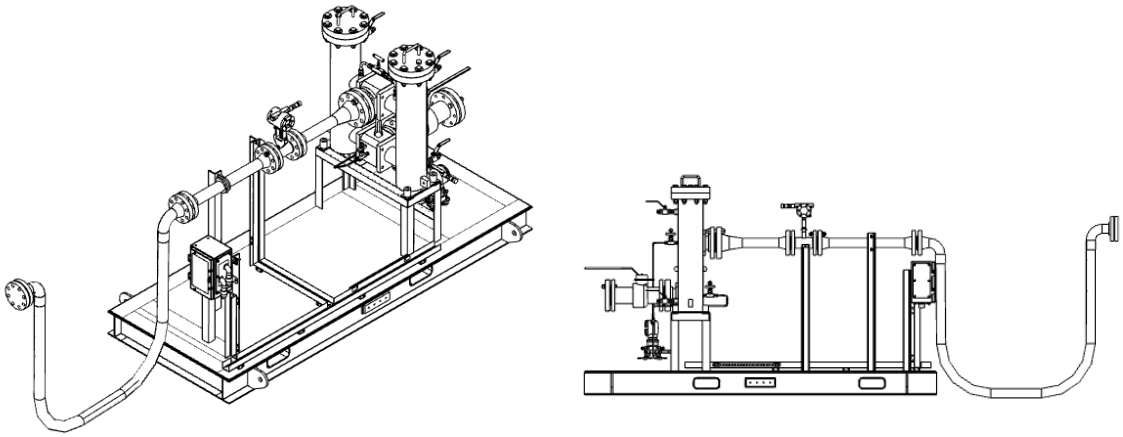
Distributed Power supplied equipment includes the following major components mounted in the turbine enclosure:

- Fuel gas strainer
- Instrumentation (pressure and temperature)
- Primary shutoff valve
- Fuel metering valve(s)
- Secondary shutoff valve
- Fuel gas manifold with 30 dual fuel nozzles
- Pressurization / vent valves
- Gas fuel skid

5.6.1 Gas Fuel Flow

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. Gas fuel enters the gas filter skid at customer connection through a manually operated ball valve that is locked open during normal operation to the duplex filter assembly. The duplex filter includes a transfer valve to permit switching between the two filter elements for service or replacement. Prior to leaving the gas filter skid, gas fuel is routed through a flow transmitter which displays totalized flow on the turbine control system operator screen. Gas fuels must meet the requirements specified in Distributed Power Standard MID-TD-0000-1.

The gas fuel system also features a function that allows for gas fuel venting upon unit shutdown. Once the gas fuel is cut by the two Shutoff Valves, the control system/customer controller opens the External Vent Valve to depressurize the gas supply line. Also, the control system will quickly open and close the External Shutoff Valve to burp the gas pressure between the two Shutoff Valves while the External Vent Valve still remains open to release any trapped gas fuel. The fuel-metering valve varies the fuel flow rate and controls turbine speed, acceleration and power output. The primary and secondary shutoff valves and the vent valve provide “double block and bleed” for gas-tight shutoff when the turbine is stopped.



Gas Fuel Skid

Liquid Fuel System

Distributed Power supplied equipment includes the following major components mounted in the turbine enclosure:

- Pressure and temperature instrumentation
- Fuel metering valve(s)
- Shutoff Valve(s)
- Pressurization Valve
- Fuel Manifold with 30 fuel nozzles
- Control valves for fuel transfer purge

5.6.2 Liquid Fuel Flow

A liquid fuel system with control valve is supplied in the basic package offering. 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 and meet the requirements of MID-TD-0000-2.

5.6.3 Water Injection System

A water injection metering system is provided to reduce NOx emissions for gaseous fuel or liquid fuel operation. Demineralized water is injected into the combustor through ports in the fuel nozzles to produce NOx suppression. Water is supplied to the nozzles by a special water manifold. 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.

GE provides the necessary controls, metering equipment, and interconnecting piping between the gas fuel skid and the engine. All piping is stainless steel, and the valves are trimmed with stainless steel. The customer must provide a supply of pressurized water and liquid fuel in accordance with the specifications.

5.7 Lube Oil Systems

Turbine Lube Oil 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. Turbine lube oil flows from the TLO/HLO tank to an engine-driven pump, which then supplies pressurized oil to the (gas generator) turbine bearings, power turbine bearings, and variable geometry actuators. The LM2500+G4™ turbine is lubricated by an internal pump and lubrication system. There is also an external

lube oil system to filter, cool, and de-aerate the lube oil discharged from the internal system. The external system is fed by a scavenge pump, which is driven by the turbine accessory gearbox whenever the turbine gas generator is rotating.

The turbine uses synthetic lube oil to:

- Lubricate and cool the high-pressure (HP) and low-pressure (LP) rotor bearings and sumps
- Lubricate and cool the transfer gearbox (TGB) and accessory gearbox (AGB)
- Operate the actuators for the variable stator vanes (VSVs)
- Lubricate the over-running clutch for the hydraulic starter motor

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

These two systems combine to form a dependable and efficient lubrication system. They are described in more detail below:

Air/Oil Separator

Mounted on the TM2500 GEN8 auxiliary gearbox is a mechanical air-oil separator which is used to separate sump air/oil mixture and vent the sump air into the exhaust duct.

Generator Lube Oil System

The TM2500 GEN8 Generator Lube Oil (GLO) uses mineral oil to lubricate, cool and clean the generator journal and thrust bearings. To prevent damage, the generator bearings must be lubricated when in operation (rotor shaft turning). Lubricating oil must be supplied to the bearing assemblies during startups, at operational speeds, and while the unit is coasting to a stop after shutdown. The generator bearings are pressure-lubricated. The bearing faces are grooved for even oil distribution and the drive-end bearing incorporates thrust pads to limit fore-and-aft movement of the generator rotor. Labyrinth seals and oil slingers are mounted on the generator rotor shaft to prevent oil leakage from the bearing housings. At operational speeds, the bearings are lubricated by oil from a pump-mounted outboard from the assembly and driven by the generator rotor. At startups and shutdowns, lubricating oil is

provided by a DC motor auxiliary pump, which also serves as a backup in case of shaft pump failure.

To ensure that these lubrication requirements are met under all conditions, the GLO system has two types of pumps:
1. An auxiliary 125 VDC lube oil pump
2. Generator driven lube oil pump

Cooling System

The fin-fan heat exchangers utilize an electric fan to force ambient cool air through the heat exchanger coil for the Turbine Lube Oil (TLO), Generator Lube Oil (GLO), and Hydraulic Start systems.

5.8 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 which drives a hydraulic pump assembly consisting of a charge pump, pressurized filter, main pump, and variable SOV-actuated valve; provides pressurized hydraulic fluid to the hydraulic start motor and clutch. This pressurized hydraulic fluid delivers the required pressure to operate the engine installed hydraulic start motor at the Accessory Gearbox (AGB). The hydraulic pressure rotates the starter which provides sufficient torque for starting the turbine. Local gauges allow the operator to monitor the hydraulic charge pump and main system pressures and fluid levels.

5.9 Off-Line Water Wash System

Over time, gas turbines experience a loss of performance due to contaminant deposits on internal components. This loss is indicated by a decrease in power output and an increase in heat rate. These deposits result from the ingestion of air that contains dirt, dust, and hydrocarbon fumes. A large portion of these contaminants is removed by inlet air filtration, but contaminants that pass through the filters have to be removed from the compressor by washing. Optimal turbine performance is achieved by periodically cleaning compressor stages of the gas turbine. The water

wash system provides a mean for washing the turbine when it has been shut down (off-line water washing).

The primary purpose of the water wash system is to remove contaminants from the turbine compressor. During the washing operation, a solution (a water and detergent mix) is sprayed in to the gas turbine at the proper pressure, temperature, and flow rate to wash the compressor. The wash is followed by a rinse cycle, which is designed to remove detergent residue. Washing is performed while the turbine is off–line. Off-line water wash is accomplished by spraying cleaning solution into the bellmouth while the engine is being motored by the starter. After a short wait, the compressor is rinsed with water and allowed to dry. Off-line water wash will usually restore compressor performance

The water wash tank, located on the auxiliary skid on the gooseneck of the turbine trailer, has 2 inlets, a hand controlled valve for water supply, supplied by the customer, and a tank drain valve. Water is manually supplied to water wash tank. The third inlet will allow detergent to be added manually on the top of the tank.

Water Quality Standards

The water shall not contain particles larger than 100 microns absolute, and shall comply with Distributed Power Specification MID-TD-0000-4.

Water Quality Standards:

	Limit	Test Method
Total Matter, ppm, max	100	ASTM D5907
pH	6.5-8.5	ASTM D1293
Sodium + potassium, ppm, max	25	ASTM D4191 & ASTM D4192

5.10 Fire and Gas Protection System

The fire and gas protection system for the MGTG (mobile gas turbine generator) set monitors the turbine-engine enclosure for the presence of fire and accumulation of combustible gas. Aerosol is used as the fire-extinguishing agent for the turbine trailer. The fire and gas detection system consists of an Eagle Quantum programmable microprocessor-controlled panel that receives inputs from thermal spot detectors, combustible gas detectors, and manual release stations.

The fire and gas protection system is comprised of a fire protection panel (FPP), located in the generator control panel (GCP), which is connected to 2 spot thermal detectors, 2 manual release stations, 2 horns and 3 strobe lights. In addition to these instruments, there are 5 gas detectors, a horn acknowledge switch and a fire suppressant release block LOTO hand switch.

Each electric element in the system is monitored for instrument fault conditions and will indicate an alarm condition should an element indicate a fault. Power for this system is drawn for the control system batteries.

The system is activated by one of the following conditions:

- Enclosure temperature exceeds the specified set temperature as detected by one of the spot thermal detectors (rate of rise). This is an automatic release.
- An operator manually releases aerosol fire suppressant via one of the manual pull stations.

Once a fire is detected, the Fire Protection Panel (FPP) will turn on the horn and strobe lights, issue a turbine trip, and activate the aerosol electric generators after a thirty (30) second delay. The RX3i will then trip the fuel pump and turn off the ventilation fan. The Fire Protection Panel will discharge the aerosol suppressant.

6. Optional Equipment

The equipment and services listed in Section 4 and described in Section 5 are included with the TM2500 GEN8 Mobile Gas Turbine Generator set basic price.

Options (to the basic package) include:

1. Power System Stabilizer
2. Primary Frequency Control
3. Remote HMI
4. Remote Monitoring and Diagnostics service
5. Full String Test
6. Air Pulse Filtration
7. Winterization
   - Static Air Filter Anti-Icing system
   - Air Pulse Filter Anti-Icing System
8. Transport Trailer (with or without Crane)

6.1 Power System Stabilizer

The GE EX2100e digital power system stabilizer integrates supplementary control signals to the generator's voltage regulator to control power fluctuations and to help improve the stability of the power system.

6.2 Primary Frequency Control (PFC)

The purpose of PFC is to help provide grid stability by allowing the gas turbine to automatically increase (or decrease load) load when a grid frequency deviation occurs outside of a frequency band, and maintain this increased (or decreased) load while the deviations persist. Primary Frequency Control will control the gas turbine unit to a pre-selected load set point, such that it will respond to frequency excursions that exceed the hysteresis dead band setting by adjusting load in response to frequency change in order to help maintain the grid frequency. PFC can increase the GT output to maximum control limit, but would not allow over-fire or over-load condition to occur.

6.3 Remote HMI

A remote HMI system can be placed virtually anywhere a network communication link to the Control House can be installed. For distances greater than 300 feet, a fiber optic card will be required under the customer scope. The standard remote HMI is a desktop computer version of the HMI installed locally in the Control House. The same Cimplicity HMI application is loaded into both the local HMI and the remote HMI. The ability to configure the remote HMI as a viewer-only is standard.

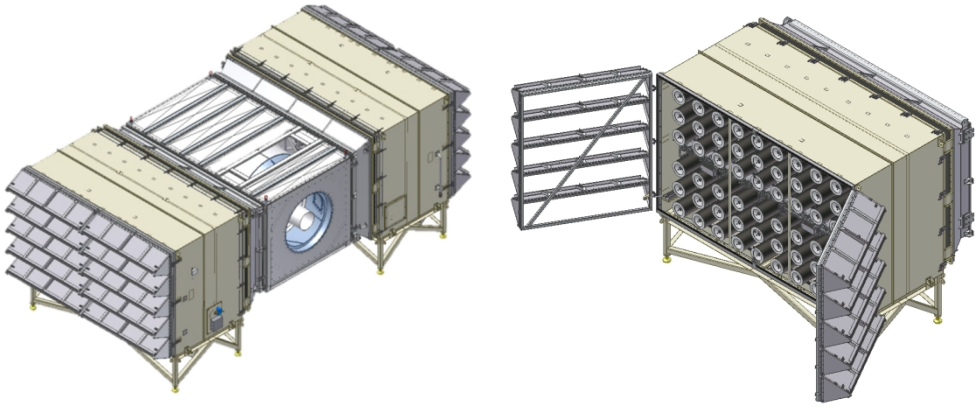
6.4 Remote Monitoring and Diagnostics services

Monitoring and Diagnostics Service helps aeroderivative turbine plant operators improve availability, reliability, operating performance, and maintenance effectiveness. Monitoring of key parameters by factory experts may lead to early detection of equipment problems and avoid expensive secondary damage. Diagnostic programs seek out emerging trends, prompting proactive intervention to avoid forced outages and extended downtime. The ability for GE engineers to view real-time operation accelerates troubleshooting and sometimes eliminates the need for service personnel to visit the plant.

6.5 Full String Test

A full speed, no load test of the LM2500+G4™ gas turbine engine is conducted before shipment, utilizing contract unit controls and facility hardware for generator load applications, inlet air filtration and intercooler circuit components.

6.6 Pulse Filtration



6.7 Winterization

Distributed Power recommends the addition of winterization where ambient operating temperatures fall to (or below) 40°F (4°C).

For temperatures between 40°F (4°C) and 0°F (-18°C), cold temperature assemblies and winterization kits (for heat trace & insulation of the main assemblies/components) are available.

Options include:

- Anti-Icing Static Filter
- Anti-Icing Pulse Filter
- Heat tracing and blanketing:
  - Generator Lube Oil system
  - Liquid Fuel system
  - Gas Fuel system
  - Water Injection system
  - Turbine Lube Oil system
  - Exhaust Drain
  - Hydraulic Start system

For temperatures between -1°F (-18°C) and -39°F (-39°C), cold temperature assemblies and winterization kits (for heat trace, insulation of the main assemblies/components), and cold kit components (mechanical and electrical parts) are available.

Options include:

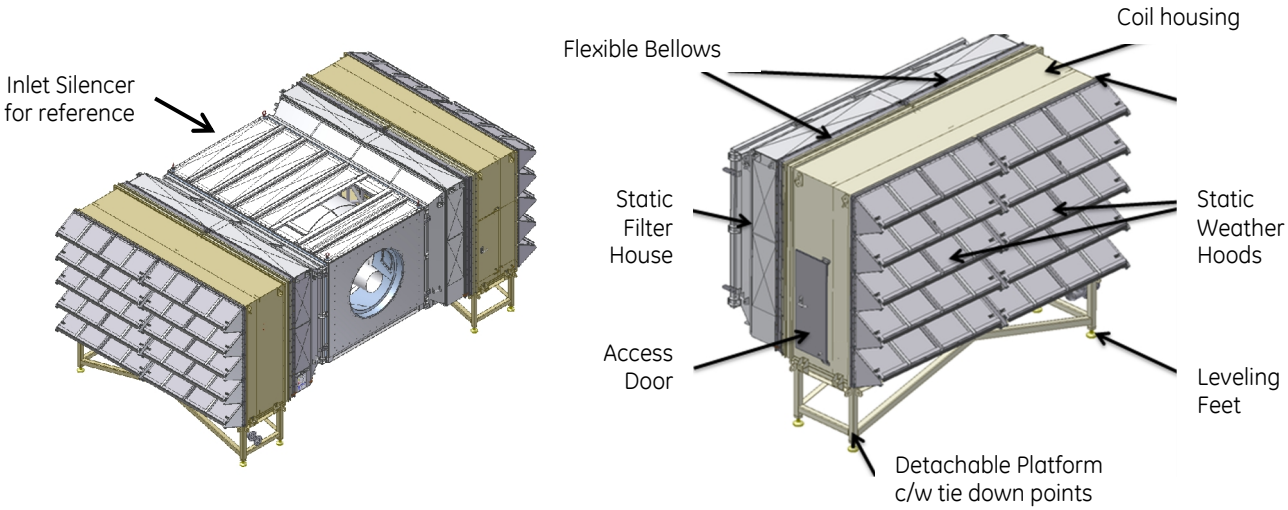
- Includes above changes
- Thermostatic Control Valve changes for TLO/GLO

Cold Steel Generator Option for below -25°F (-32°C) transportation, is also available

For temperatures below -39°F (-39°C), contact Distributed Power for availability.

Anti-icing Systems

An anti-icing system can be provided as an option for ambient temperatures below 43°F (6°C) and relative humidity above 65%. With this option, heating coils are provided at the silencer enclosure inlet prior to the pre filters, with static filtration or after the final filters with pulse filtration to warm the inlet air prior to entering the combustion/ventilation air system. For anti-icing a weather station is added, and the turbine control system provides T0, T2, RH, and an icing conditions present signal as outputs to the customer's control system. A temperature sensor, which is part of a weather station, that also includes a humidity sensor, provides inlet temperature information to the control system, and is only provided if the anti-icing option is purchased.



Static Air Filter with Anti-Icing System

Air Pulse Filtration

The optional air pulse filtration system can be used with or without the optional anti-icing system. The air pulse filtration system uses a canister style filter and cannot be used with the static filters.

The air pulse filtration system option comes with a stand-alone compressor and a control panel that will automatically actuate the system when necessary. The air pulse filtration system also has the ability to self-protect the silencer and turbine inlet from freezing when combined with the downstream anti-icing coils.

6.8 Transport Trailer (with or without crane)

The transport trailer is an optional trailer used to provide storage and transportation location for the turbine air filter modules, turbine exhaust silencer and the generator inlet stacks. This trailer is also available with an optional self-contained mobile crane. The optional crane provides the necessary lifting capability to allow the unit to be self-reliant for installation. The crane is rated and capable of lifting all components required to install the package and can only be used with the prime mover of the trailer connected.

