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## TECHNICAL SPECIFICATION

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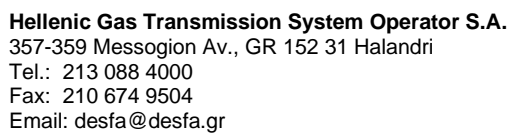
### HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

## EMERGENCY DIESEL GENERATORS

JUNE 2021

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## 1. INTRODUCTION

## 2. SCOPE AND OBJECTIVES

This Specification covers the minimum requirements for the design, supply and installation for the emergency diesel generators for the stations and pipelines of the natural gas transmission system.

## 3. REFERENCES

### 3.1 Reference Documents

### 3.2 Reference Codes and Standards

2006/42/EEC	Machinery
2014/34/EU	Equipment Explosive Atmospheres Directive
2014/35/EU	Low Voltage Directive
2014/30/EU	Electromagnetic Compatibility Directive
ELOT EN 1594 E3	Gas Supply Systems. Pipelines for Maximum Operating Pressure over 16 bar. Functional Requirements
ELOT EN 14161+A1	Petroleum and Natural Gas Industries. Pipeline Transportation Systems
ELOT EN 60529	Degrees of Protection provided by Enclosures (IP Code)
ELOT EN 60617	Graphical Symbols for Diagrams
ELOT EN ISO 9001 E4	Quality Management Systems
ELOT EN ISO 14001	Environmental Management Systems - Requirements with Guidance for Use
ELOT HD 384	Requirements for Electrical Installations
ELOT HD 60364	Electrical Installations of Buildings
EN 60034	Rotating Electrical Machines
EN 60072	Dimensions and Output Series for Rotating Electrical Machines
EN 60085	Electrical Insulation - Thermal Evaluation and Designation



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EN 60445	Basic and Safety Principles for Man-machine Interface, Marking and Identification. Identification of Equipment Terminals and of Terminations of Certain Designated Conductors, Including General Rules for an Alphanumeric System
IEC 60034-11-2	Rotating Electrical Machines - Part 11: Built-in Thermal Protection - Chapter 2: Thermal Detectors and Control Units Used in Thermal Protection Systems
IEC 60034-14	Rotating Electrical Machines - Part 14: Mechanical Vibration of Certain Machines with Shaft Heights 56 mm and Higher - Measurement, Evaluation and Limits of Vibration Severity
IEC 60279	Measurement of the Winding Resistance of an A.C. Machine During Operation at Alternating Voltage

## 4. ACRONYMS

AC	Alternating Current
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ATEX	ATmosphères EXplosibles (Explosive Atmospheres)
ATS	Automatic Transfer System
BMS	Building Management System
BVS	Block Valve Station
BCC	Back-up Control Centre at Nea Messimvria
CCTV	Closed Circuit Television System
CPR	Construction Products Regulation
CP	Cathodic Protection
CPU	Central Processor Unit
CS	Compressor Station
DB	Distribution Board
DC	Direct current
DCS	Distributed Control System
DEG	Detailed Engineering



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DIN	Deutsches Institut für Normung (German Institute of Standardization)
DVA	Digital Voice Announcer
DVD	Digital Video Disc
EDG	Emergency Diesel Generator
ELOT	Hellenic Organization for Standardization
ELV	Extra Low Voltage (nominal voltage not exceeding 50 V AC or 120 V DC (ripple-free) between conductors or to earth, as defined by the Standard EN 61558)
EN	European Norms
EPC	Engineering, Procurement and Construction
EU	European Union
ESD	Emergency Shut Down
F&G	Fire and Gas
FACP	Fire Alarm Central Control Panel
FARP	Fire Alarm Repeater Control Panel
FAT	Factory Acceptance Test
FEG	Field Engineering
FC	Floer Computer
FOC	Fibre Optic Cable
GCC	Gas Control Centre at Patima
HEDNO	Hellenic Electricity Distribution Network Operator
HDPE	High Density Polyethylene
HMI	Human Machine Interface
HVAC	Heating Ventilation Air Conditioning
I/O	Input / Output
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU	International Telecommunication Union
LAN	Local Area Network
LCS	Local Control System



