

DOCUMENTO:

**GAS TURBINE GENERATOR AND ACCESSORIES SPECIFICATION
FOR CONVERSION TO DUAL FUEL SYSTEM OF GE 7EA UNITS**

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1. COMBUSTION TURBINE GENERATOR

1.1. GENERAL

The equipment, materials, and services covered by these specifications will be incorporated at Planta La Raisa, Valles del Tuy, Miranda State, in Venezuela and at Planta Juan Bautista Arismendi, Isla de Margarita, Nueva Esparta State in Venezuela, simple cycle electric power generation plants consists of 2 x 71EA class units for each project and all associated balance-of-plant equipment need for conversion of these units to dual fuel system and including the addition of water injection system for NOx control when operating on liquid fuel.

A liquid fuel forwarding system, which will be required to provide pressurized liquid fuel to the on-base system, it has to include the replacement of the stage 17 compressor blades, and technical services for the installation and commissioning.

Supplier shall provide design loads and interface dimensions for design of foundations, wiring/cabling/conduit, and interconnecting piping by others.

The unit's serial numbers 298034 and 298035 will be located at Planta Juan Bautista Arismendi, Isla de Margarita, and the primary fuel will be No. 2 fuel oil, but at this time in Isla de Margarita there in not natural gas fuel sources. Unit's serial numbers 298036 and 298037 will be located at Planta La Raisa, Valles del Tuy, and the primary fuel will be natural gas and No. 2 fuel oil will be the backup fuel.

1.2. GAS TURBINE SYSTEMS

The MS7001 (EA) gas turbine has a single shaft, bolted rotor with the generator connected to the gas turbine at the turbine or "hot" end. Major components of the MS7001 (EA) for dual conversion are described below.

1.3. FUEL SYSTEM

The purpose of this conversion is to deliver No. 2 fuel oil from the fuel forwarding system to the combustion nozzles. The system is mounted on or off the accessory base. The system will filter the fuel and will control the fuel flow to each of the nozzles in the combustion turbine combustion chambers.

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Complete dual natural gas and No. 2 fuel oil systems for the units requiring single connections for each fuel at the turbines shall be furnished. The fuel systems shall be capable of operating the gas turbine generators throughout their entire load range for the full range of ambient conditions on both natural gas and No. 2 fuel oil. The fuel systems shall be capable of automatic, on-line changeover from gaseous to liquid fuel or vice versa, at any load level, without causing a disruption of service of any kind.

The adding dual fuel is to increase the flexibility of a combustion turbine so it can operate in periods when one particular fuel is more available or to continue to operate during a fuel upset, changing over to the alternate fuel automatically.

All electrical equipment associated with the fuel system shall meet the requirements for hazardous areas, NFPA-70 Article 501. All mechanical equipment and valves associated with the fuel system shall be Factory Mutual (FM) certified or approved.

1.3.1. Liquid Fuel System

No. 2 fuel oil to be in accordance with General Electric (GE) fuel specifications GEI-41047 and GE has to take into account the liquid fuel specification available in Venezuela. Typical properties of this fuel will be specified on Section 7 below.

The fuel oil system consists of storage and delivery equipment to forward distillate fuel oil to the gas turbines. As a backup fuel, equipment sizing is based on providing fuel oil to operate two (2) gas turbines at full load for a 72-hour period.

For plants with dual fuel capability the oil system should be activated on a regular basis to ensure it will function properly when needed. It is recommended that a transfer from gas to oil be done once a week and this applied in a site where the natural gas is the primary fuel.

A fuel oil forwarding skid is supplied with spare capacity. Oil is pumped from the oil tank into a common header. Feed lines from the header to each gas turbine include a strainer, pressure control station and fuel flow meter. The liquid fuel equipment located on the liquid fuel/atomizing air module consists of:

No. 2 fuel oil strainers and filters.

Fuel pressure and flow regulating valves.

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Fuel oil flow meter of the turbine meter type or Coriolis type to measure the No. 2 oil flow rate and oil consumed shall be provided for the gas turbines with local display of flow rate and totalized flow. Flow rate and totalized flow shall be displayed and recorded in the GT control system. Flow measurement shall be temperature corrected. Temperature shall be displayed in the control system. Flow metering accuracy shall be at least 0.5 percent or better. Flow straighteners shall be provided if necessary. Redundant transmitters shall be considered if the flow measurement is used for turbine controls.

Pressure gauges on the downstream side of fuel strainer, at No. 2 fuel oil pump suction and discharge, and at other critical points.

Thermometers to indicate temperature of No. 2 fuel oil supply.