7. Mechanical Outlines

7.1 General Arrangement and Interface drawings

Mobile Gas Turbine Generator Set (Operational Views)
- Isometric View
- Top View
- Side Views
- Trailer End Views

Turbine Trailer
- Isometric View*
- Side Views
- Trailer End Views

Generator Trailer
- Isometric View*
- Side Views
- Trailer End Views

Control House Trailer
- Isometric View*
- Side Views
- Trailer End Views

Transportation Trailer (Optional)
- Isometric View*
- Side Views
- Trailer End Views

*Indicates In Transport View

TM2500 GEN8 Mobile Gas Turbine-Generator Set

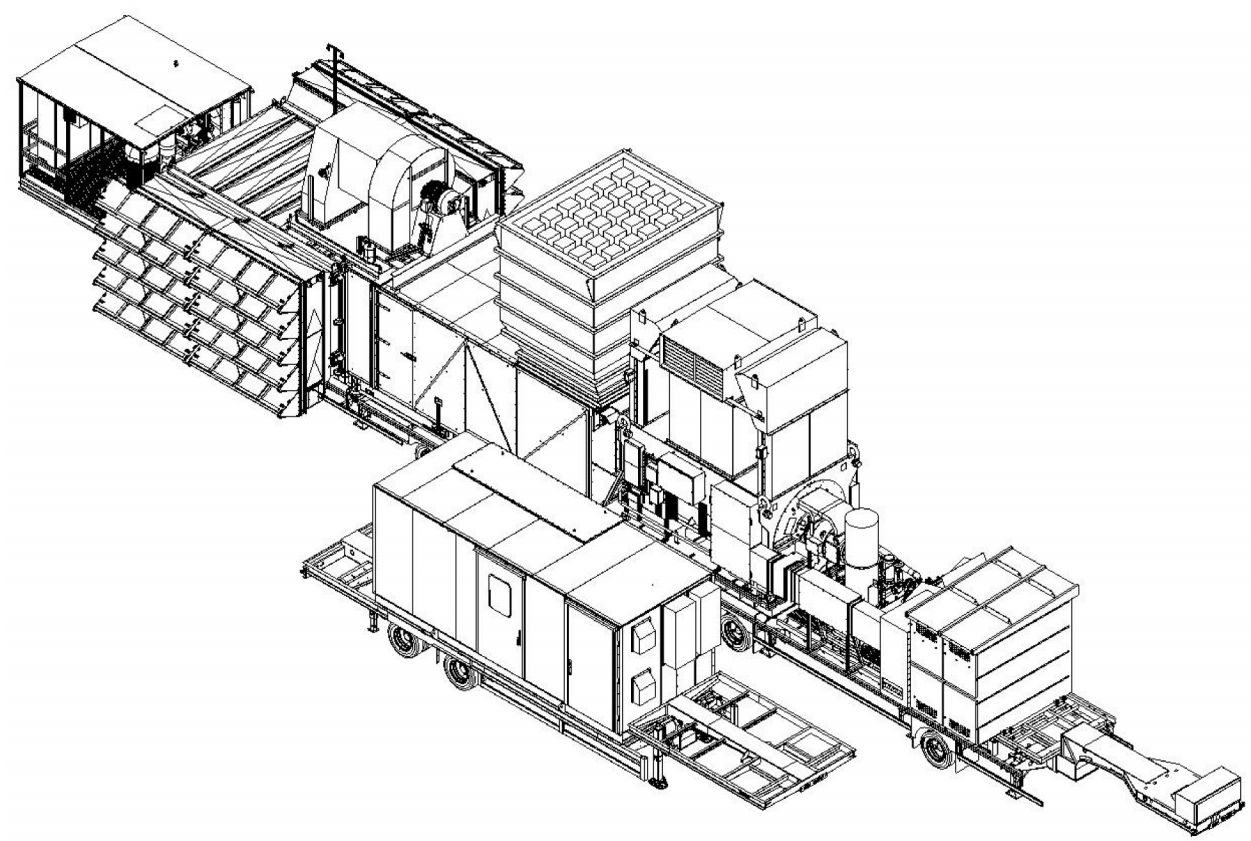


Figure 7.1 Isometric View (Operational)

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

TM2500 GEN8 Mobile Gas Turbine-Generator Set

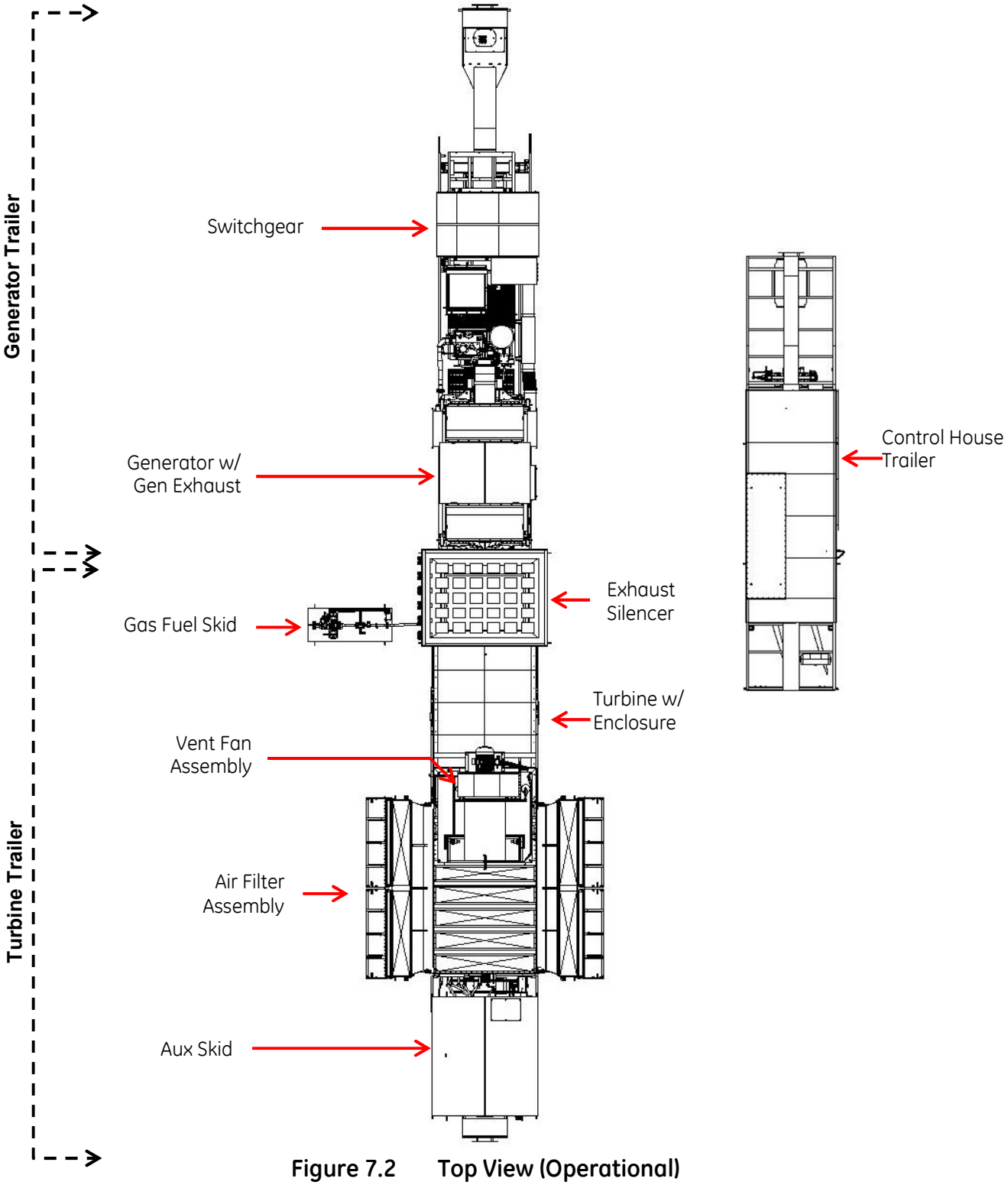


Figure 7.2 Top View (Operational)

For informative purpose only: Views and dimensions may vary according with specific package configuration.

TM2500 GEN8 Mobile Gas Turbine-Generator Set

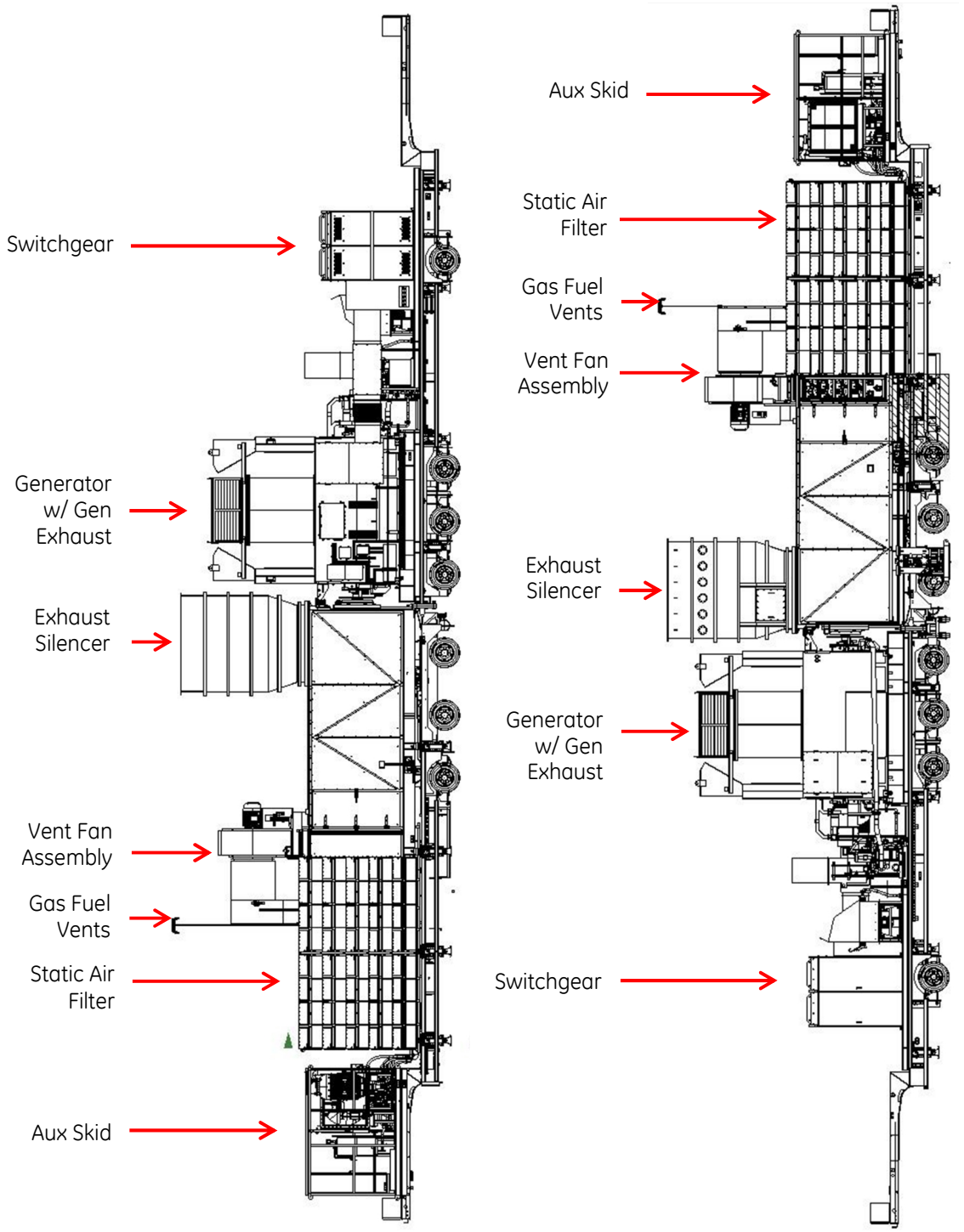


Figure 7.3 Side Views (Operational)

For informative purpose only: Views and dimensions may vary according with specific package configuration.

TM2500 GEN8 Mobile Gas Turbine-Generator Set

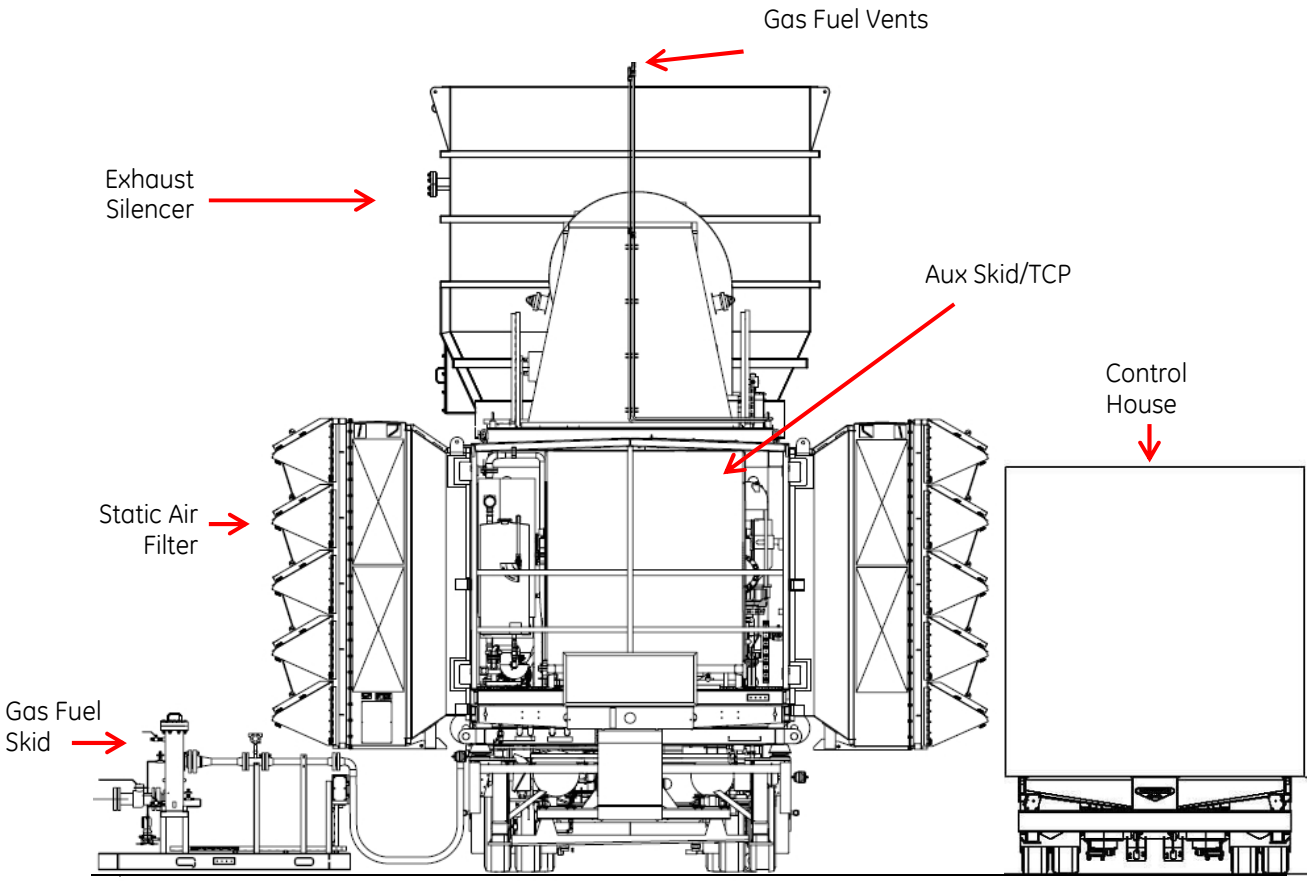


Figure 7.4 Turbine Trailer End View (Operational)

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

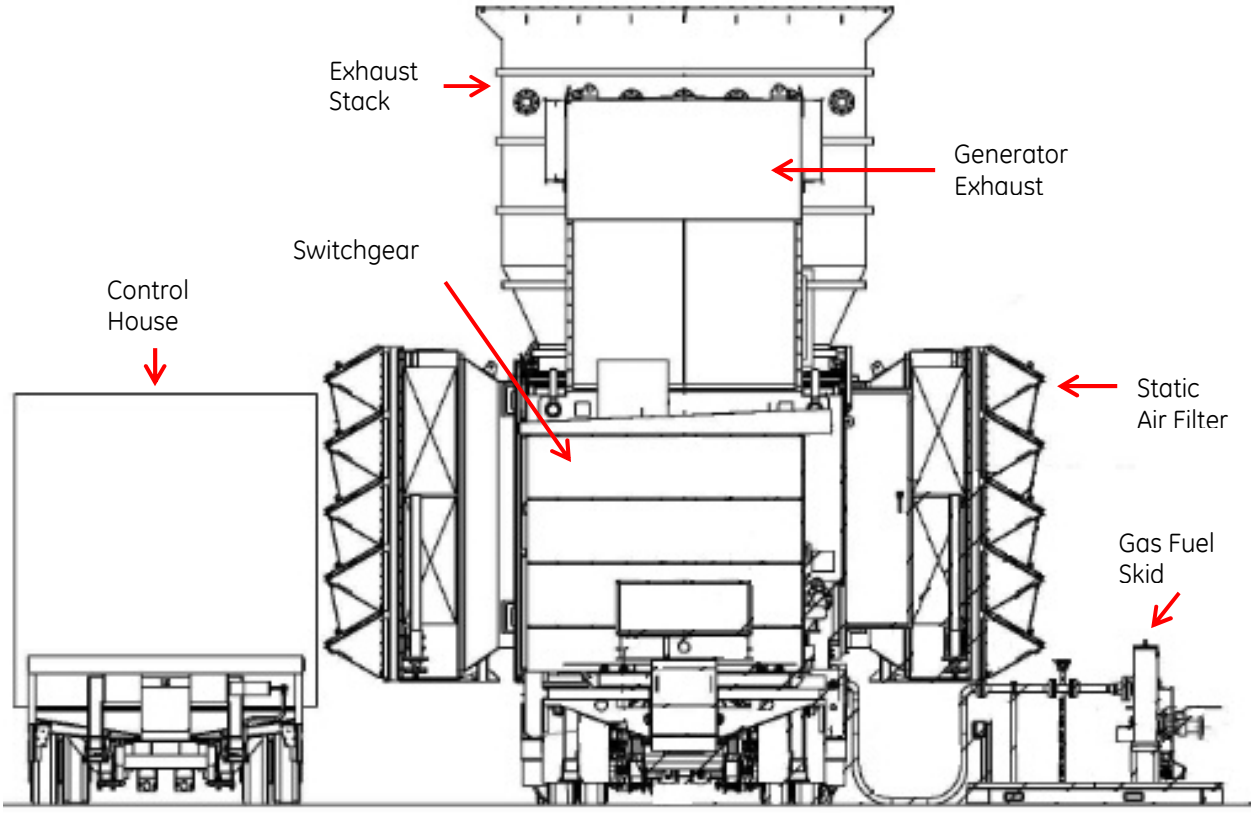


Figure 7.5 Generator Trailer End View (Operational)

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Turbine Trailer

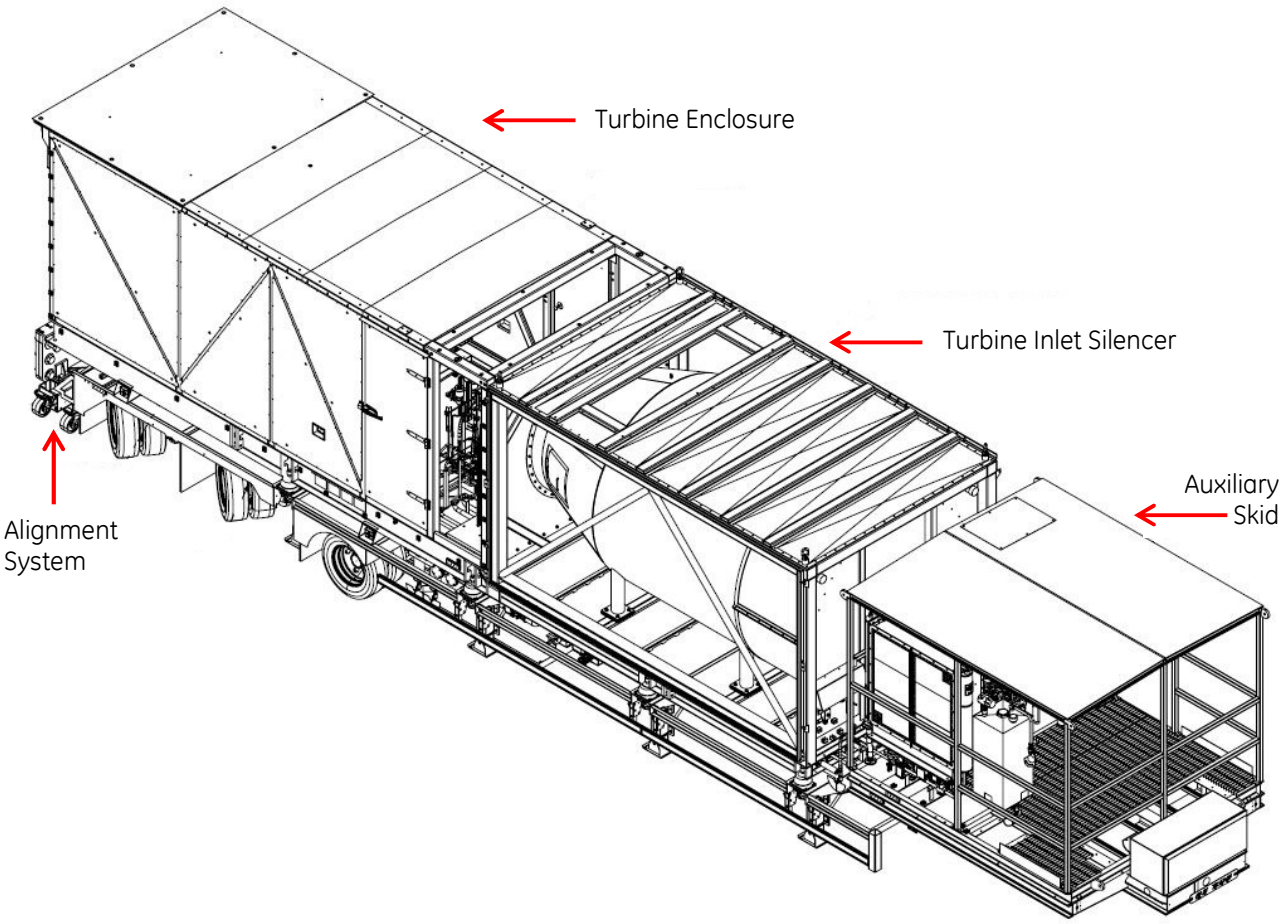


Figure 7.6 Isometric View

For informative purpose only: Views and dimensions may vary according with specific package configuration.