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LED	Light Emitting Diode
LFEP	Local Fire Detection & Fire Extinguishing Panel
LV	Low Voltage
LSP	Load Share Panel
MSC/MCS/SMC	Main Station Controller
MV	Medium Voltage
MPS	Master Project Schedule
MPR	Monthly Progress Report
NFPA	National Fire Protection Association
NNGTS	National Natural Gas Transmission System
NTSC	National Television System Committee
O&M	Operation and Maintenance
PID	Piping and Instrumentation Diagram
PA/GA	Public Address / General Alarm
PCS	Process Control System
PED	Pressure Equipment Directive
PEP	Project Execution Plan
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
PMS	Power Management System
POC	Project Organization Chart
PAL	Phase Alternate Line
PPC	Public Power Corporation
PTZ	Pan, Tilt, Zoom
PVC	Poly Vinyl Chloride
QA	Quality Assurance
RCC	Remote Communications and Controls
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detectors
RTU	Remote terminal Unit
S/S	Scraper Station



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SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition (including Telemetry)
SCS	Station Control System
SFP	Small Form-factor Pluggable
SPD	Surge Protection Device
SPL	Sound Pressure Level
UDP	User Datagram Protocol
UPS	Uninterruptible Power Supply
UV	Ultraviolet
VGA	Video Graphics Array
VMS	Video Management Software

## **5. EMERGENCY DIESEL GENERATORS DESIGN**

### **5.1 Emergency Diesel Generators Selection and Sizing**

Emergency diesel generators shall be installed in M/R and Compressor stations and designed to maintain 110% of the connected (essential) loads at maximum ambient temperature, in case of fault of mains power supply from PPC via an automatic transfer system.

Essential loads for M/R and Compressor stations are shown in respective Technical Reports for Power Supply requirements and One Line Diagrams.

In Compressor stations emergency diesel generators rating shall also be sufficient for starting them.

Estimations for M/R and Compressor stations Emergency diesel generators capacity sizes are shown in respective Technical Reports for Power Supply requirements. However, Emergency diesel generators ratings for M/R and Compressor stations shall be calculated and confirmed during detail engineering design.

The design and construction of the diesel generating sets and relevant equipment shall ensure safety to personnel under all operating and expected conditions, suitability to stations conditions and applications, as well as ease of erection, operation and maintenance.





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The minimum required cross sectional areas for neutral grounding conductors should be determined according to specification for Earthing and Lightning Protection System.

## **5.2 Documentation**

During detail design, the following drawings and documents shall be developed and submitted to the Client for review, but not limited to:

- Calculations for Emergency Diesel Generators
- One Line diagrams for Emergency Diesel Generators
- Emergency Diesel Generators Layout drawings
- Material Requisitions for Emergency Diesel Generators

### **5.2.1 Calculations for Emergency Diesel Generators**

- Calculations for each Emergency Diesel Generator and its Fuel Tank sizing shall be provided, so as that Emergency Diesel Generator should have the capacity to supply all essential loads that have been mentioned in this specification.

### **5.2.2 One Line Diagrams for Emergency Diesel Generators**


The One Line Diagrams for Emergency Diesel Generators shall include, as a minimum, information about:

- Protection and control devices ratings and settings
- Types and cross-sections of Emergency Diesel Generators and Main Low Voltage Switchboards interconnecting cables

### **5.2.3 Emergency Diesel Generators Layout Drawings**

Regarding Emergency Diesel Generators layout drawings, the following information shall be provided, at least:

- Location of Emergency Diesel Generators and Fuel Tanks
- Information about types and cross-sections of Emergency Diesel Generators and Main Low Voltage Switchboards interconnecting cables and their routing
- Earthing of Emergency Diesel Generators and Fuel Tanks

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#### **5.2.4 Material Requisitions for Emergency Diesel Generators**

Material Requisitions for Emergency Diesel Generators shall provide the whole information about technical characteristics, special requirements, quantity of Emergency Diesel Generators etc, is needed for the supply of Emergency Diesel Generators.