Fuel gas pressure gauges and thermometers before and after regulating stations

Electric oil heaters for No. 2 fuel oil (if required).

Overspeed and emergency fuel trip stop valves.

Fuel control valves sized for startup and normal operation shall be included.

Fuel control valves for starting and operating.

Necessary isolation valves and fast acting trip (fire shut-off).

Automatic control system.

Fuel forwarding pumps for No. 2 fuel oil.

Vanadium inhibitor injection equipment for No. 2 fuel oil, if required.

The main fuel oil (pressurizing) pumps for the units shall be full-capacity, driven by separate electric motors.

In addition to a fuel governor valve for each fuel system, the fuel control system shall include a separate fast acting fire safe shutoff valve or "stop valve" for the No. 2 fuel oil which stops all fuel flow to the turbine on any shutdown condition, and which will not open until all permissive firing conditions are satisfied.

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The risk from fuel leakage into the combustion turbine during operation and after shutdown shall be minimized by means such as use redundant positive shutoff valves (double block and bleed arrangement) or by use of single housing valves specially designed to provide a similar "double block and bleed" function.

Fuel filters shall be easily accessible and replaceable during turbine operation.

The fuel oil pumps shall be automatically turned off when a fire is detected.

All fuel oil pumps shall have mechanical seals.

1.3.2. Regulation of Fuel Supply

Regulation of the fuel supply to the burners shall be provided to perform the following:

Maintain the turbine at uniform speed free of hunting or surging at all loads.

Automatically shut off fuel supply on flame failure or failure to ignite on startup or on actuation of fire detection equipment.

Allow automatic, on-line changeover from gaseous to liquid fuel or vice versa from any load level without a change in power output or disruption of service of any kind.

1.4. DESIGN CONDITIONS.

The gas turbines shall be fully suitable for the conditions specified.

1.4.1. Planta Juan Bautista Arismendi, Isla de Margarita

The new site where the units will be located is possible a marine environment and unless specified otherwise, equipment and material furnished under these specifications shall be suitable for service at the following site conditions:

Atmospheric Conditions: These values were tacking from the meteorological station located at Porlamar's airport :

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	Annual Average
Site ambient design dry bulb temperatures, °C (° F)	27.8 (82.04)
Dry bulb maximum temperature, °C (° F)	32.7 (90.8)
Dry bulb minimum temperature, °C (° F)	25.0 (77.0)
Annual Average Relative Humidity, %	84.9
Maximum Relative Humidity, %	93.0
Design wind speeds, km/h (mph)	24,8 (15.41)
Prevailing wind direction	East
Average annual rainfall, mm (in.)	284 (11.14)
Barometric Pressure, psia (in. Hg.)	14.7 (29.92)
Site elevation, meters (ft) above mean seal level, approximate	24 (78.74)

1.4.1.1. Wind Design.

All structures and elements, or components of structures, shall be designed to withstand the external and internal wind pressure effects specified in the COVENIN MINDUR 2003, Building Wind Effects (Acciones del Viento Sobre las Construcciones). The analysis shall consider wind effects resulting from the pressure caused by a basic wind speed acting in any direction.

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1.4.1.2. Seismic Design

Seismic design shall be in accordance with COVENIN 1756-1:2001 (Edificaciones Sismorresistentes). This site is located in Zone 5, which it is considered as a zone of high seismic risk with a horizontal acceleration (A_0) of 0.30

1.4.2. Planta La Raisa, Valles del Tuy

Unless specified otherwise, equipment and material furnished under these specifications shall be suitable for service at the following site conditions:

1.4.2.1. Atmospheric Conditions:

	Annual Average
Site ambient design dry bulb temperatures, °C (°F)	24 (75.2)
Dry bulb maximum temperature, °C (°F)	33 (91.4)
Wet bulb maximum temperature, °C (°F)	28.3 (82.94)
Coincident Relative Humidity, %	69
Design wind speeds, km/h (mph)	78 (48.46)
Prevailing wind direction	
1st annual semester	NE
2nd annual semester	SE
Average annual rainfall, mm (in.) from August to October	1200 - 1400 (42.25 - 55.1)
Barometric Pressure, psia (in. Hg.)	14.21 (28.93)
Site elevation, meters (ft) above mean seal level, approximate	283.6 (930.44)

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1.4.2.2. Wind Design.

All structures and elements, or components of structures, shall be designed to withstand the external and internal wind pressure effects specified in the COVENIN MINDUR 2003, Building Wind Effects ("Acciones del Viento Sobre las Construcciones"). The analysis shall consider wind effects resulting from the pressure caused by a basic wind speed acting in any direction.