Turbine Trailer

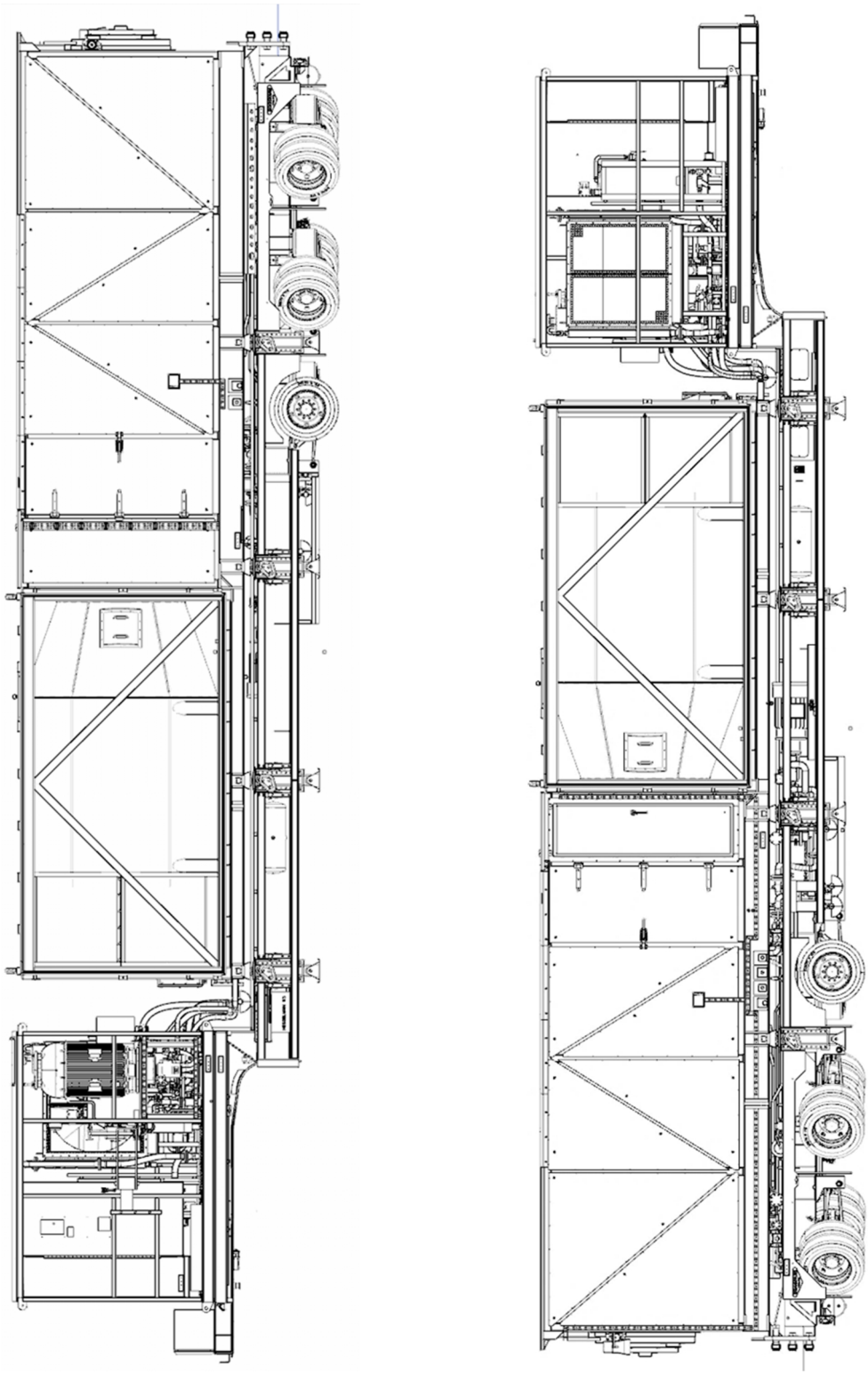


Figure 7.7 Side Views

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Turbine Trailer

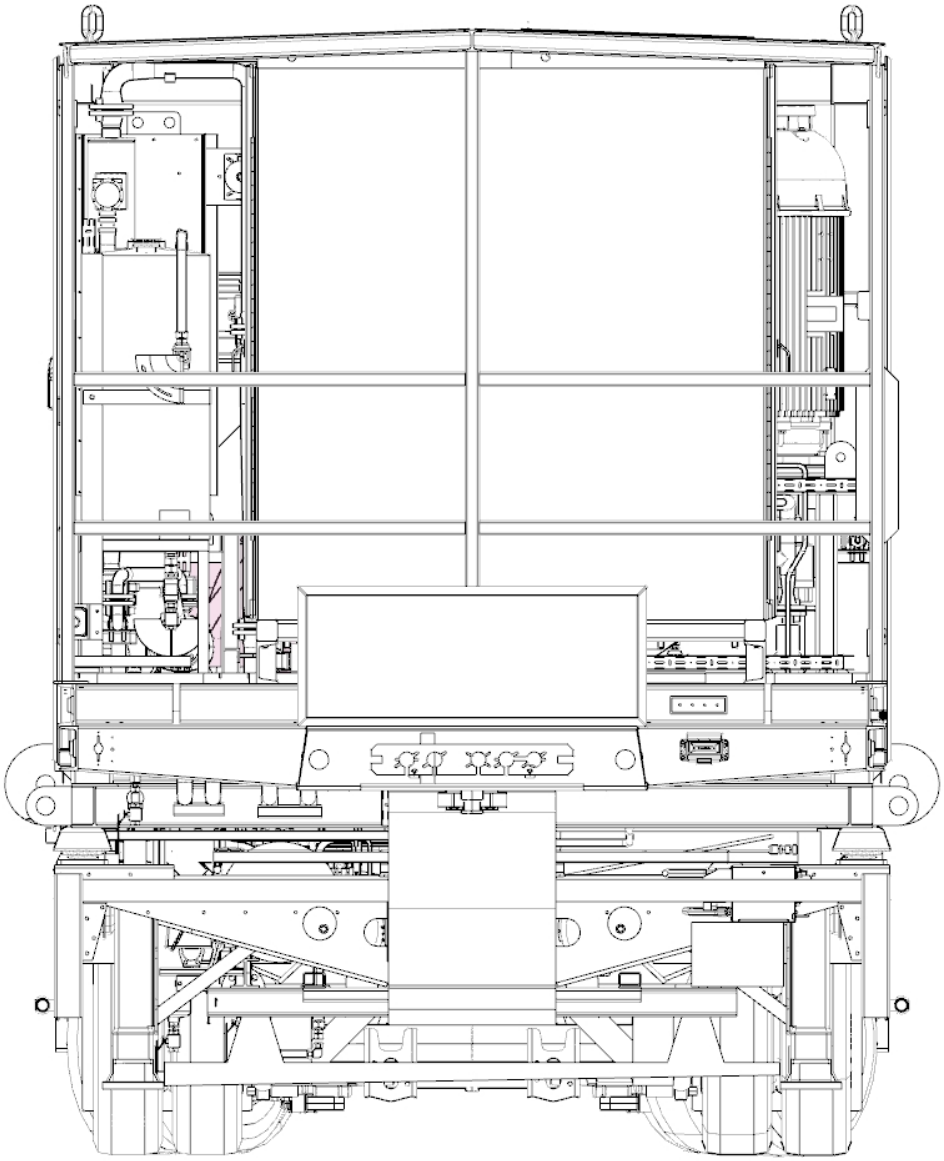


Figure 7.8 Auxiliary Skid End View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Turbine Trailer

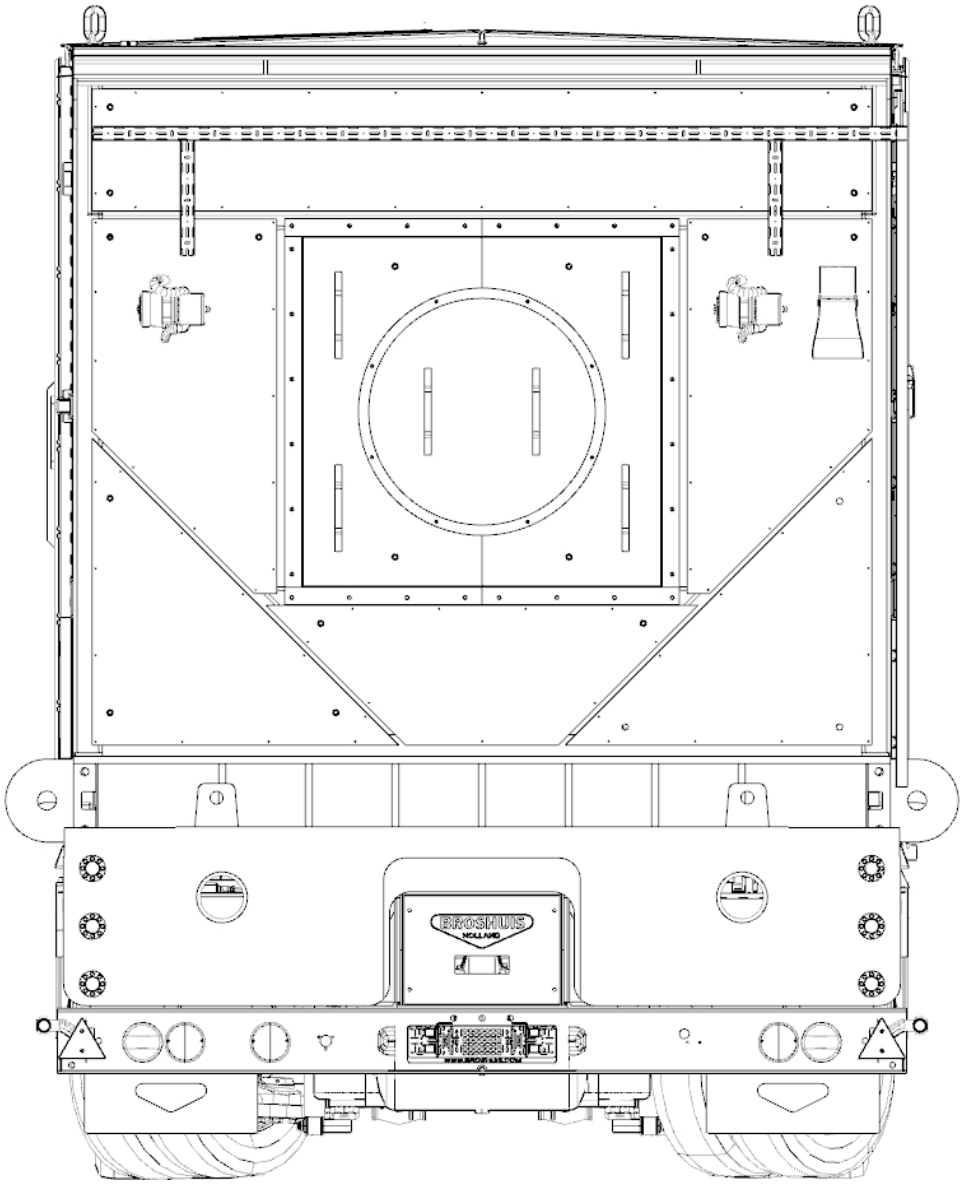


Figure 7.9 Turbine to Generator Docking Plate View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Generator Trailer

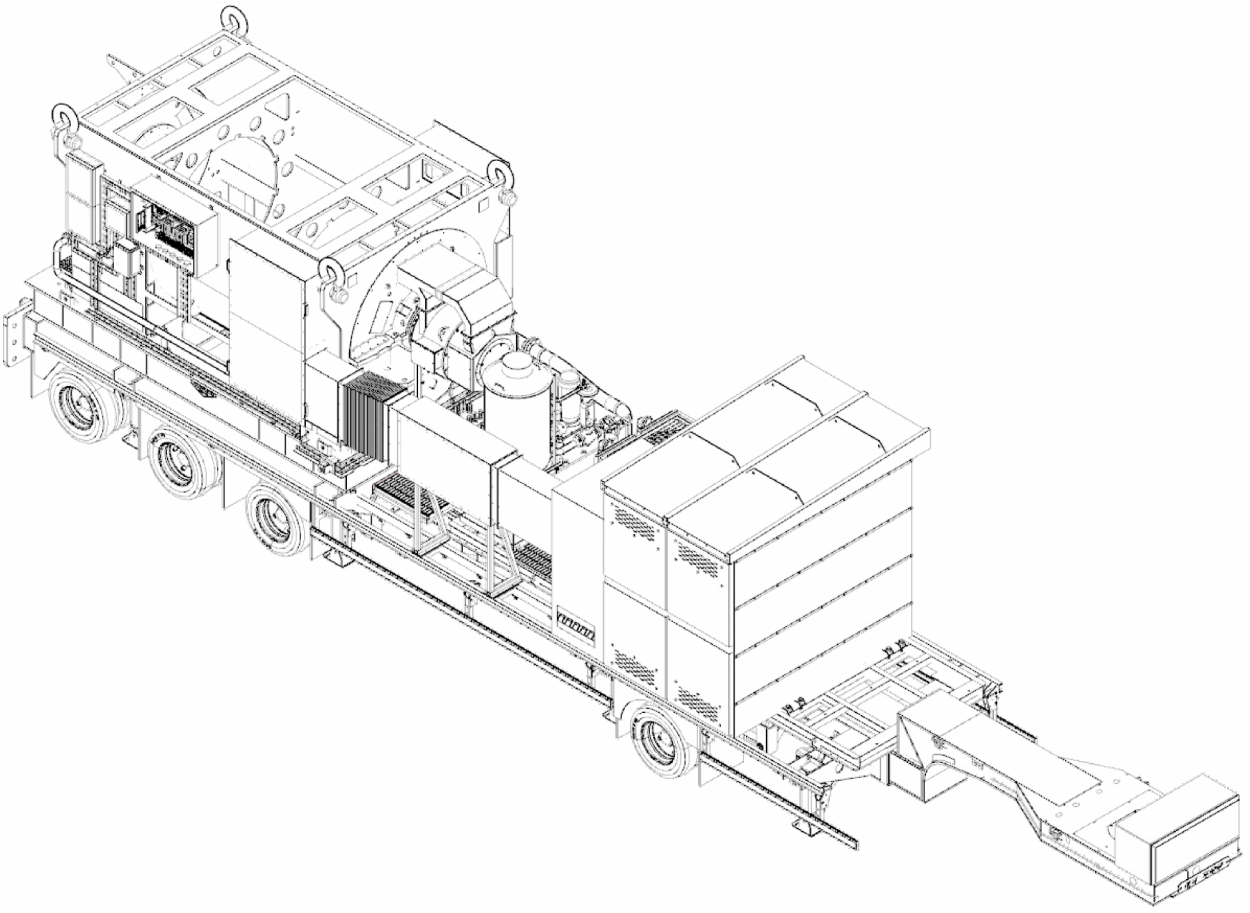


Figure 7.10 Isometric View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Generator Trailer

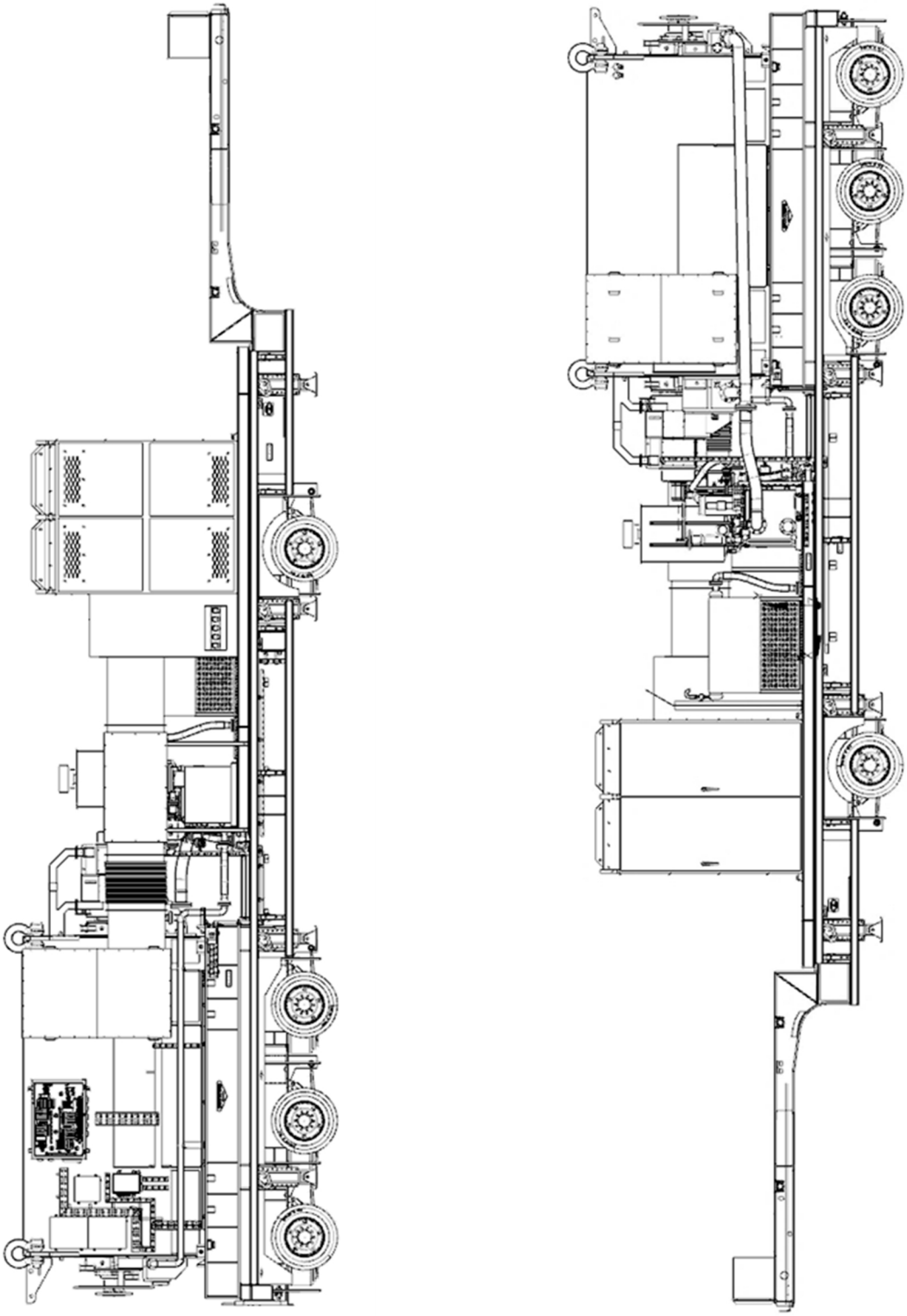


Figure 7.11 Side Views

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Generator Trailer

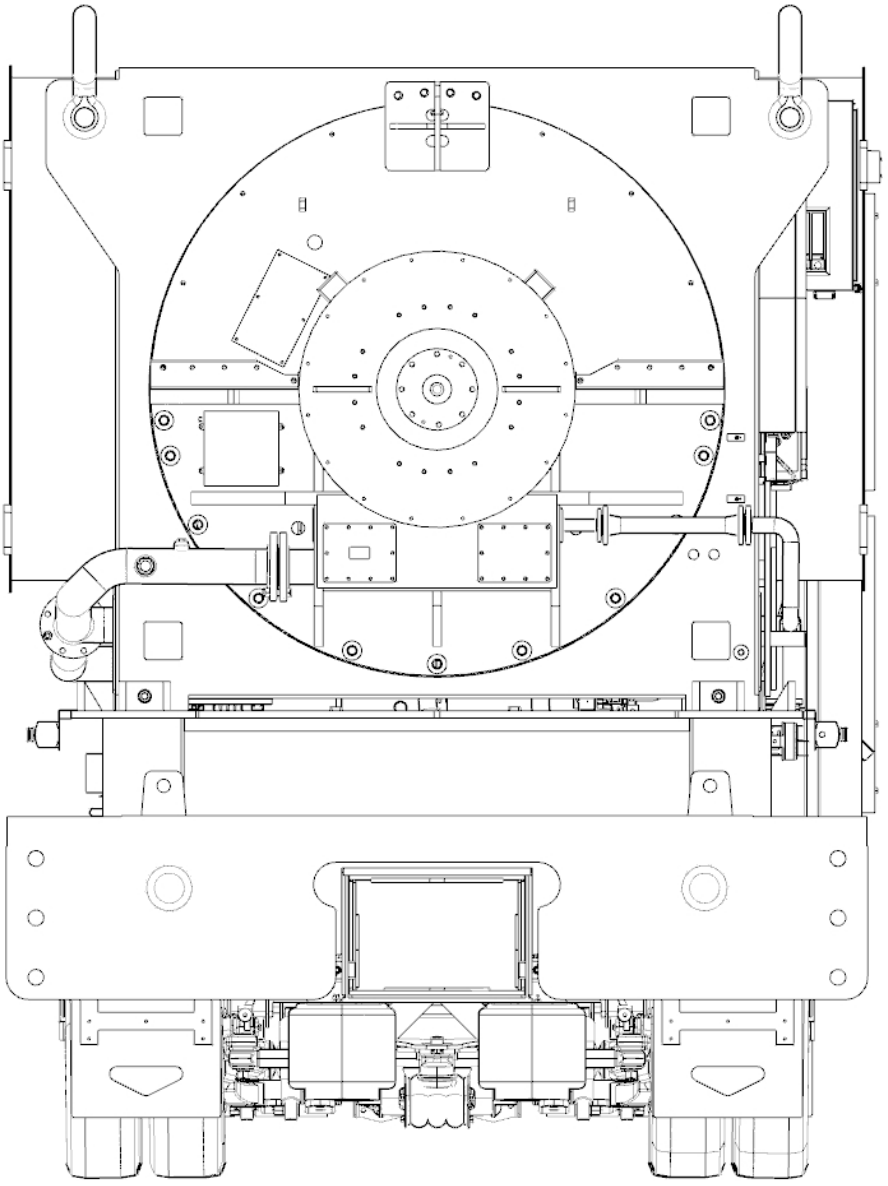


Figure 7.12 Generator to Turbine Docking Plate View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Generator Trailer

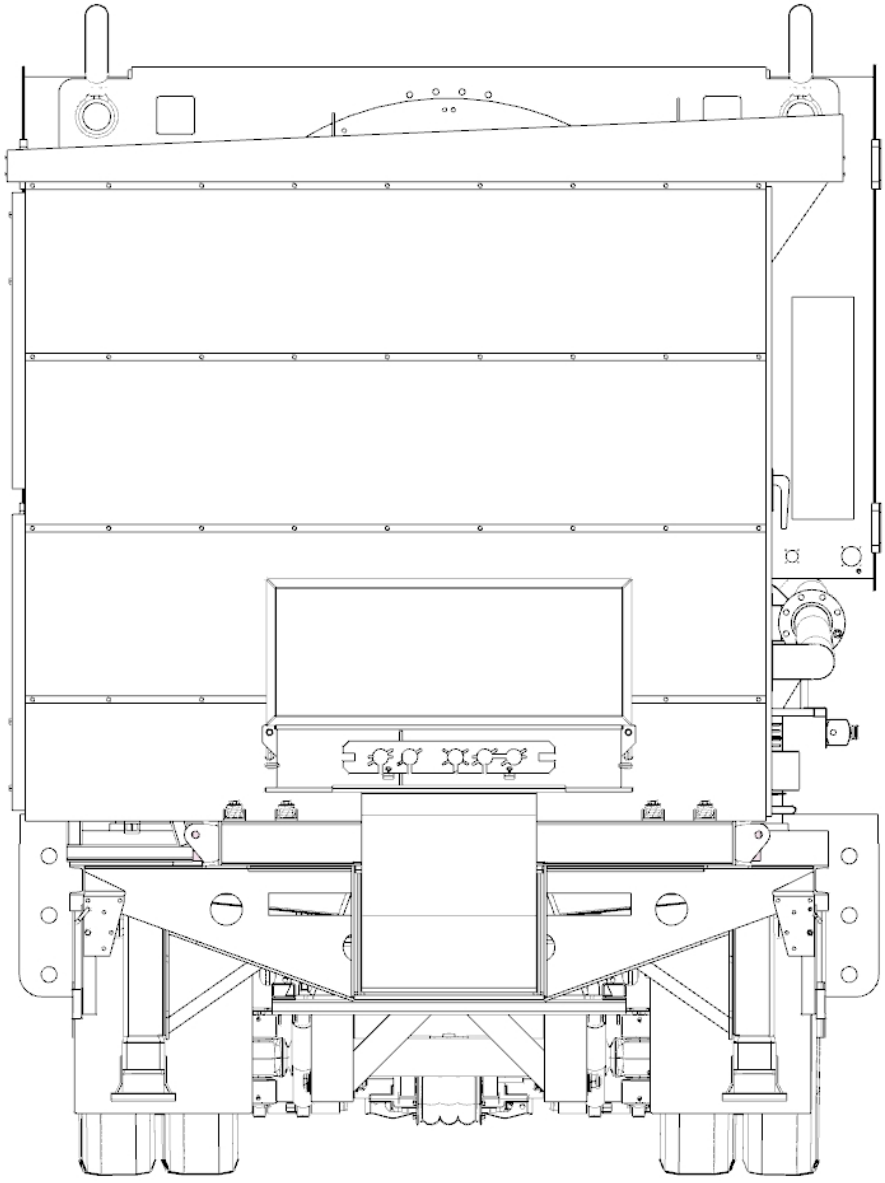
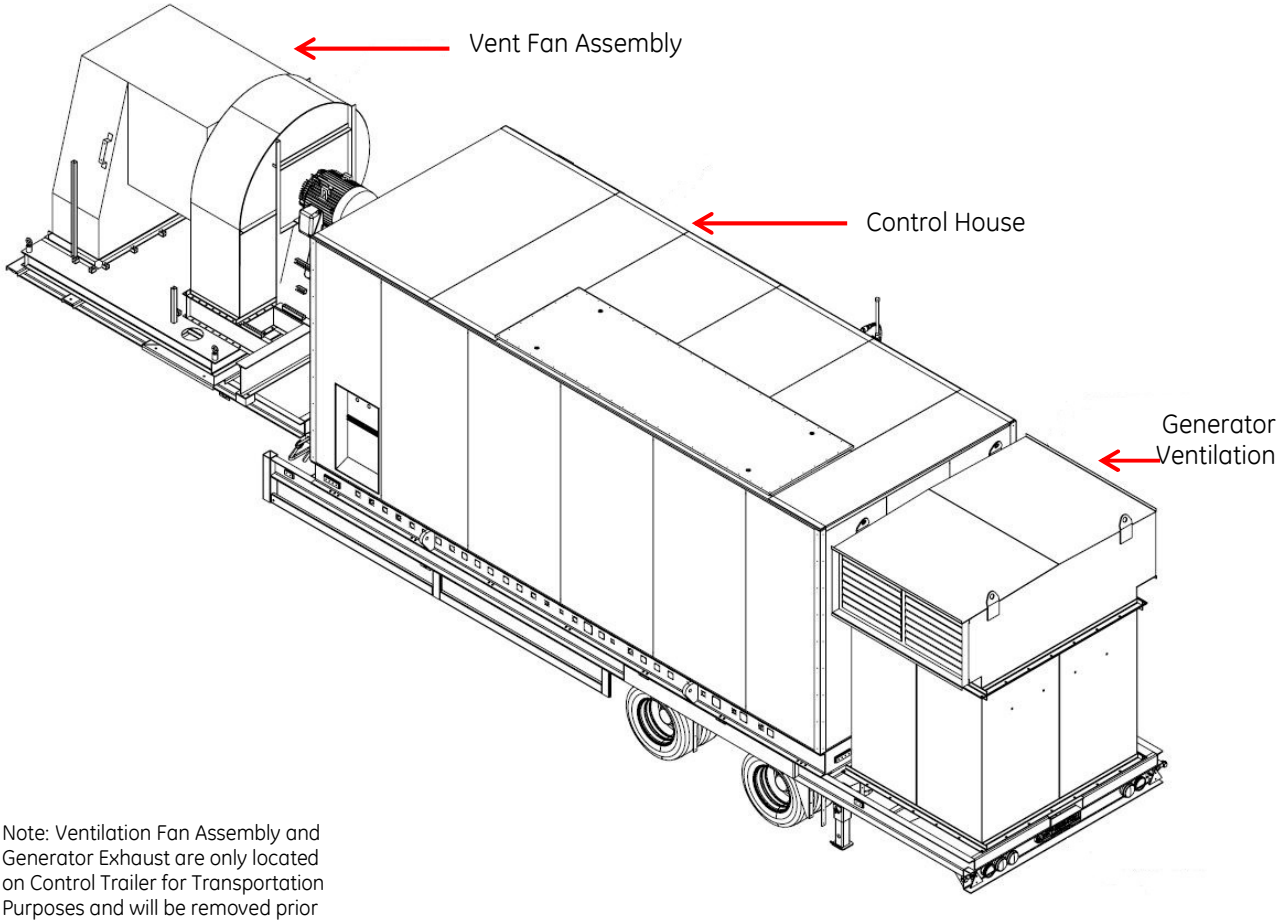


Figure 7.13 Trailer Front View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Control House Trailer



Note: Ventilation Fan Assembly and Generator Exhaust are only located on Control Trailer for Transportation Purposes and will be removed prior to operation.

Figure 7.14 Isometric View (Transport View)

For informative purpose only: Views and dimensions may vary according with specific package configuration.

Control House Trailer

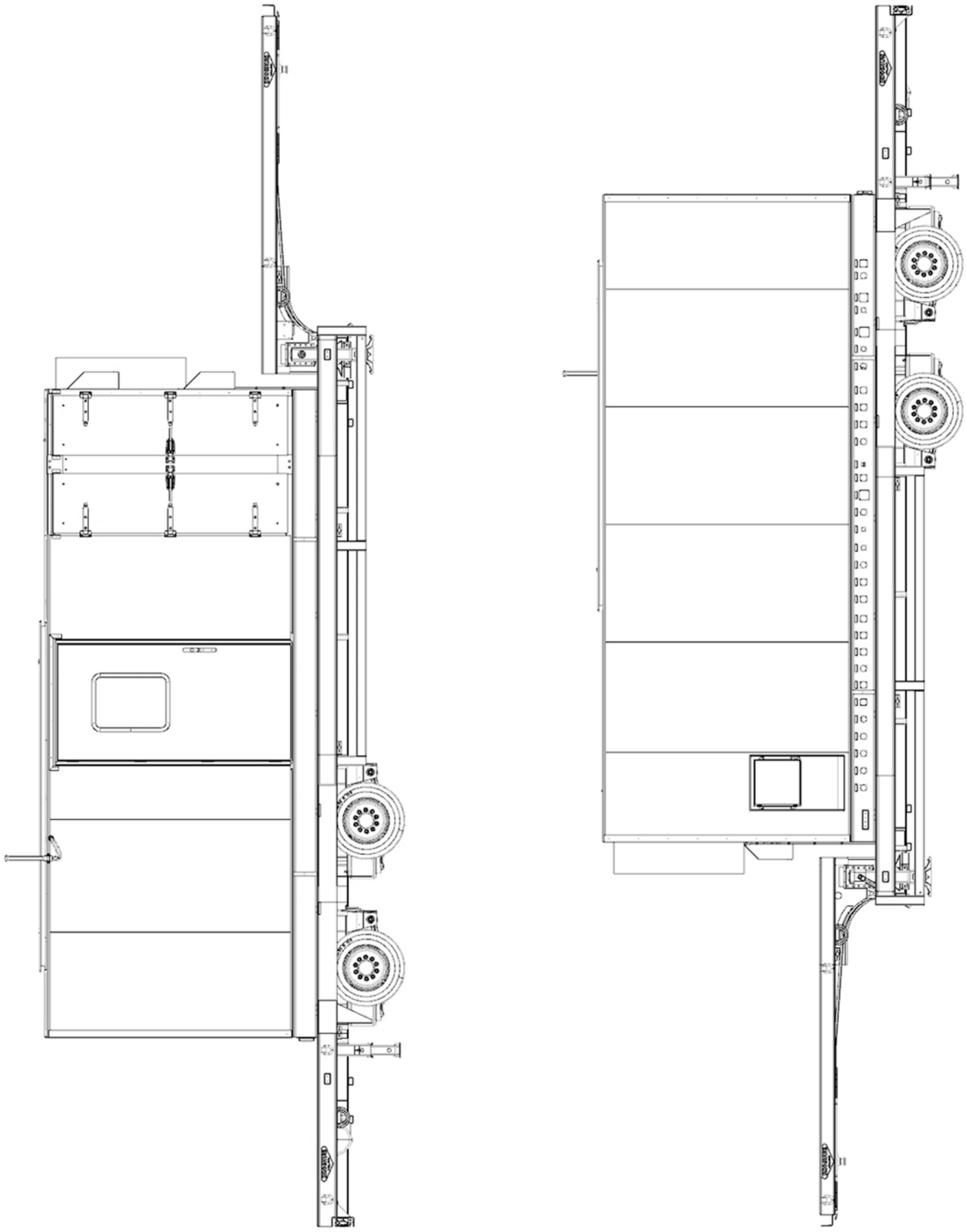


Figure 7.15 Side Views (Transported Assemblies Removed)

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Control House Trailer

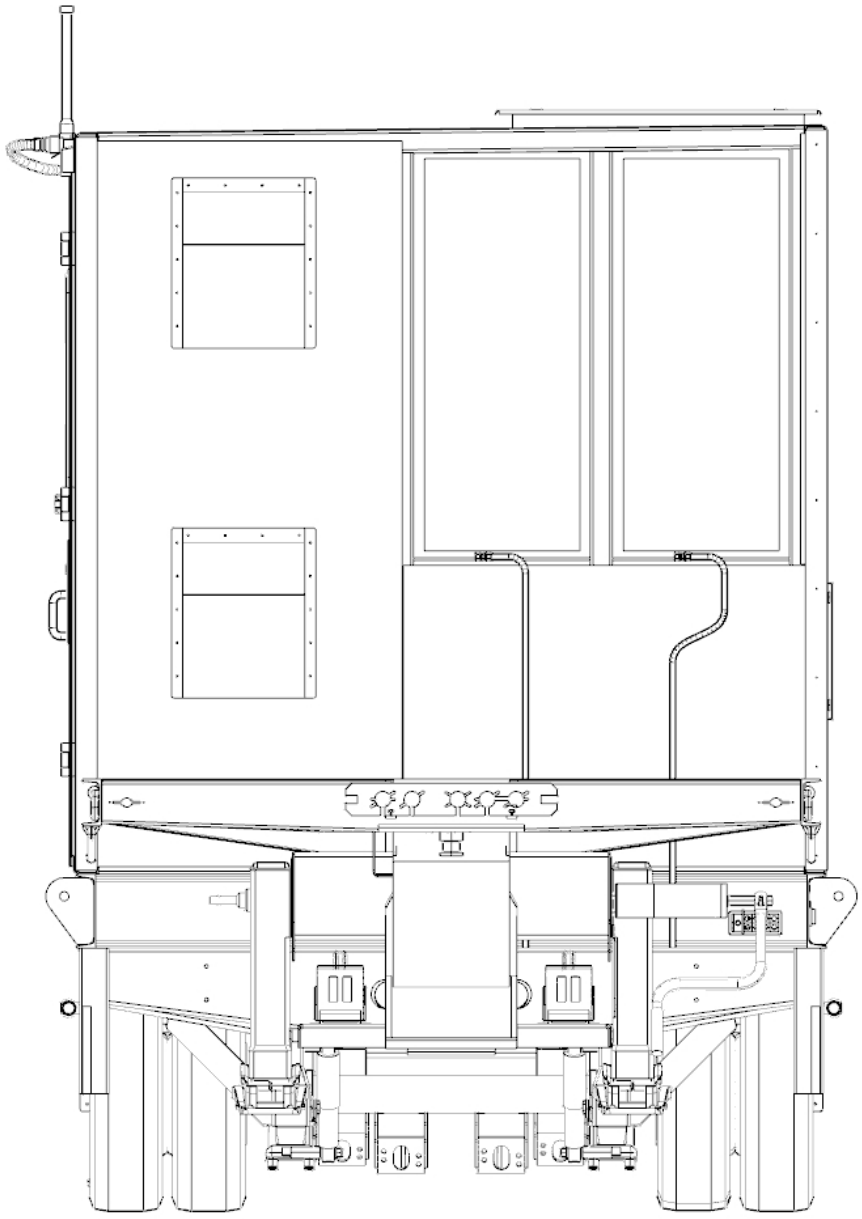


Figure 7.16 Trailer Front View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Control House Trailer

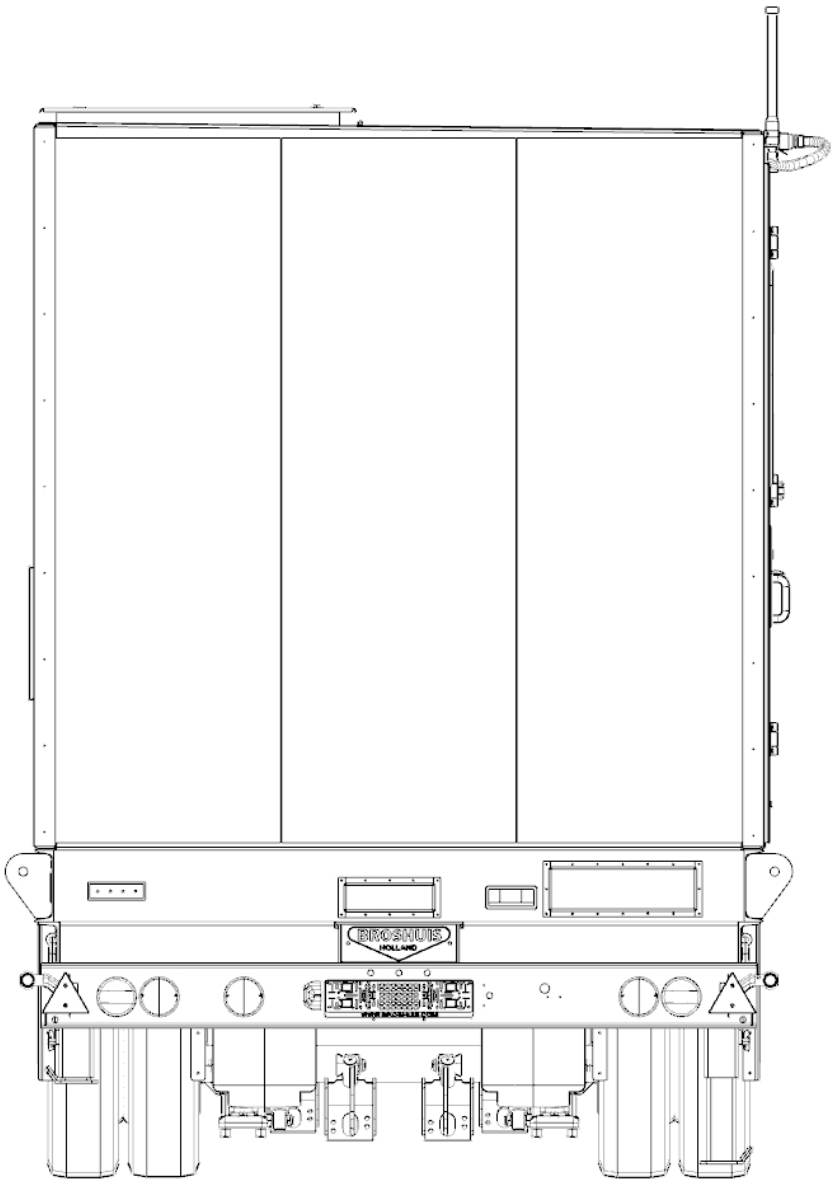


Figure 7.17 Trailer Rear View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Transportation Trailer (Optional)

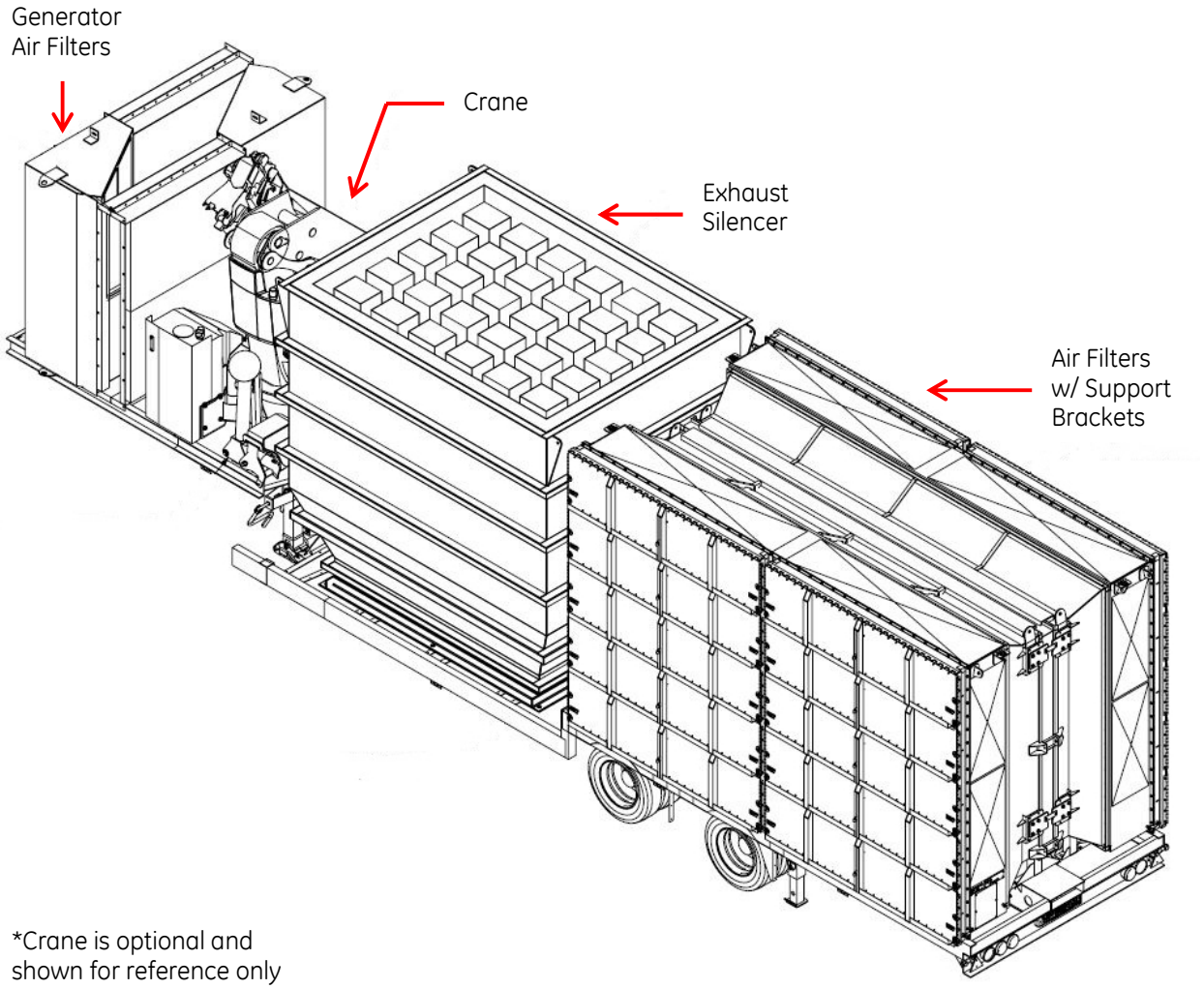


Figure 7.18 Isometric View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Transportation Trailer (Optional)