1.4.2.3. Seismic Design

Seismic design shall be in accordance with COVENIN 1756-1:2001 (Edificaciones Sismorresistentes). This site is located in Zone 4, which it is considered as a zone of medium seismic risk with a horizontal acceleration (A_o) of 0.25.

1.5. FUELS AND AUXILIARIES

No. 2 fuel oil will be the main fuel during at least the first 4 years of operation, after that the primary fuel for the combustion turbine will be natural gas. The combustion turbine generators shall be designed to operate satisfactorily when firing either of the fuels specified. For dual fuel option, the turbines shall be capable of transferring, on-line, over the entire load range, from one fuel to the other with no change in electrical output.

The addition of liquid fuel requires more heat rejection due to the atomizing air system, meaning to increase the units cooling capacity and the Contractor has to analyze the existing cooling water in order to determine the new equipment that might be required.

Any special requirements that the fuels must meet to ensure satisfactory operation of the combustion turbine shall be stated in the proposal.

1.5.1. NO_x Control Injection Water

The water required for No. 2 fuel oil operation NO_x control will be provided by the Contractor. Water quantities, quality, and conditions shall be detailed by the Contractor in the proposal.

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1.6. CODE REQUIREMENTS

The equipment shall be designed and constructed at a minimum in accordance with the latest Venezuelan applicable requirements of the codes and standards listed below:

Covenin 2003 Building Wind Effects (Acciones del Viento Sobre Edificaciones). Venezuelan Commission for Industrial Standards.

Covenin 1756-1:2001 Seismic Requirements for Buildings (Edificaciones, Antisísmicas). Venezuelan Commission for Industrial Standards.

Gaceta Oficial No 4.899 Decreto No 638 Normas sobre Calidad del Aire y Control de Extraordinario la Contaminación Atmosférica.

Other Codes and Standards of Practice are the 19128 April 1999, Pollution Prevention and Abatement Handbook 1998. Toward cleaner production by The World Bank Group.

Conflicts between the above requirements and the contract documents shall be referred to the Owner for resolution.

Use of alternate codes and standards that deviate from those listed above will not be allowed unless such code and standard deviations are identified in the proposal and accepted by the Owner at the time of contract award.

The proper stamps shall be affixed to denote conformance to the appropriate codes. The date for establishing code requirements such as year of issue and addenda shall be the contract date.

All data reports and inspection certificates required by the codes shall be submitted in accordance with this document.

1.7. FUEL SPECIFICATIONS

Typical properties of the No. 2 fuel oil are specified herein.

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Item	Fuel Oil No. 2		Test Method
	Min.	Max.	
Water and sediment % (V/V)	--	0.10	COVENIN 422
Sulfur Content, % (p/p)	--	1.0	COVENIN 1133
Ash Content, % (p/p)	--	0.01	COVENIN 880
Copper Plate Corrosion (3h at 50 °C)	--	2	COVENIN 872
Distillation, 90% recovered volume , °C	--	370	COVENIN 850
Flash Point, °C	60.00	--	COVENIN 425
Conradson residual carbon % (p/p)	--	0.15	COVENIN 879
Sodium + Potassium	--	1	
Vanadium	--	0.5	COVENIN 2044
Calcium	--	2	
Lead	--	1	COVENIN 2296
Kinematic viscosity 740 °C, cSt	--	6.7	COVENIN 424
Color	--	3.0	COVENIN 890
Fluidity point, °C	--	6	COVENIN 877
Gravity, ° API	32.4		COVENIN 1143
Cetane number	--	--	COVENIN 1134
Gross heat value, Btu/lb	19,100		COVENIN 3093

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1.8. SPARE PARTS

Provided two (2) sets of filters for fuel oil filter units.

1.9. AIR INLET SYSTEM.

For the units to be installed in Isla de Margarita and if the site selected is in front of the coastal of the Caribbean Sea, the selection and design of the air inlet system to the compressors shall take into account the marine environmental for the problems of inlet air contaminations, as salt from seawater, and this can give rise of corrosion.

1.10. CONTROL SYSTEM FUNCTIONS

The control system shall be designed for firing natural gas or No. 2 fuel oil with water injection for NOx control on liquid fuel, and gas protection system. The firing mode shall normally be single fuel firing with provisions for mixed fuel firing. Provisions shall be made for automatic switching between primary fuel and backup fuel on loss of primary fuel when the turbine is on line. GE will include any upgrade needed of the Mark V existing in these gas turbines.