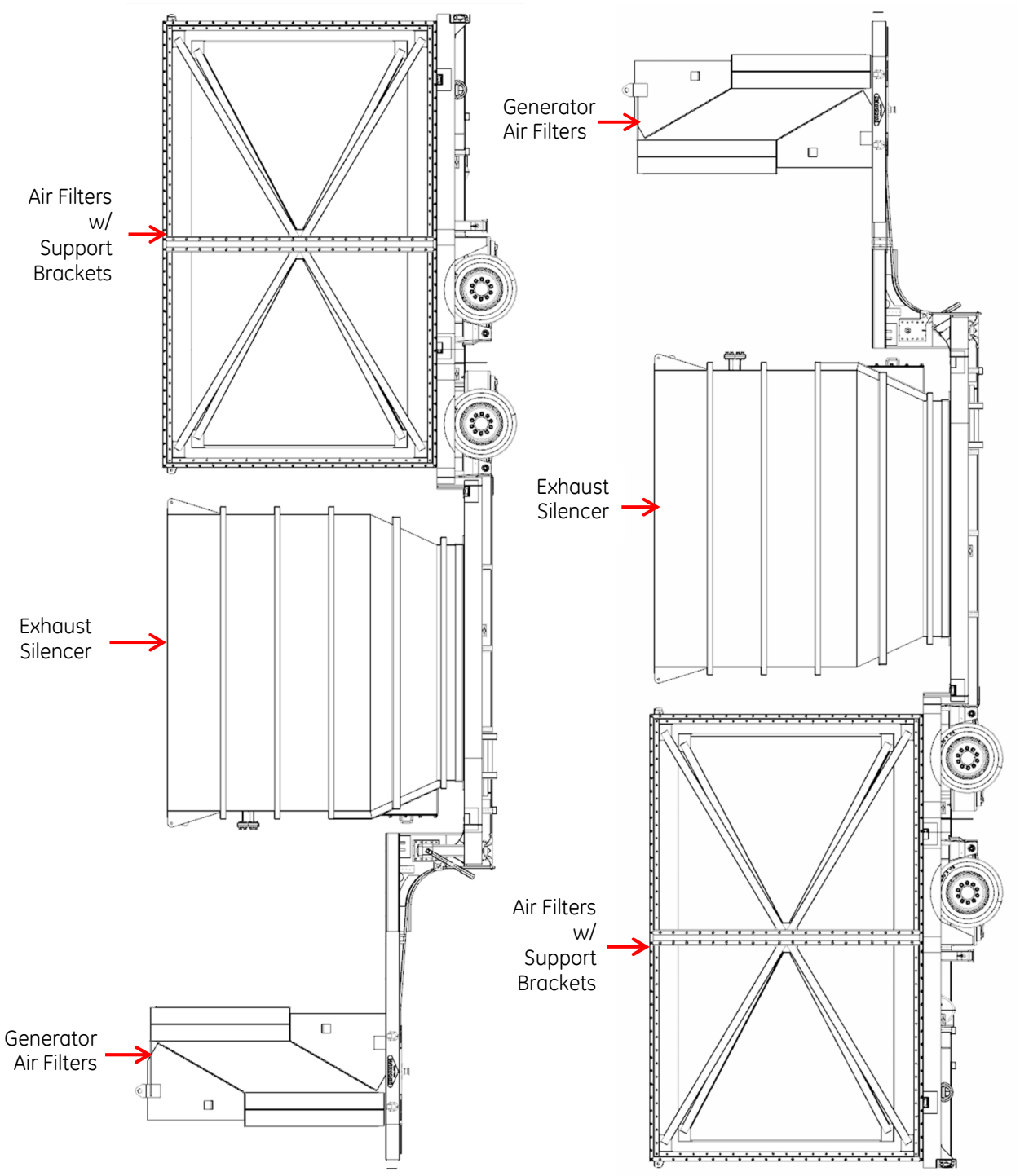


Figure 7.19 Side Views (Crane option not shown)

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

Transportation Trailer (Optional)

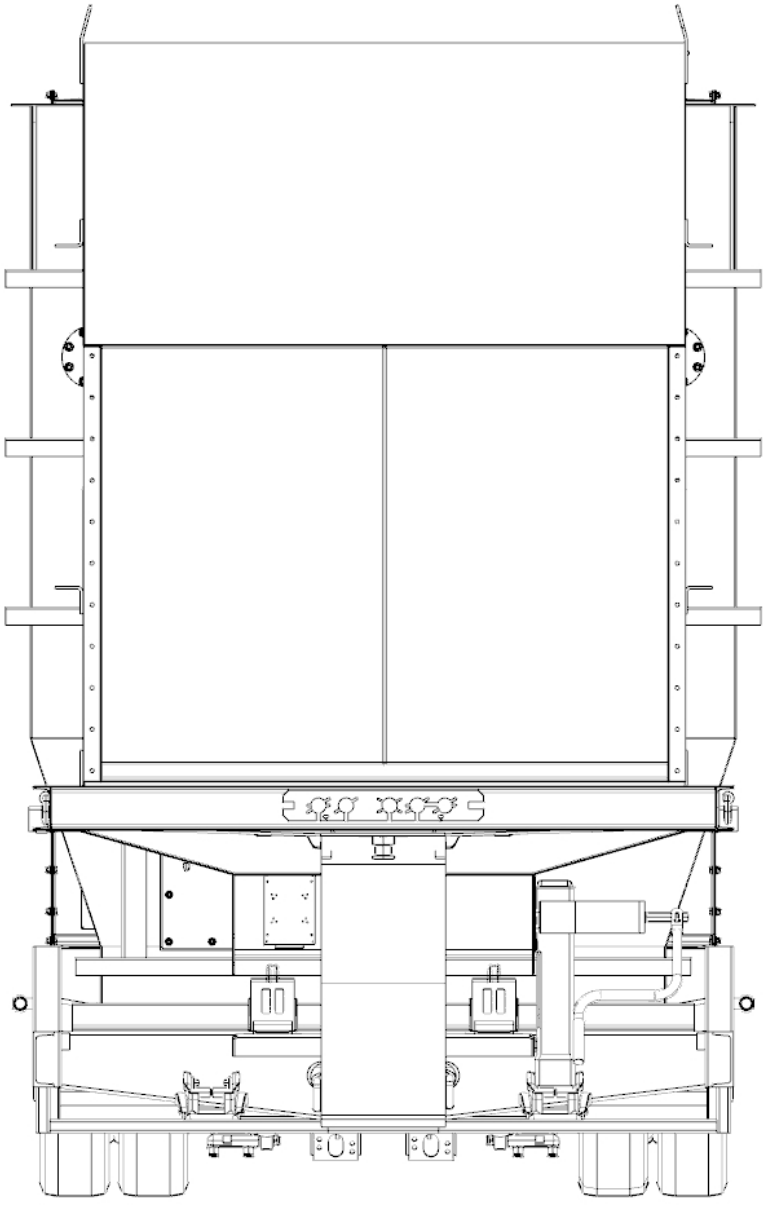


Figure 7.20 Generator Filters End View

For informative purpose only: Views and dimensions may vary according with specific package configuration.

Transportation Trailer (Optional)

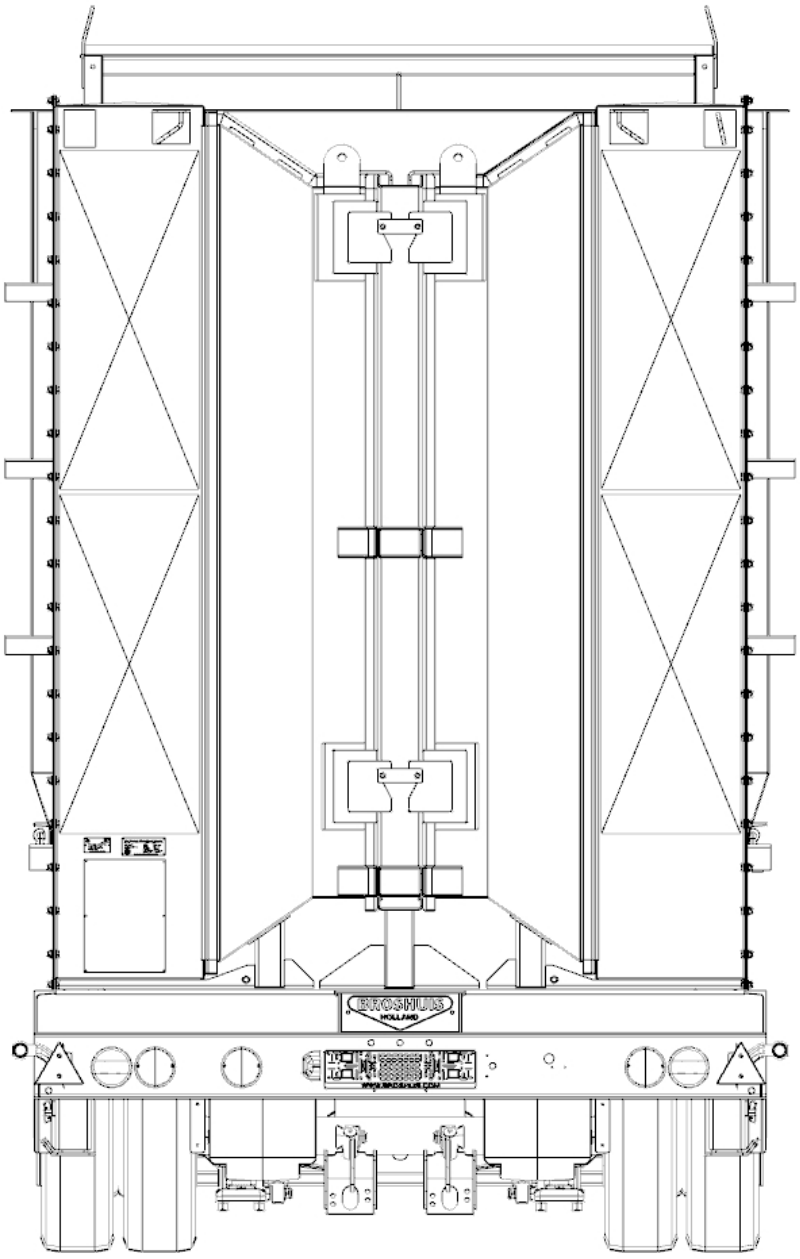


Figure 7.21 Air Filters w/ Support Bracket View

For informative purpose only: Views and dimensions
may vary according with specific package configuration.

8. Electrical Generator System Description

8.1 Generator Design

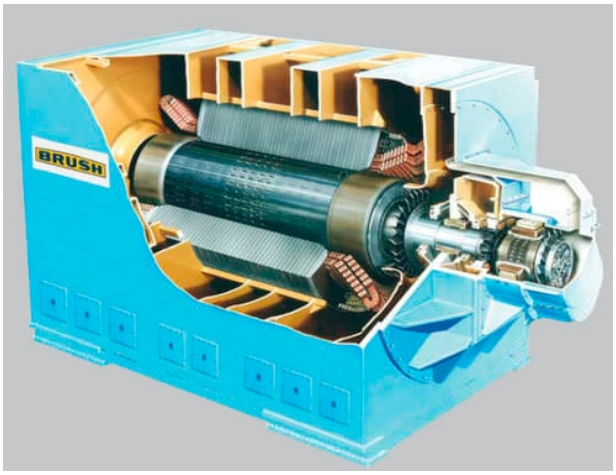
The TM2500 GEN8 MGTG set features a Brush Model BDAX62-170ERT air cooled generator, which is a two-bearing machine equipped, configured with a brushless rotating exciter, flying bridge array and a brushless permanent magnet generator (PMG) on the non-drive end. The rotor is supported by two split-sleeve bearings lubricated by a pressurized mineral oil system.

The generator is complete with the following features:

- Permanent Magnet Generator (aka Pilot Exciter)
- Generator Exhaust
- Rotor Earth Fault Monitor (REFM)
- Oil supply system
- Canopy/Enclosure

Generator Design Data

	13.8kV 60 Hz	**11.5kV 50 Hz**
Terminal Voltage	13,800 Volts	11,500 Volts
Frequency	60 Hz	50 Hz
Speed (rpm)	3,600 rpm	3,000 rpm
Power Factor	0.9	0.9
Standard	IEEE C50.13	IEC 60034-3
Coolant	Air at 15°C	Air at 15°C
Output	38,333kVA (34,500kW)	34,222kVA (30,800kW)



8.2 Generator Codes and Standards

The generator is designed to meet codes and standards applicable to most areas of the world. The primary standards are IEC.60034-3 for the 50 Hz Generator and IEEE C50.13 for the 60 Hz Generator.

8.3 Stator Design

Stator Frame

The stator frame is a rigid structure, fabricated from mild steel plate and designed to withstand the mechanical stresses imposed during operation and under accidental short circuit conditions. Mounting pads are incorporated at appropriate points on the underside, with holes in each pad for installation bolts.

Stator Core

The core is built into a fabricated steel frame and consists of low loss silicon steel segmental stampings insulated by a layer of varnish on both sides. It is clamped firmly between heavy plates, keyed in position under pressure. It is divided into short sections by radial ventilating ducts formed by fingers extending from the tip of each tooth to the back of the core, and welded to a thick stamping at one side of the duct. The stampings are held in line by dovetail keys bolted to the stator frame.

Stator Winding

The stator winding is of the two layer diamond type with coils held in open slots by epoxy resin baked fabric wedges, the two layers having a similar separator. The coils are made in two halves, each half being fully formed before fitting in the stator. The insulation is synthetic resin bonded mica glass tape throughout, the slot portion being pressed hot to its final size. All current carrying joints in the windings are clipped and brazed.

The laminations of the stator winding are transposed in a regular pattern to minimize circulating currents and losses. The completed coils are protected against corona formation by conducting tape in the slot length and with corona relief tape at each end of the core.

In the end winding, the coils are braced with polyester cord synthetic resin bonded packing blocks and supported from the core ends by insulated brackets

Insulation System

The insulation system is based on a resin-rich mica glass tape that produces a high performance insulation system capable of continuous operation at temperatures up to 302°F (150°C) (Class F).

Coil Winding and Connections

Spacer blocks are fitted between adjacent coil sides to produce a strong, resilient, composite structure. Finally, the completed stator is "baked" in an oven to fully cure the insulation. Resistance Temperature Detectors (RTDs) are embedded in the windings at selected points, and anti-condensation heaters are fitted into the stator frame.

To ensure electrical performance, the individual coils and the completed windings are given high-voltage tests.

8.4 Cylindrical Rotor

The cylindrical rotor is manufactured from an integral forging of vacuum poured nickel-chromium-molybdenum alloy steel. The resulting forging is thermally stable, uniform in composition, and has excellent tensile and mechanical properties. As assembly proceeds, slots are machined in the rotor surface, and insulated coils of high-conductivity silver-copper strip are pressed into the slots. Then damper windings and wedges are added.

Finally, end caps of nonmagnetic manganese chromium steel are shrink-fitted to the ends of the rotor body.

8.5 Bearings and Lubrication Oil System

The main bearings are conventional, white metal lined, hydrodynamic elliptical bearings, split on the horizontal center line for ease of inspection and removal. The two halves are bolted and dowelled together.

The generator incorporates pressure lubricated bearings. An orifice in the supply line controls the bearing oil flow. The bearings are sealed with air taken from the generator fans by means of knife edge seals. Drain oil discharges into the bottom of the bearing housing from where it is returned to the lubricating oil system via a drainpipe. The bearings are sealed with air taken from the generator fans and the oil drainpipe is therefore also used to remove air from the bearing.

Bearing and lubrication system:

Non-Main Exciter End (NEE)

- Endframe
- Plain Sleeve
- Elliptical
- Force Lubricated
- Insulated
- Thrust Pad
- Radial Jacking Supply Provision

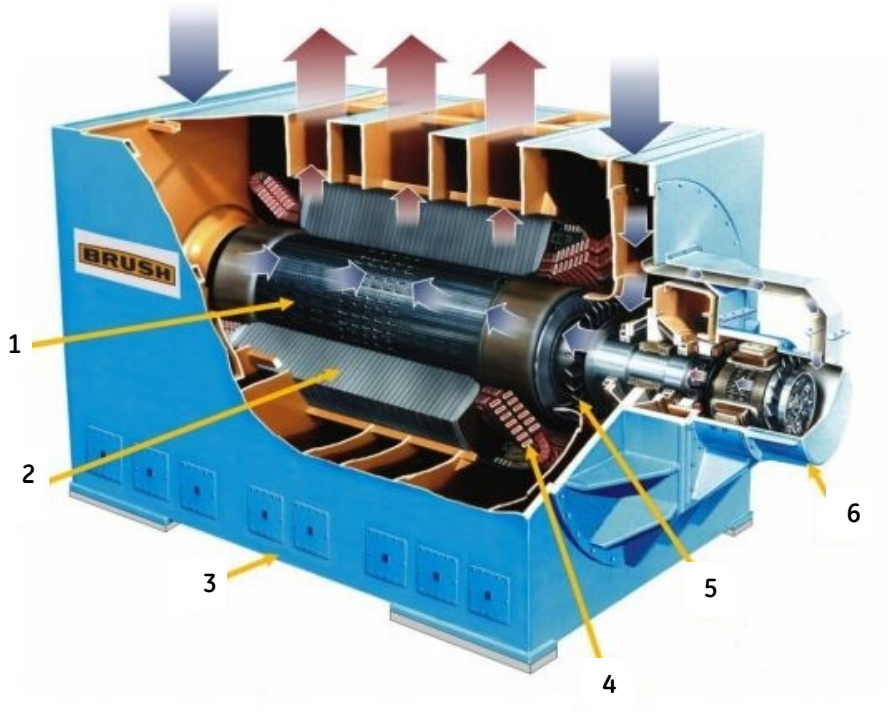
Main Exciter End (EE)

- Endframe
- Plain Sleeve
- Elliptical
- Force Lubricated
- Insulated
- Radial Jacking Supply Provision

8.6 Internal Air Circuit

Air is drawn in at each end of the machine by shaft-mounted fans and divides between the rotor, the stator end windings and the air gap. It then passes through the radial ducts in the stator core and out through the stator frame. Cooling circuits are designed to cool the windings as uniformly as possible. Open ventilated generators are cooled by ambient air drawn into the machine through filters and exhausted through an outlet duct connected to the stator air outlet flange.

Site considerations such as severe desert conditions, extremely salty atmospheres or unsuitably contaminated environments may necessitate the use of a closed air circuit machine, where the hot exhaust air is cooled by the secondary coolant, air, before being returned to the inlet.



Typical Generator Internal Air Circuit

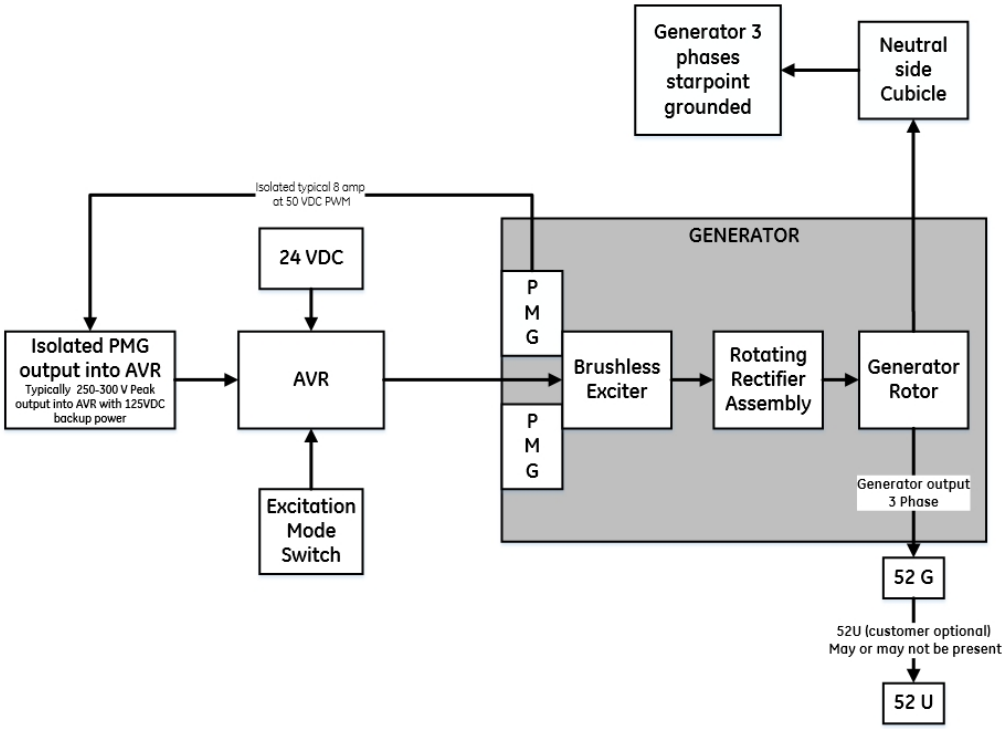
1. Rotor
2. Stator Core
3. Stator Frame
4. Stator Winding
5. Rotor Mounted Cooling Fan
6. Exciter

8.7 Generator Excitation and Regulation

The generator excitation system provides the power required to ramp the generator output voltage up to the rated level during unit startup, and to maintain the voltage at the desired level during fluctuating load conditions.

The generator excitation system contains the following components:

- Permanent Magnet Generator (PMG)
- EX2100e Automatic Voltage Regulator (AVR)
- Brushless Rotary Exciter
- Rotating Rectifier Assembly
- Excitation Mode Switch
- Generator Rotor and Stationary output winding
- Generator-Output Switching and Automatic Synchronization



Generator System

Permanent Magnet Generator

The PMG (occasionally referred to as "pilot exciter") supplies single-phase voltage for the Manual AVR. The PMG consists of a stator coil assembly surrounding a rotor made up of permanent magnets and has rotating components. The PMG windings have been mounted in the exciter housing and the PMG rotor on the generator rotor shaft. The PMG is electrically isolated from the main generator output coil, and its output is only affected by changes in rotor speed loading. This voltage headroom allows almost immediate compensation for sudden changes in the generator load.

EX2100e AVR

The EX2100e Automatic Voltage Regulator (AVR) system maintains the generator output voltage by controlling the excitation of the generator. The AVR also monitors generator excitations and drive generator current output levels to maintain generator operation within the generator capability curve.

Brushless Rotary Exciter

The brushless rotary exciter is an integral part of the AC generator. The exciter armature is mounted on the non-drive end of the generator rotor shaft and enclosed by the stationary exciter field winding. The exciter housing, bolted to the generator end frame, supports both the stationary exciter field windings and the PMG stator windings.

Rotating Rectifier Assembly

The rotating rectifier assembly converts the 3ϕ current from the exciter armature into DC, which polarizes the rotating main field windings of the generator. The rectifier consists of six silicon diodes, each of which connects to one of the three exciter armature leads through a protective fuse. The diodes provide full-wave rectification for each exciter current phase.

Excitation Mode Switch

The voltage regulator excitation selector switch allows the operator to select between MANUAL EXCITATION or AUTOMATIC EXCITATION mode control.

Generator Rotor and Stationary Output Windings

The rotor is fabricated of solid alloy steel forging with copper windings held in slots by wedges. The coils are made of ferrous rectangular bars of copper strip.

Generator Output Switching and Automatic Synchronization

The generator output is connected to the high-voltage bus through the self-contained bus circuit breaker (52G) within the constraints of the synchronizing circuits, customer provided 52U is optional. Through switchgear and transformers (optional), the high-voltage bus is connected to the utility bus and the turbine-generator MCC.

Under normal circumstances the auto synchronizer controls breaker closure. When in manual, the synchronizer provides a permissive to breaker closure. The automatic synchronizer adjusts generator excitation and speed to match with the load, voltage and phase so that the generator frequency and voltage output are exactly in sync with the existing power.

8.8 Generator Accessories

Generator Exhaust

The stator and rotor are cooled by means of air forced around the generator by means of fans mounted on the rotor shaft. The generator receives filtered air from an external air treatment unit. The filters must be properly maintained so that the total pressure drop external to the generator taking into account all ducting, filters (maximum dirty pressure drop), silencers, louvres etc., at the inlet and outlet, must not exceed the specified system design pressure drop. A differential pressure switch is connected across the filter to give a signal to warn the machine operator when renewal of the filter pads is necessary.

Rotor Earth Fault Monitor (REFM)

To continuously monitor the condition of the rotor winding, the rotor earth fault monitor (REFM) uses an electronic unit to detect a single earth fault. This dispenses with the need for brushes and slip rings, resulting in enhanced reliability and reduced maintenance costs. The REFM is an electronic unit designed to provide a brushless generator with an alarm in the event of a rotor earth fault. General practice on generators with brushless excitation is for the rotor (main field) winding to be fully isolated from earth so that, in the event of a single earth fault, the generator could continue running. However, a second earth fault would short circuit part of the winding, necessitating an immediate shutdown and corrective action. Detection of a single earth fault allows the generator to be taken out of service for investigation and repair at the earliest opportunity, usually as part of a planned maintenance program.

Resistance Temperature Detectors (RTDs) and Thermocouples

Resistance temperature detectors (RTDs) or thermocouples are fitted to the generator to monitor temperatures in the various parts of the machine. These detectors or separate temperature switches (thermostats), if specified, are commonly used to initiate trip and alarm functions.

Temperature detectors of the resistance type comprise an element with a non-inductively wound platinum coil having a value of 100Ω at 0°C. Operation of the detector is based on the principle that the resistance of a metallic conductor varies linearly with temperature.

Space Heaters

The purpose of the heaters is to prevent condensation of moisture on the windings and metal which could lead to low insulation resistance or corrosion. The generator heaters are mounted at the ends of the stator. Heaters for the main exciter are mounted between poles at the bottom of the main exciter and are accessible by removing the main exciter endframe.

Vibration Detectors

To gain a true motion of the shaft it is usual to place two probes at 90° to each other on each bearing. The probe signals are sent via signal conditioners, mounted locally to the probes, to the remote monitoring equipment. Non-contacting shaft motion proximity equipment is usually supplied as part of an overall vibration monitoring package.

Lineside and Neutral Cubicles

Lineside and neutral cubicles are bolted onto the outside of the generator for the customer's power and metering connections.

8.9 Integrated Generator Protective System (IGPS)

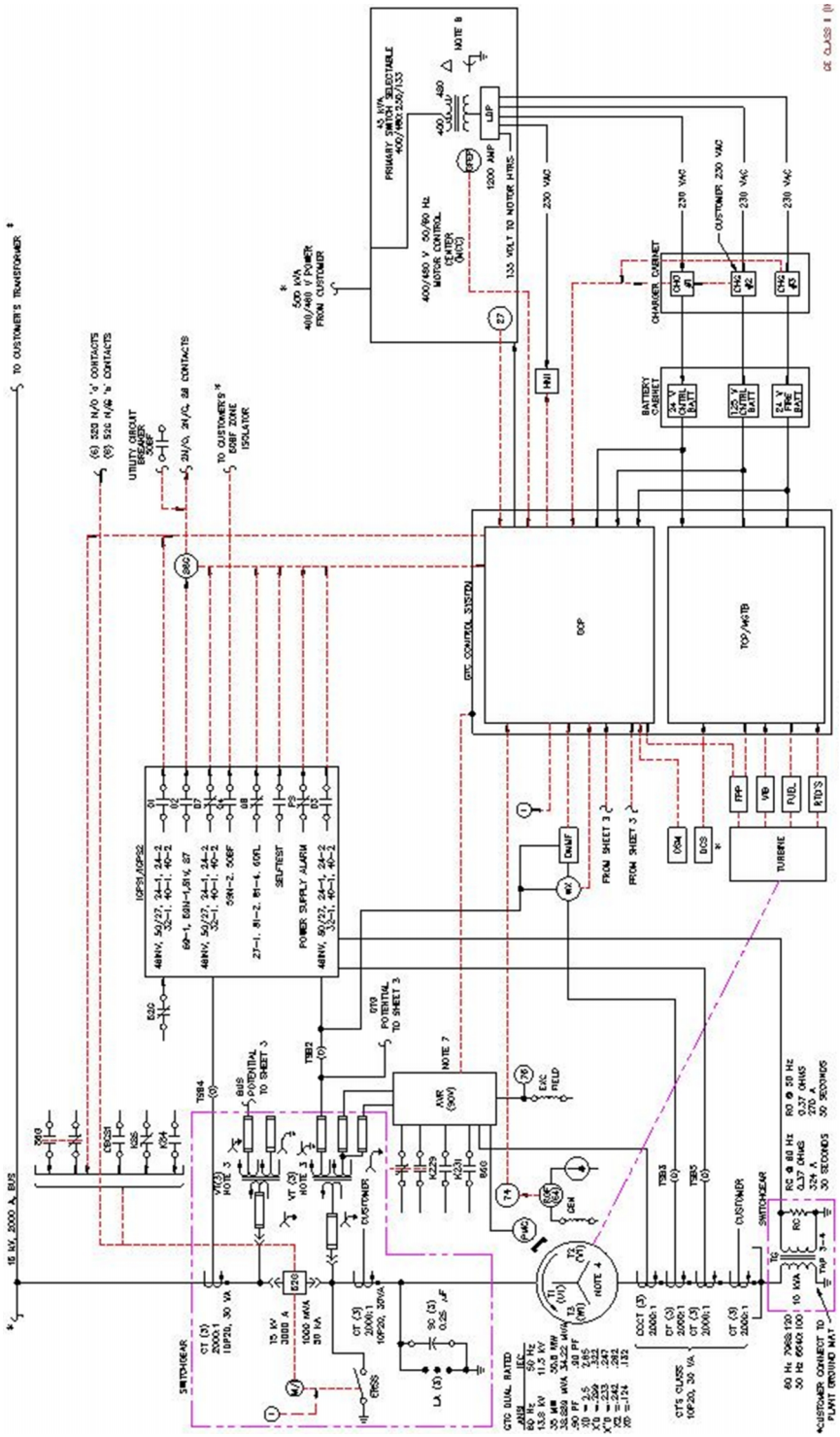
The generator protective relay system is a microprocessor-based design used to provide protection, control, and monitoring of the AC generator, switchgear, and high-voltage bus network. The integrated generator protection system (IGPS) is installed in the Generator Control Panel (GCP).

The IGPS can protect a generator from abnormal voltage and frequency, internal winding faults, system faults, inadvertent energizing, negative sequence current, reverse power, loss-of-field, and over excitation (V/Hz) disturbances, while also providing loss-of-VT-fuse detection, and breaker failure/flashover protection.

Six input contacts can be programmed to block any relay function and/or to trigger to oscillograph recorder. Any of the functions or input contacts can be individually programmed to activate any one or more of the eight programmable output contacts.

9. One Line Diagram

9.1 50 Hz/60 Hz One Line Diagram – Sheet 2



10. Control System Description

Control System Overview

The MGTG set is operated through use of a turbine electronic-control system. This system comprises computerized-control subsystems installed in the TCP (Turbine Control Panel). The microprocessors and digital logic circuitry in these subsystems provide the speed and autonomy of operation required for safe and efficient operational control. The heart of the control system is the GE Intelligent Platforms RX3i Programmable Logic Controller©. The majority of operator interaction with the system will be via the human machine interface (HMI) on the GE supplied computer. When the MGTG is operated at site the operator will normally operate the MGTG set via the HMI (local mode), and occasion (usually for maintenance purposes) the operator can perform certain functions via the GCP (local mode). The MGTG may also be operated from a remote location when in Remote mode; however for this operation, required hardwired customer interconnects must be installed.

The control system manages all critical operations of the TM2500 GEN8 MGTG set including all individual turbine-generator system monitoring and operating indicators, controls, and transmitters as well as the central electronic control system. The TCP and GCP house the majority of the control system equipment additional modules are located in the MGTB. From the GCP, the operator can initiate the turbine-generator's electronic control system to perform automatic startup, fuel management, load assumption, and system operation. Critical parameters are constantly monitored from the control system in the TCP and alarms or shutdowns are initiated automatically, as appropriate, for out-of-tolerance conditions. Automatic fuel control and turbine sequencing are controlled by the logic control system software and hardware. Operator interfaces, such as the HMI (Human machine interface) and local control switches on the GCP allow personnel to monitor and control the TM2500 GEN8 MGTG.

10.1 Turbine Control Panel (TCP)

The TCP located on the gooseneck of the turbine trailer contains the RX3i CPU (central processing unit), switches, and various control system components connected with the MGTG set. Automatic fuel control and turbine sequencing are controlled by the logic in the control system software and hardware. Also, an operator or anyone on site can initiate, as necessary, a manual emergency shutdown at any time. Critical parameters are constantly monitored by the RX3i and alarms or shutdowns are initiated automatically, as appropriate, for out-of-tolerance conditions. This panel contains the vibration monitoring system panel.

Major components located in the TCP are:

- GE-IP RX3i Programmable Logic Controller©.
- VersaMax Remote I/O Controllers
- Woodward Servo Position Controllers
- Bently Nevada 3701 Vibration Monitor System
- Jaquet T401 Tachometer System

Control System

The RX3i PLC is a flexible controller with both local and distributed I/O. CanOPEN, DeviceNet, PROFINET and Ethernet are used to communicate with the different sub-systems such as: distributed I/O, fuel control valves, variable geometry drivers, auxiliary devices and the HMI.

A suite of software tools (CIMPLICITY PROFICY Machine Edition, Woodward Control Assistant) are used for the RX3i and related controls as a common software platform for programming, trending, and analyzing diagnostics. It provides a single source of quality, time-coherent data at the controller and plant level for effectively managing equipment assets.

The controller communicates with networked I/O over one real time network. The controller rack consists of the main processors and two power supplies. A real-time, multitasking operating system is used for the main processor and I/O. Application software is provided in configurable Ladder Diagram, Structured Text, Function Block Diagram, and C. Application software is stored in non-volatile flash user memory.

The RX3i controls both the fuel supply to the engine and the system sequencing. The sequencing and fuel supply functions are described as follows:

Sequencer

The sequencer controls the order and timing of critical events in the operation of the MGTG set. It issues operating commands to the control sub-systems in response to data received from the sensors and detectors in the equipment and MGTG sub-systems.

Fuel Supply Manager

The RX3i fuel control is programmed to maintain a constant turbine speed from no-load to full-load conditions.

The controller also performs the following functions:

- Matches generator output frequency to the active bus for automated synchronization
- Controls the acceleration and deceleration rates of the turbine engine
- Initiates, regulates, and terminates the flow of water injection into the combustor

VersaMax Controller

The VersaMax* PROFINET Scanner (PNS) module interfaces a remote node of VersaMax modules to a PROFINET IO-Controller. The PROFINET Scanner scans the modules in its node, retrieving input data and providing output data, and publishes input data on the PROFINET Network at the configured production rate. The PNS manages PROFINET communication and module configuration between an IO-Controller and modules within the remote node. If network communications are lost, the PNS manages I/O states according to the individual module configurations.

Vibration Monitoring

The Bently-Nevada 3701 vibration monitoring system monitors the vibration levels at critical points along the turbine-generator package and is interfaced to the control system via Ethernet communications and hardwired connections.

10.2 Generator Control Panel (GCP)

This panel contains the voltage regulator and switches for controlling generator operating conditions. This panel contains controls for local turbine operation and the Beckwith Integrated Generator Protection System (IGPS) for monitoring the operation of the turbine engine and generator. Also located in this panel is the fire protection panel, Ex2100e for generator excitation control and circuit breakers for the distribution of the 24VDC control power and 24VDC fire and gas protection system power.

Major components located in the GCP are:

- VersaMax Remote I/O Controllers
- Beckwith M-3425A IGPS (Integrated Generator Protection System)
- GE-IP Ex2100e AVR (Automatic Voltage Controller)
- Eagle Quantum Premier FPP (Fire Protection Panel)
- Woodward DSM (Digital Speed switch)
- SATEC PM-174 DMMF (Digital Multi-Function Meter)

Integrated Generator Protection System (IGPS)

The Beckwith M-3425A IGPS (integrated generator protection system) is a microprocessor-based digital relay system that provides protection, control, and monitoring of the generator.

Ex2100e AVR (Automatic Voltage Regulator)

The GE EX2100e excitation controller is designed to control the excitation of the brushless generator.

Fire and Gas Monitoring

The fire and gas protection system is comprised of an Eagle Quantum Premier FPP (fire protection panel) that is linked to thermal spot temperature detectors, and gas detection sensors inside and outside the turbine compartment. The fire and gas protection system interfaces with the turbine control system to provide the necessary system alarms and shutdowns.

Digital Multi-Function Meter (DMMF)

The SATEC PM174 multifunction generator meter simplified monitoring of generator electrical conditions and power output. Values are relayed via EGD to the main control system for display on the HMI.

10.3 Main Generator Terminal Box (MGTB)

This panel provides the wiring interface between the TCP and GCP panels; it is primarily used for I/O (Input/ Output) wiring related to the generator.

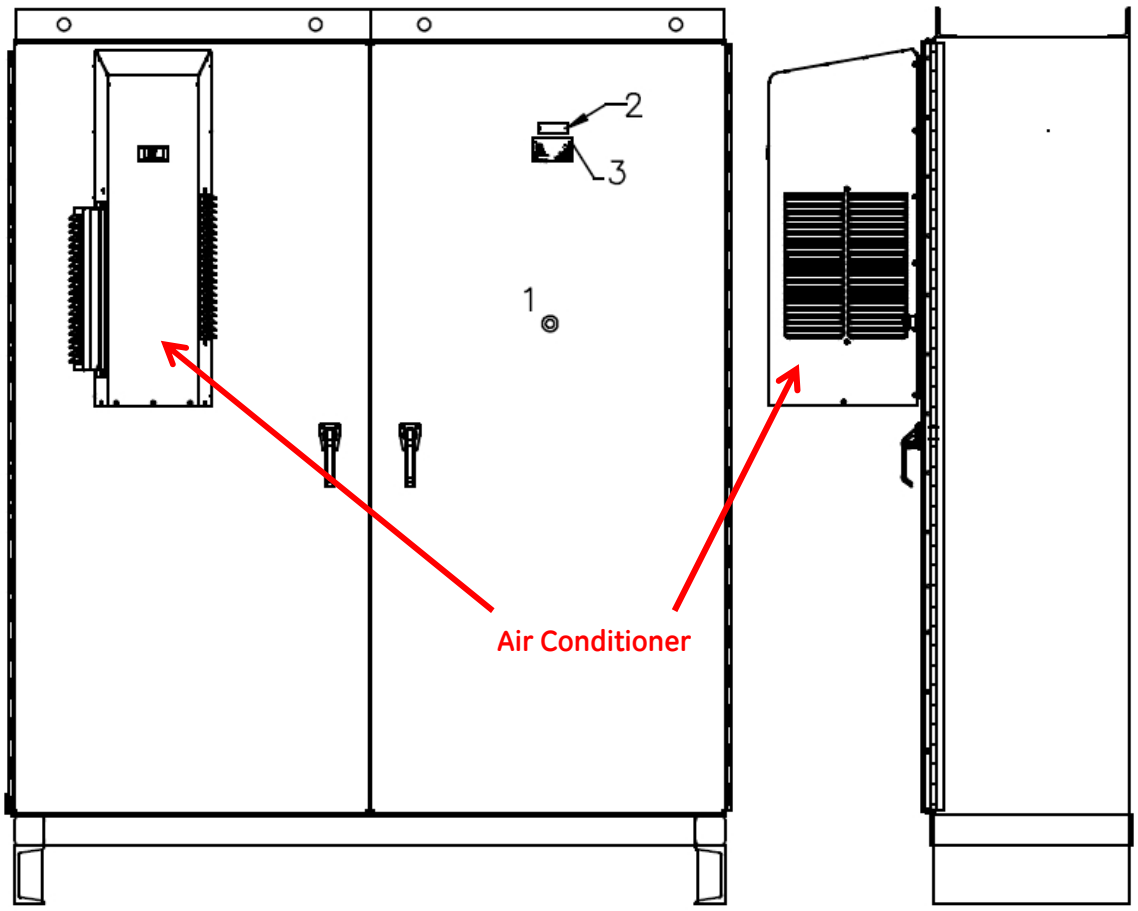
10.4 Operator Interface

The operator interface is commonly referred to as the HMI. It is a PC with a Microsoft® Windows®-based operating system, client/server capability, a PROFICY CIMPLICITY HMI graphics display system. The Human-Machine Interface (HMI) displays turbine operations data on various system screens. It includes operator input and function pushbuttons. Ethernet switches are part of the unit data highway (UDH) connecting the HMI server with the RX3i and other unit control equipment.

System (process) alarms for fault conditions are time tagged at frame rate in the controller(s) and transmitted to the HMI alarm management system. System events are time tagged at frame rate alarms can be sorted according to ID, time, and priority. A standard alarm/event log stores data for 30 days and can be sorted in chronological order or according to the frequency of occurrence.

Data is displayed in English or Metric engineering units with a one second update rate. Operator commands can be issued to increase / decrease a set point or a numerical value can be entered for a new set point.

10.5 Digital Control and Monitoring System



Front View Side View

Turbine Control Panel Tag List		
Item #	**Item Description**	**Tag**
1	SWITCH, EMERGENCY STOP (TCP)	ESTCP
2	NAMEPLATE	
3	IP RATING NAMEPLATE	

Figure 10.1a Turbine Control Panel (TCP)

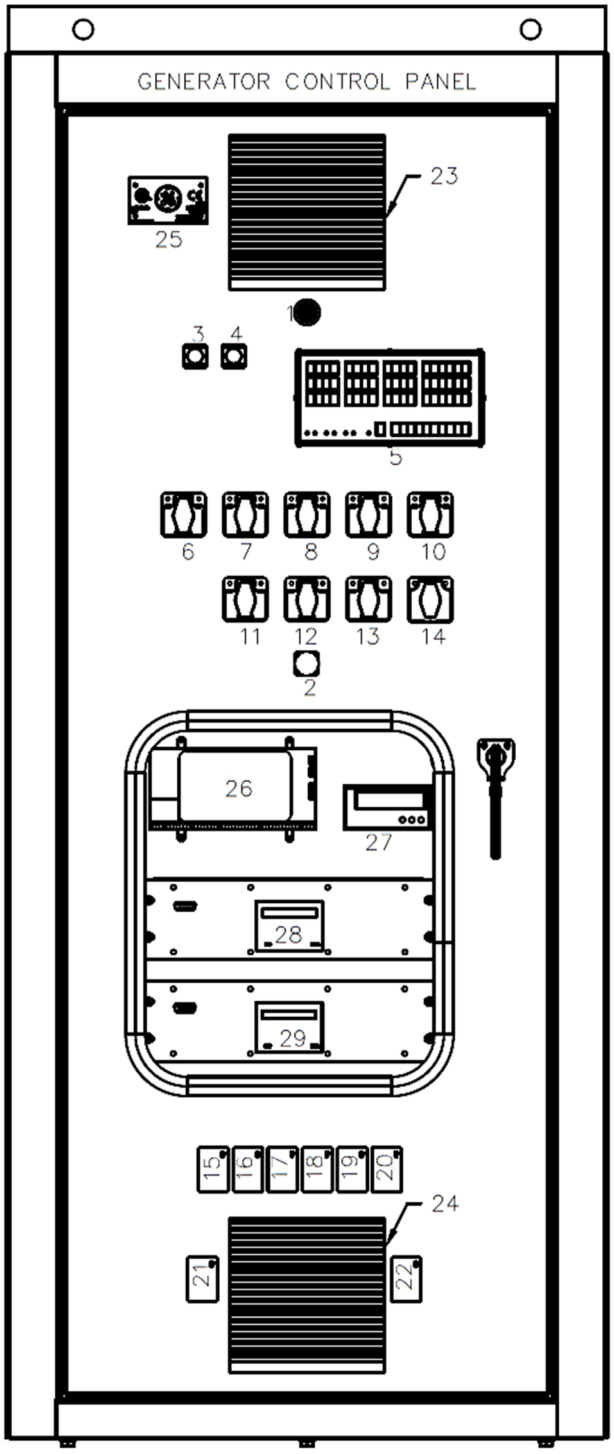


Figure 10.1b Generator Control Panel (GCP)
(See following page for item descriptions)

Generator Control Panel Tag List (GCP)		
Item #	**Item Description**	**Tag**
1	HORN	
2	SWITCH, EMERGENCY STOP (GCP)	ESGCP
3	LAMP, SYNCHRONIZING	SL1
4	LAMP, SYNCHRONIZING	SL2
5	METER, DIGITAL MULTIFUNCTION DISPLAY	DMMF DIS
6	SWITCH, TURBINE START-STOP (GCP)	TSS
7	SWITCH, SYNCHRONIZE	SS
8	RELAY, LOCKOUT (GENERATOR)	86G
9	SWITCH, EXCITATION MODE	EMS
10	SWITCH, AUTOMATIC/MANUAL VOLTAGE REGULATOR ADJUST	AMVAS
11	SWITCH, CIRCUIT BREAKER CONTROL “52G”	CBCS1
12	SWITCH, PF/VAR CONTROL ENABLE	VCES
13	SWITCH, SPEED ADJUST	SAS
14	SWITCH, LOCAL/REMOTE SELECTOR (GCP)	LRS
15	SWITCH BLOCK, TEST , BUS VOLTAGE	TSB1
16	SWITCH BLOCK, TEST , GENERATOR VOLTAGE	TSB2
17	SWITCH BLOCK, TEST , GENERATOR CURRENT METERING	TSB3
18	SWITCH BLOCK, TEST , BUS CURRENT PROTECTION	TSB4
19	SWITCH BLOCK, TEST , GENERATOR CURRENT PROTECTION	TSB5
20	SWITCH BLOCK, TEST , GENERATOR LOCKOUT RELAY (86G)	TSB6
21	SWITCH BLOCK, TEST , SPARE	TSB7
22	SWITCH BLOCK, TEST , SPARE	TSB8
23	FILTER, GENERATOR CONTROL PANEL	FLTR2
24	BLOWER, GENERATOR CONTROL PANEL	BLR2
25	NAMEPLATE	
26	PANEL, FIRE PROTECTION	FPP
27	SYNCHRONIZER, AUTO SPEED-VOLTAGE MATCHING	DSM
28	INTEGRATED GENERATOR PROTECTION SYSTEM (50 Hz)	IGPS1
29	INTEGRATED GENERATOR PROTECTION SYSTEM (60 Hz)	IGPS2

11. Buyer Furnished Equipment and Services

In order to provide a complete operational installation, additional equipment and services, not included in the basic unit scope, must be provided by the buyer or the installer, unless modified by specific agreement. These include, but are not limited to, the following:

11.1 Civil / Structural

- Grounding grid and connections, lightning protection
- Necessary drainage, including sumps and drain piping
- Site facilities
- Support steel works and hangers for gas turbine ducting, silencing and pipe work.

11.2 Mechanical

- In accordance with GE fuel specifications listed in Section 12:
  - Natural Gas: Provide 50°F (28°C) of heating above the dew point. In addition, a gas shutoff valve located remotely from the unit must be provided to shut off the gas supply to the turbine when the unit is not in operation
  - #2 Distillate Oil: Provide storage tanks, filtration/purification systems, and piping to the liquid fuel inlet.
- Demineralized water for the water injection system at required pressure
- Heated fluid for anti-icing system, if included
- Access ladders and platforms as required

11.3 Electrical

- 480 VAC (60 Hz) or 400 VAC (50 Hz) electrical power for gas turbine starting and accessories
- Electrical power connections (power cable or duct) from the generator lineside cubicle to the Buyer's electrical systems
- Electrical control connections from the on-base terminal points to the turbine generator control panel and to the Buyer's systems

- Motor control centers (MCC) auxiliary power transformers distribution panel as necessary for station services such as:
  - Fuel Gas Compressors
  - Distillate Fuel Forwarding Skids
  - All MGTG Package Auxiliary Loads
- The following cables:
  - Power cables from the Buyer 's electrical system to the MCCs Load sharing control
- Power system studies
- Distribution plant control
- Customer remote control (Quoted separately)
- High voltage transformers, cables, and associated equipment
- Balance of plant and energy optimization controls
- Sensing and metering voltage transformers
- Generator controls other than defined in scope of supply
- See the "One Line Diagram" in Section 9 of this document for further definition

11.4 Miscellaneous Services (quoted separately)

- Transport, unload, place and install the equipment
- Construction services including electric power, lighting, temporary heaters, test equipment, compressed air, crane(s) and all required standard tools
- Storage and security for equipment received
- Site labor
- Field supervision (quoted separately)

11.5 Balance of Plant Equipment (as necessary)

- Fuel gas filtration, separation or regulation
- De-aeration and chemical injection equipment
- Heating Medium feed pumps and auto level control assemblies
- Automatic blow down controls
- Non-standard inlet filter house support structures
- Power plant calibration tools
- Spare parts and consumables
- Distillate fuel filtration and purification systems

11.6 Start-Up/Test (quoted separately)

- Operating personnel for starting, preliminary runs and tests
- Lubricating fluid, greases, and supplies for starting, preliminary runs, tests and normal operation thereafter.
- All field performance tests. Such tests to measure quoted guarantees shall be in accordance with General Electric recommended test procedures. Fuel and load for tests are customer owner responsibilities.

Note: Various types of contracts are available from NPAOy, thus the above may not reflect the contracted scope. In case of conflict, the agreed upon Contract with NPAOy prevails.

12. Reference Specifications

Fuel Gases for Combustion in Aeroderivative Gas Turbines	MID-TD-0000-1
Liquid Fuel Requirements for GE Aeroderivative Gas Turbines	MID-TD-0000-2
Requirements for Water and Steam Purity for Injection in Aero Derivative Gas Turbines	MID-TD-0000-3
Compressor Cleaning Water Purity Specification for GE Aircraft Derivative Gas Turbines in Industrial Applications	MID-TD-0000-4
Liquid Detergent for Compressor Cleaning for GE Aircraft Derivative Gas Turbines	MID-TD-0000-5
Lubricating Oil Specification for GE Aircraft Derivative Gas Turbines	MID-TD-0000-6
Water Supply Requirement for Gas Turbine Inlet Air Evaporative Coolers	GEK 107158

13. Maintenance, Special Tools and Spare Parts

13.1 Maintainability Features

The LM2500+G4™ gas turbine is designed for high availability. The principle maintainability features include:

- Modular construction permits replacement of the aero components without total disassembly.
- Multiple borescope ports allow on-condition monitoring without turbine disassembly.
- Condition based maintenance and remote diagnostics will be employed.
- Split casing construction of the low-pressure compressor (LPC) and high-pressure compressor (HPC) allows detailed inspection and partial blade replacement on-site.
- Hot section field maintenance can be done in a few days.
- Accessories are externally mounted for ease of on-site replacement.

13.2 Service Intervals

The expected service intervals for the LM2500+G4™ gas turbine (based upon normal operation) are:

Hours of Operation	Scheduled Maintenance Action	Outage Duration
4,000	Inspection (Every 4,000 hours)	12-16 hours
25,000	On-site Hot Section Replacement	3 days
50,000	Depot Refurbishment*	2-3 days
75,000	On-site Hot Section Replacement	3 days
100,000	Depot Refurbishment*	2-3 days
125,000	On-site Hot Section Replacement	3 days

* Spare or lease engine installed during refurbishment.
Maintenance intervals above are based on gas fuel operation.

13.3 On Condition Maintenance

The LM2500+G4™ gas turbine is designed for easy maintenance. To reduce maintenance time, the LM2500+G4™ gas turbine has a horizontally split compressor casing and external fuel nozzle access. Twenty-one borescope inspection ports permit "on condition maintenance." Under this plan, the engine is given a thorough internal borescope inspection every 6 months. This inspection reveals mechanical problems and wear. Replacement parts are installed only when the inspection shows a specific need, rather than on an arbitrary time schedule. For example, in a hot section repair, individual blades and vanes are replaced as necessary, rather than replacing the entire set (of high-pressure blades or nozzles). This "on condition" repair saves parts, labor and downtime. It eliminates the waste caused by maintenance plans based on clock hours only.

13.4 Preventive Maintenance

GE/NPAOy literature and training stress preventive maintenance. Less downtime and reduced cost-of-ownership are achieved when operators take the following preventive measures:

- Condition monitoring of critical parameters
- Trend analysis of performance
- Visual inspection of auxiliary systems and external wiring
- Borescope inspection
- Water wash
- Filter changes and inspections
- Lube oil sampling

In addition, Distributed Power trains operators to perform routine "condition monitoring," to include:

- Gas generator speed
- Power turbine speed
- Gas generator exhaust gas temperature
- Gas generator discharge pressure
- Vibration
- Oil pressure & temperature

Condition monitoring, in conjunction with borescope inspections, can provide an essential history of engine condition versus operating time. This allows maintenance to be predicted and scheduled for an appropriate time.

13.5 Water Washing

Water washing the turbine helps to recover performance that has been lost over time due to compressor airfoil fouling.

All LM2500® units have a “crank soak” or off-line cycle capability. The engine bell mouth is equipped with a spray manifold for water detergent solutions and rinse water.

13.6 Maintenance Level

On-site and off-site maintenance tasks are divided into categories, or “levels,” described below. Downtime for maintenance is reduced by virtue of the LM2500+G4™ gas turbine's modular design. Routine maintenance tasks are done on-site, while major engine repairs are performed at specialized off-site facilities, saving the customer the expense of tooling and equipment.

On-Site Maintenance

Level 1
On-Site External Maintenance - includes protective and corrective tasks such as:

- Adjusting or replacing externally accessible components
- Engine replacement
- Compressor Cleaning (Off-line Water Wash)
- Scheduled Inspections

Level 2
On-Site Internal Maintenance & Module Replacement - requiring partial disassembly of the engine and replacement of components including:

- Compressor blade/vane replacement
- Hot section component replacement
- HPT blade replacement
- Accessory Gearbox

Off-Site Maintenance

Level 3
Off-Site Internal Maintenance - includes all Level 2 capabilities, plus a complete teardown and rebuilding of engine, and replacements of major sub-assemblies (with spare sub-assemblies).

Level 4
Off-Site Overhaul - includes Level 3 capabilities plus complete disassembly of the major sub-assemblies of the gas turbine and rebuilding sub-assemblies with replacement parts. A permanent shop and a test cell are required for a Level 4 overhaul facility.

Distributed Power has full Level 4 maintenance capabilities for customer's needs. We feature full-load testing of the repaired engine to assure maximum field performance.

13.7 Owner's Maintenance

In most cases, the Owner prefers to have their operators trained to perform Level 1 maintenance to the gas turbine, and Levels 2 - 4 maintenance tasks handled by outside contract. However, Distributed Power can train operators for Level 2 maintenance tasks if desired.

13.8 Special Tools

Special tools are required to provide Levels 1 and 2 maintenance activities. These tools are offered at a separate price for customers desiring to perform maintenance themselves. The tooling to remove and install the turbine from the engine compartment is provided by Distributed Power in the basic scope of supply. Lifting pins & rigging required at initial startup are provided without charge if returned to Distributed Power (freight prepaid) after the equipment is installed.

14. Customer Drawings and Documentation

General Overview

Distributed Power prepares a comprehensive drawing package for each gas turbine generator set. The package includes:

- Proposal Drawings **-** Drawings furnished with the proposal to assist Customer evaluation of the product.
- Project Drawings **-** Approval and Information Drawings furnished as part of the project to document the contractual configuration gas turbine generator set. Approval Drawings are submitted for specific customer approval, while Information Drawings are of standard manufactured items in the turbine package furnished for customer information only.

Distributed Power provides all engineering drawings on-line at a secure server, Documentum . Each customer can enter this database and view, print or annotate project drawings. Documentum provides the customer with immediate access to the latest drawings revisions. Documentum speeds job completion and saves weeks of time mailing drawings back and forth.

Distributed Power also provides extensive documentation to help install, commission, operate and maintain the Mobile Gas Turbine Generator set. These unit specific manuals are made available on a secure Internet website, as well as in hardcopy and digital media versions.

This documentation includes:

- Installation and Commissioning Manuals
- Operation and Maintenance Manuals
- Gas Turbine Operation and Maintenance Manuals

14.1 Customer Drawings

Proposal Drawings

These drawings are “Preliminary” in nature. They help to define the product for evaluation, and they form the basis for an Engineering “ODM” (Order Definition Meeting) following contract award.

Distributed Power prepares Proposal drawings to show:

- General Arrangement of the Mobile Gas Turbine Generator set
- Electrical "One Line" Information

Project Drawings

Approval Drawings

After the contract ODM, which defines the project details, Distributed Power updates the general arrangement and one-line drawings and submits them for Customer approval.

General Arrangement Drawings

These drawings define the orientation of the major Distributed Power modules. A general arrangement drawing with Plan and Elevation views is prepared for each of the following major components:

- Mobile Gas Turbine Generator set and Control House trailer
- Turbine Control panel
- Generator Control Panel
- Battery System

The general arrangement drawings include the following information:

- Overall dimensions of the equipment
- Weights and centers of gravity of assemblies
- Access space required for removal or maintenance of major components
- Foundation loads, foundation bolthole locations and sizes, plus any special requirements
- Lifting arrangements and provisions
- Customer piping connections with appropriate dimensions

One Line Electrical Drawings

These drawings are an electrical schematic of the power system from the generator terminals to the purchaser's high voltage bus and ground connections, including the generator excitation and synchronizing systems. Also shown are the protective relays, potential transformers, circuit breaker, and auxiliary/main transformers, some of which may be furnished by others. In cases where the Distributed Power equipment will be interfaced with an existing facility or with customer supplied

devices, a customer's one line drawing must be furnished to Distributed Power for preparation of the Distributed Power one line electrical diagram.

Revisions to Approval Drawings

Customer should mark any requested revisions on one copy of the Approval Drawings and return them to Distributed Power within two weeks. Distributed Power will then reissue drawings showing mutually agreeable corrections. When returning drawings electronically, the customer should make any requested revisions electronically on the Approval Drawings through the Documentum website, and submit them to Distributed Power within two weeks. Distributed Power will then upload revised drawings showing mutually agreeable corrections.

Certified Drawings

Distributed Power certifies only drawings showing anchor bolt locations, foundation loading and customer piping connection locations.

Information Drawings

These drawings cover standard manufacturing items. They provide a reference for construction, maintenance and operations. The drawings are submitted for "information only" and are not subject to approval.

Electrical System Interconnection Plan

This drawing shows recommended sizes for interconnecting cables and corresponding minimum cable lengths between Distributed Power supplied modules and the customer's control room. The Interconnection plan assists the customer in purchasing wire and cable for interconnection and helps in planning the site layout. Point-to-point interconnection wiring diagrams are also provided. These drawings are completed after other system drawings have been finalized.

Flow and Instrument Diagrams (F&ID)

F&IDs are issued for each of the fluid systems in the Distributed Power scope of work. This typically includes the following:

- Fuel System with Water Injection
- Off-Line Water Wash System
- Hydraulic Start System
- Turbine Lube Oil System
- Generator Lube Oil System
- Fire and Gas Protection System
- Ventilation and Combustion Air System
- Laser Alignment System

Each F&ID drawing shows the equipment components, piping, valves and instruments in the system, complete with piping line sizes. The part number of each item on the F&ID is shown on a bill of material, which is part of each F&ID drawing. The F&IDs also show the pressure, temperature and volume limitations of the system, including set points for alarms and shutdowns. Each working fluid in the system is identified and initial fill quantities for fluid reservoirs are shown. For clarity, the F&ID drawings are schematic in nature. Pipe elbows, fittings and similar details are omitted.

Plan and Elevation

This Plan & Elevation drawing provides installation details for operator information. The drawing shows the front of the unit control panel as viewed by the operator, including meters, indicator lights, and switches. Overall dimensions and installation footprint are shown on this drawing. Plan and Elevation drawings include the Turbine Control Panel, Generator Control Panel, and the Battery System.

Drawings with Manuals

In addition to the above drawings, a complete set of system wiring diagrams is included in the operation and maintenance manuals to serve as a reference for field checkout and troubleshooting.

Typical Drawing List for the MGTG Package

Some of the drawings listed in the table below may not be applicable to specific projects.

Typical mechanical, electrical, and reference drawings and their submittal times in weeks are shown in the following tables. Please note that some drawings listed in the following tables may not be applicable to specific projects.

Mechanical Drawings

Drawing Title	Code	Group	Timing
General Arrangement, TM2500 GEN8	CA	1	4
Plot Plan and Foundation Load Table TM2500 GEN8	CI	1	4
Transportation Arrangement, TM2500 GEN8	CI	1	4
Lifting Arrangement, TM2500 GEN8	CI	1	4
Flow & Equipment Symbols, Mechanical	CI	2	5
Flow & Instrument Diagram, Hydraulic Start System	CI	2	5
Flow & Instrument Diagram, Dual Fuel System with Water Injection	CI	2	5
Flow & Instrument Diagram, Ventilation and Combustion Air System	CI	2	5
Flow & Instrument Diagram, Turbine Lube Oil System	CI	2	5
Flow & Instrument Diagram, Generator Lube Oil System	CI	2	5
Flow & Instrument Diagram, Fire & Gas Protection System	CI	2	5
Flow & Instrument Diagram, Off-Line Water Wash System	CI	2	5
Instrument Diagram, Auxiliary Systems	CI	2	5

Electrical Drawings

Drawing Title	Code	Group	Timing
One-Line Diagram	CA	1	4
Three-Line Diagram, Generator Metering	CI	1	4
Electrical Symbols, Abbreviations and Reference Data	CI	1	4
Plan & Elevation, Turbine Control Panel	CI	1	4
Plan & Elevation, Battery System	CI	1	4
Schedule, Motor Control Center	CI	1	4
Generator Protective Relay Settings	CI	2	5
Area Classification Drawing	CI	2	5
Area Classification Report	CI	2	5
Digital Multifunction Meter Settings	CI	2	5
Automatic Voltage Regulator Settings	CI	2	5
SPM-Digital Synchronizer Settings	CI	2	5

Electrical Drawings (continued)

Drawing Title	Code	Group	Timing
Speed Switch Settings	CI	2	5
Schematic Diagram, Motor Control Center	CI	3	6
Schematic Diagram, Discrete Control	CI	3	6
Schematic Diagram, Analog Control	CI	3	6
Schematic Diagram, Circuit Breaker Control	CI	3	6
System Schematic, Generator Excitation	CI	3	6
System Schematic, Lighting & Distribution	CI	3	6
System Schematic, Fire & Gas Protection	CI	3	6
System Schematic, Vibration	CI	3	6
System Schematic, Communication	CI	3	6
Worksheet, Fuel Control & Sequencer Layout	CI	3	6
Worksheet, Control System	CI	3	6
Interconnect Plan, Electrical, Customer	CI	3	6
Interconnect Wiring Diagram	CI	3	6
Interconnect Wiring Diagram, Control House	CI	3	6

Reference Drawings

Drawing Title	Code	Group	Timing
Wiring Diagram, Turbine Control Panel, Control Cubicle	M	-	-
Wiring Diagram, Turbine Control, Termination Cubicle	M	-	-
Wiring Diagram, Turbine Skid	M	-	-
Wiring Diagram, Auxiliary Skid	M	-	-
Wiring Diagram, Air Inlet Filter	M	-	-
Wiring Diagram, Generator Skid	M	-	-
Wiring Diagram, Lineside Cubicle	M	-	-
Wiring Diagram, Neutral Cubicle	M	-	-
Wiring Diagram, Fire & Gas Protection System	M	-	-
Nameplate List, Engraving Schedule & Switch Development	M	-	-

Notes:

1. CA = Customer approval. Customer Approval is limited to errors, omissions, or corrections of standard designs and verification that customer selected options have been included. Customer is allotted 3 weeks (21 calendar days) for review of approval drawings. After this time has passed with no communication of changes from customer, the drawings will be deemed acceptable.

2. CI = Customer information only, not an approval drawing
3. M = Drawings supplied with operation and maintenance manuals. Supplied approximately 30 days after RTS
4. Submittal time is for a contract with standard equipment and is shown in weeks after the post award Customer Kick-Off Meeting (CKOM).
5. Drawing dates for standard equipment only. Custom designed features for specific project requirements may require additional times for drawing submittals.
6. A drawing is considered submitted when uploaded to the online secure internet site
7. For submittal of drawings, there are three groups:
   Group 1 = 4 weeks Group 2 = 5 weeks Group 3 = 6 weeks
8. Distributed Power places customers' drawings on a secure internet site. On this site the drawings can be viewed, printed and annotated by the customer.
9. Distributed Power provides all manuals in CD format for convenient access and distribution. In addition, by using web-based technology GE provides today's customers instant and secure access to their unit's operation and maintenance documentation with easy updates and "real time" information.

14.2 Documentation

Distributed Power provides extensive documentation to help install, commission, operate and maintain the Mobile Gas Turbine Generator set. The above-mentioned documentation includes:

Installation & Commissioning Manual (ICM)

The Installation section of the manual provides detailed instructions on:

- Transporting, receiving and inspecting the equipment
- Assembly of the components
- Scheduling, manpower and tooling

The Pre-Commissioning section of the manual provides detailed instructions on:

- Mechanical and Electrical pre-commissioning activities complete with checklists
- Scheduling, manpower, and tooling

The Commissioning section of the manual provides detailed instructions on:

- Commissioning activities including pre-start testing, rotation test, initial fired start, and auxiliary systems
- Scheduling, manpower, and tooling

The Installation & Commissioning Manual is a one-volume publication. Three copies are shipped to the job site approximately 1 month before shipment of the Gas Turbine Generator.

Operation and Maintenance (O&M) Manuals

A team of engineers, writers, illustrators and editors prepares this multi-volume manual. It is specifically edited for each project to include project specific drawings and details.

The O&M manual is designed as a reference for the operators and technicians in the field. It provides system descriptions, specifications, and procedures for field operation and maintenance. Project details and illustrations are included for the following:

- Product Description
- Turbine and Generator Specifications
- Unit Operating Procedures
- Turbine Operating Sequences
- Generator Operating Data
- Control System Components & Operations
- Fire & Gas Protection System
- Electrical and Mechanical drawings

In addition to the above information, Distributed Power includes vendor's operation and maintenance data on all major systems and components.

Six copies of the O&M manuals in CD form are shipped approximately 30 days after shipment of the Gas Turbine Generator. This allows Distributed Power time to include the latest engineering drawings. The manuals are also available on a secure internet website.

Drawing Quantities and Format

Distributed Power places customers' drawings on Documentum, a secure internet site. On this site the drawings can be viewed, printed and annotated by the customer.

Distributed Power provides all manuals in CD format for convenient access and distribution. In addition, by using web-based technology Distributed Power provides today's customers instant and secure access to their unit's operation and maintenance documentation with easy updates and "real time" information.

15. Extended Scope Equipment and Services

15.1 Extended Scope Equipment

Distributed Power can supply additional equipment upon request to support the turbine generator package.

Continuous Emissions Monitoring System

Distributed Power can provide a Continuous Emissions Monitoring (CEM)/Data Acquisition Historical Storage (DAHS) system for the gas turbine package. The system utilized is an extractive sampling system that is capable of monitoring NOx, CO, CO_2, O_2, and NH_3. The system is provided complete with a walk-in shelter with a wall-mounted air conditioning unit. The system will also consist of the necessary stack probes and sample lines.

Distributed Power can provide the following equipment and services, as an option, if required for the project:

- Uninterrupted Power Supply (UPS) for PLC and analyzers
- Inlet NOx for SCR system/performance measurement
- Opacity monitoring system
- Installation and commissioning supervision
- Training
- Certification testing by a third party tester

Initial Fill Lubricants

GE/NPAOy can provide first fill of lubricants to include the turbine lube oil, generator lube oil (includes low pressure compressor), hydraulic start system oil and chemical water wash.

Oil Type	Specification
Turbine Lube Oil / Hydraulic Oil – Synthetic	MIL-TD-0000-6
Generator Lube Oil – Mineral	ISO-VG32
Water Wash Chemical	MID-TD-0000-5

Auxiliary Transformer – Low Voltage

Distributed Power can provide pad mounted auxiliary transformers for the various plant loads as required. The size of the transformers is dictated by the plant design.

Black Start Generator

Distributed Power can provide a diesel engine driven generator package to provide MGTG start-up capability in the event of a loss of connection to the grid. For black starts, the diesel generator provides AC power for the MGTG hydraulic starter motor, package ventilation fans, and various accessories. In addition to the diesel engine and generator, the black start system includes a breaker cubicle, distribution and control panel, and fuel tank.

15.2 Extended Scope Services

Installation and Commissioning Services

Distributed Power can provide technical advisory supervision services for the Installation and Commissioning of the combustion turbine package. Installation services include supervising the installation of the combustion turbine package by the Owner's construction contractor. Commissioning services will include commissioning supervision of combustion turbine mechanical systems, checkout and commissioning supervision of combustion turbine electrical systems, and checkout and commissioning of the combustion turbine package control system. When contracted for installation and commissioning services, Distributed Power will provide all general hand tools required for the commissioning of the unit.

Engineering Studies

Distributed Power can provide other various engineering support services including complex or new product design, troubleshooting, problem solving, and power plant conceptual layouts. Quite often, Distributed Power will coordinate with third party expertise to meet the project requirements.

Exhaust Emissions Testing

Distributed Power can provide complete and comprehensive combustion turbine exhaust emissions mapping testing services for the project if required. For these services, GE/NPAOy will provide a testing specialist at the jobsite to conduct the typical exhaust emissions testing services including:

- Preliminary O_2 traverse, if required
- Nitrogen oxides (NOx)
- Carbon monoxide (CO)
- Unburned hydrocarbons
- Oxygen (O_2)

A formal site data test report will be provided once the testing is completed.

Extended Scope Systems Training

In conjunction with the training provided by the gas turbine instructors, Distributed Power can provide specialized operator training on each of the extended scope systems.

16. Customer Technical Training

GE Power & Water's Customer Technical Training (CTT) is your key to turning knowledge into power by providing high-quality training that will help you maximize the efficiency of your equipment, minimize the costly mistakes that can jeopardize your plant, and build life-long skills. We offer a variety of training solutions for GE Heavy Duty Gas Turbines, Steam Turbines, Generators, Control Systems, Aeroderivative LM Turbines, and Package Training. Our training courses are conducted by high-caliber instructors who are experts in OEM design, installation, maintenance, and startups.

Training is not one time, one class, one subject matter, but rather a continuous path of learning for plant personnel to gain the knowledge needed to achieve success in running an efficient, well-operated and well-maintained plant. Our instructors, training options, and Learning Paths will help you achieve these goals. Go to CTT's website www.geenergytechnicaltraining.com for further details on course schedules and locations.

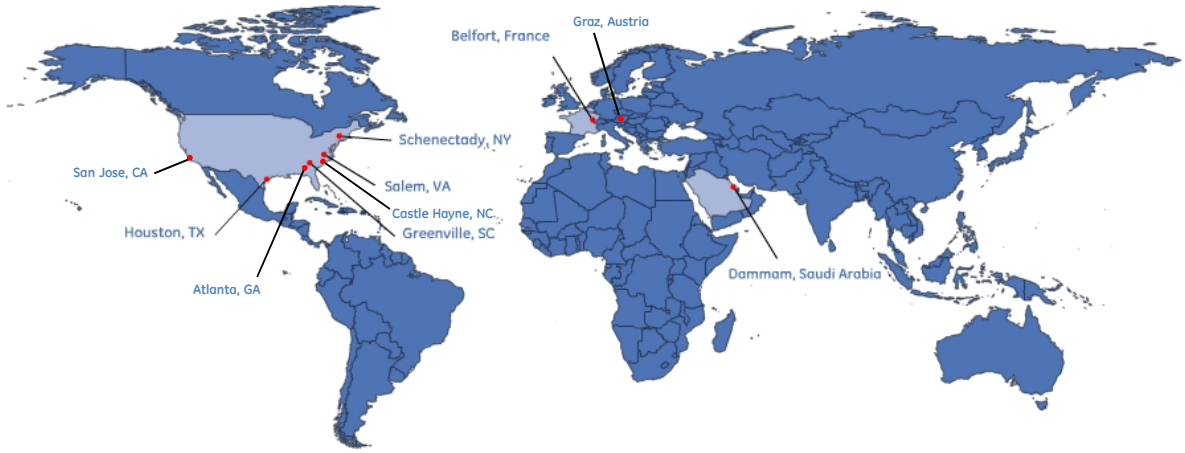
16.1 Course Offerings

Gas Turbine Familiarization
Gas Turbine - Level 1 & 2: Hot and Cold Section Maintenance (Open Enrollment only)
Borescope Inspection (Open Enrollment only)
Package Operations & Familiarization
Package Maintenance
Package Controls Systems - Operation, Maintenance, and Troubleshooting
Turbine Controls – Training for Operators, Maintenance Technicians & Engineers
Generator Excitation Maintenance - Operation, Maintenance, and Troubleshooting (Intro and Advanced)
Generator & Electrical Training (Online Course)
Gas Turbine Systems (Online Course)
DLE Familiarization and Mapping Overview (Open Enrollment only)

***** Reference CTT website for a complete list of courses, their available delivery methods and locations.

16.2 Customer Technical Training Locations

All training courses conducted at CTT locations have been founded on decades of experience and are reflective of the latest processes and proven practices. Each year we train over 15,000 students and grow their knowledge within a top notch-learning environment, which includes fully equipped classrooms and labs.



Locations:

- Houston, Texas
- Greenville, South Carolina
- Salem, Virginia
- Schenectady, New York
- Belfort, France
- Dammam, Saudi Arabia
- Seoul, Korea Republic
- Castle Hayne, North Carolina
- Graz, Austria
- Atlanta, Georgia
- San Jose, California

16.3 Training Delivery Methods

Online Courses - Our various online learning solutions will help you train your personnel anytime, anywhere. Once a course is purchased, the student will have unlimited access to the training for 6 months. During this time, students are able to learn at their own pace, and retrain on any modules as they see fit. Online courses are a cost effective, flexible solution for staff members who may not be as experienced and require extra training.

Open Enrollment Training - These courses have been designed to help you maintain a trained work force that is skilled in controls, operations, and maintenance. These courses offer you the opportunity to train at a GE Facility with students from around the world. This training is also a cost effective alternative for customers who have a small staff, or new team members.

On-Site Plant Specific Training - Site-Specific training provides you the opportunity to have a course tailored to your Site-Specific information, as opposed to the Open Enrollment courses which are typically generic in content. Site-Specific training can be conducted on-site, which provides the opportunity for saving on travel expenses and time away from work. However, always available is the option to conduct the training at one of our GE Facilities. This option removes participants from the daily work area and interruptions that can reduce the quality of training.

16.4 Typical Gas Turbine Familiarization

Basic Gas turbine theory and operation and the knowledge required to ensure consistent, trouble-free performance from the engine and its associated equipment.

The Gas Turbine Familiarization course covers the following areas:

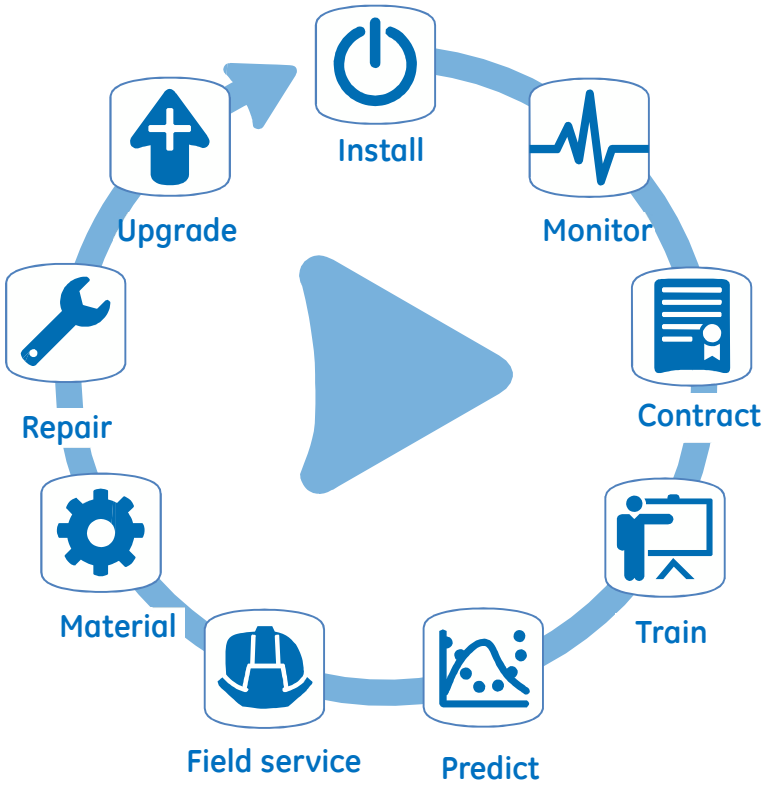
- Introduction and History of the LM2500®/lineage
- Terms and abbreviations
- Frames, Cases and Rotors
- Comparison 2500 versus 2500+
- VSV Control System - Overview, Operation and Limits
- Air Systems - Primary / Secondary / Parasitic
- HP recoup / Thrust Balance
- Fuel Systems
- Sump Pressurization
- Bearings
- Oil System- Component Description / Function / Operation
- Sensors / Instrumentation

Duration: Three (3) consecutive days in length, exclusive of weekends and holidays.
Textbook: Student textbooks are supplied and will be retained by the customer.
Language: English

16.5 Customer Technical Training - Contact Info

For more information about gas turbine and/or package technical training contact your regional NPAOy Sales Person, Service Manager, or Contract Manager.

17. Aftermarket Services



Modern energy production demands reliable, efficient asset operation. By combining innovative technology, service and support, GE/NPAOy brings value across the life cycle of your asset. GE/NPAOy's Distributed Power business delivers results in reduced unplanned downtime, increased workforce efficiencies and reduced operating costs. Whatever your equipment or your task, you're in the hands of established experts.

We bring a powerful combination of skill, expertise and process improvement to worksites across the globe. Helping operators and technicians become more efficient and productive, while increasing engine uptime from the first moment of startup.

17.1 Services Overview

Distributed Power has a full portfolio of offerings to help its customers focus on their core business activities while we do the rest. Our LM2500®/TM2500® Services include:

- Conversions, Modifications, and Upgrades
- Contractual Service Agreements
- Predict
- Material
- Installation and Commissioning
- Remote Monitoring, Diagnostics and Servicing
- Training
- Field Service
- Overhaul and Repair Services

17.2 Installation and Commissioning

Planning and installation from one trusted source - GE/NPAOy can fulfill your project requirements with multiple technologies combined into a single turnkey installation. One convenient package can encompass everything you need, including a reciprocating engine or gas turbine, the catalytic converter, the heat exchanger and all balance-of-plant equipment and controls. Our experienced certified field technicians make sure your engines and turbines are installed according to your requirements.

GE/NPAOy's technical experts also have the ability to help you:

- Develop your balance-of-plant specifications
- Perform engineering and site and design work to meet spatial requirements

Because all installations can be removed for maintenance at the same time, GE/NPAOy's comprehensive packages streamline your service experiences.

17.3 Remote Monitoring, Diagnostics and Servicing

Remote Monitoring and Diagnostic technology to reduce unplanned downtime - Our Remote Monitoring and Diagnostic (RM&D) technology gives you 24/7 access to proactive data analysis. Pressure, temperature and ignition monitoring offer a variety of advantages:

- Guiding service planning
- Managing operations
- Reducing operating costs
- Increasing equipment availability
- Reducing corrective maintenance expenses
- Online monitoring of engine parameters
- Remote software updates

With timely and accurate technical support, our remote monitoring, diagnostics and servicing is provided globally through our service network.

17.4 Contractual Service Agreements

Customized to your specific needs - Multi-Year agreements help protect your investment, and are custom-tailored to your exact needs. Each contract integrates the latest OEM technological knowledge with a full range of remote monitoring diagnostic solutions, field services, original spare parts and repairs.

Service agreement benefits include:

- Full or partial maintenance cost risk transfer
- Predictable costs
- Maintenance planning
- Performance improvement
- Outages aligned with workload
- Greater availability of parts, materials and technicians
- Thermal and operational performance programs
- Condition-based maintenance options
- Lease engine and unit exchange options

Our flexible service agreements meet your maintenance requirements while giving maximum cost control for the life of your equipment.

17.5 Training

Expert training for improved operations - GE/NPAOy's training instructors use extensive engine expertise and decades of industry knowledge to help improve the skillsets of your technicians helping them to work better, faster and smarter.

Training features:

- Highly knowledgeable and skilled technical trainers
- Hands-on activities and in-class exercises to drive retention of the skills and knowledge technicians need
- Advanced technical training in multiple languages
- One-on-one training
- Available at any location for aeroderivative gas turbines or reciprocating engines
- Available on your jobsite
- The latest product information
- Easy-to-read operating manuals
- Electronic assistance
- Easy-to-read operating manuals and service bulletins

Our participant-oriented training programs ensure the best operation and maintenance of your equipment.

17.6 GE's Predictivity™

Real-time data meets real-world demands - GE/NPAOy's Predictivity™ portfolio of Industrial Internet solutions combines machine data, predictive analytic software and GE/NPAOy expertise to proactively manage machine repairs. This data-based solution delivers numerous benefits:

- Eliminates unplanned downtime
- Increases workforce efficiency
- Reduces operating costs
- Uncovers new revenue opportunities

Sensors feed data to predictive analytic solutions, allowing operating teams to intervene and take corrective action with:

Proactive notification
Alerts operating staff at the first sign of an event, so action can be taken quickly

Performance analysis
Enhances sub-system understanding of event risks during engine operation, enabling proactive maintenance scheduling

Root cause identification
Eliminates uncertainty and facilitates faster correction by using engineering expertise to discover the root cause behind the issue

17.7 Field Service

Professional expertise, immediate availability - More than 460 dedicated service technicians are standing by to assist you, all trained on Distributed Power solutions and backed by local support in more than 170 countries. Together, they use the highest-quality parts, tools and technical support to reduce downtime and operating costs while improving plant safety and efficiency.

17.8 Material

Enhanced performance, reliability and durability - GE/NPAOy uses advanced engineering techniques and high-quality materials to manufacture spare parts that get more out of your assets. Every part is thoroughly tested, and backed by our OEM warranty.
We also offer reUp™, a remanufactured parts program for reciprocating engines that returns previously used parts to their original factory specifications. Remanufactured GE parts are guaranteed to work seamlessly with new engine parts, and are backed by the same robust warranty. Our original spare parts ensure maximum service life and reliability for your equipment.

We also offer asset management, including full engine and modular exchanges, and lease offerings.

17.9 Overhaul and Repair Services

Innovative repair, overhaul and upgrade solutions - As the original manufacturer, no one knows your engine throughout its life cycle better than GE/NPAOy. Our Distributed Power business' 12 service centers provide expert solutions to help you maintain and enhance the performance of your reciprocating engines and aeroderivative equipment.

At our centers, you benefit from ongoing innovative repair, overhaul, and upgrade solutions throughout the life cycle of your products. Furthermore, as an OEM, we offer the latest technologies in accordance to standards, hardware and controls upgrades and emissions upgrades.

17.10 Configuration, Modifications and Upgrades

Complete solutions for all-around asset enhancement - Upgrade offerings leverage the latest technology and engineering expertise, allowing you to keep pace with changing market conditions and new industry needs and challenges. By providing added flexibility and capability to your equipment, GE/NPAOy's Conversions, Modifications & Upgrades (CM&Us) will allow you to keep increasing the value of your equipment through its operating life.

GE/NPAOy's engineering skills and expertise is used to develop solutions that:

- Increase output
- Improve efficiency
- Increase availability
- Enhance operational flexibility
- Extend asset life
- Reduce emissions
- Lower operating costs

CM&U solutions are available for turbines, engines, their associated packages and/or balance-of-plant equipment. These customized solutions can help you respond to nearly any changing market condition or operating requirement. From improved performance to changing emissions requirement, GE/NPAOy has the right solution to meet your unique needs.

17.11 Extensive and Experienced Service Network

We have a global presence, with the resources, personnel and materials to solve problems anywhere, in the most efficient way possible. Each of our solutions are backed by research and experience on a level that only GE/NPAOy can offer.

Quick Response Center

The highly skilled technical representatives in our Quick Response Centers (QRC) provide support and can remotely tune your engine to improve emissions and performance levels.

The Quick Response Center offers:

- A Level 1 response team of OEM expert technicians who apply years of expertise to every case
- Over 13 languages for a local presence
- The ability to represent the customer and escalate cases within GE/NPAOy to facilitate a fast return to service
- Event diagnostics
- Remote monitoring tools to enable fast issue resolution

Global Services Distribution Centers

Our global services parts distribution centers act as centralized warehouses, offering local and regional coverage. This means greater parts availability, on-time delivery and faster order fulfillment.

Service Centers

With 12 service centers worldwide, we can provide faster turnaround and exceptional asset support. We offer the only LM service centers globally certified to Aerospace AS9100 quality standard, with services that include:

- Individual component repair
- Complete major assembly overhaul
- Comprehensive testing

Field Services

By anticipating service needs throughout the asset life cycle, G/NPAOyE's global field services network reduces downtime and operating costs.

Offerings include:

- Periodic routine inspections of engine and package related to maintenance schedule
- Field service support, when an unplanned event occurs
- Check and inspect of all rotating components
- Performance testing
- Extensive maintenance support during comprehensive service events