## **6. SUPPLY OF EMERGENCY DIESEL GENERATORS**

### **6.1 General**

Supply of emergency diesel generators shall include, but not limited to, procurement planning, purchasing, expediting, inspection and testing, spare parts procurement, packaging, shipment, transportation and delivery at site.

Emergency diesel generators shall be selected to comply with the latest editions of relevant EU Directives, Greek Legislation, European Standards and International Codes or Standards, as well as relevant project job specifications or requirements specified in other project documents or drawings.

Therefore, all latest approval revisions of relevant project documents and drawings shall be forwarded to Supplier(s).


Apart from emergency diesel generators, Supplier(s) shall submit to the Client their documentation package consisting of necessary drawings and data to cover project requirements.

Procurement of emergency diesel generators shall be performed in accordance with job specification for Supply of Electrical Equipment and Materials.

### **6.2 Shop Inspection and Testing**

Electrical Examination and/or testing shall be as per applicable Codes and Specifications, including EN 60034 and IEC 60279.

Emergency diesel generators must have a CE conformity mark, according to all applicable EU Directives.

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The manufacturer(s) of emergency diesel generators should have a Quality Assurance System ELOT EN ISO 9001 and ELOT EN ISO 14001 for the emergency diesel generators construction and assembly.

During fabrication and testing, Manufacturer's Quality Department must perform all the required inspection activities.

After final inspection at Manufacturer's Workshops, the Manufacturer shall release copies of test certificates as imposed by the applicable codes or specifications to the Client and/or the Contractor.

Factory tests shall include routing tests and type tests.

## 7. EMERGENCY DIESEL GENERATORS CONSTRUCTION, INSTALLATION AND CONNECTIONS

### 7.1 Responsibility

Contractor shall provide labor, supervision, appropriate tools, equipment, consumables, services and all materials and accessories necessary for emergency diesel generators installation and connections. It is Contractor's responsibility to execute emergency diesel generators installation and connections according to approved detail design drawings and documents, as have been described in paragraph 5.2 of this specification, as well as all relevant specifications and applicable codes and standards.

Contractor's engineers are responsible for:

- receipt and visual check for damages or omissions of emergency diesel generators.
- visual inspection of the execution of emergency diesel generators installation and connections with reference to the applicable Project's Specifications.
- performing all works according to the safety requirements set by the Supplier and the Local Authorities.
- keeping the corresponding quality records for erection works and examination procedures.
- ensuring the quality of any remedial works that are essential to take place.



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### **7.2 General Notes for Emergency Diesel Generators Installation and Connections**

Cables and cable routing material installation, as well as cable installation accessories and connections related to emergency diesel generators shall be in accordance with job specification for Cables and Cable Routing (Document Number 495-000-SP-ELE-05) and applicable codes and standards.

Earthing and lightning protection of each emergency diesel generator shall be in accordance with specification for Earthing and Lightning Protection System and applicable codes and standards.

Manufacturer's recommendation and applicable codes and standards for emergency diesel generators installation and connections shall be taken into consideration.

### **7.3 EDG Set Location**

Each EDG set location shall ensure the adequate ventilation for combustion and cooling air.

Any heat emitted by radiation from the alternator, engine and lube oil system and any emissions from the exhaust system shall be extracted by the engine ventilation system directly to the atmosphere to ensure that the temperature is maintained at a safe level for the generator equipment operating at full load.

In case that an EDG set is located outdoors, this shall be installed in a closed soundproof canopy (appropriate for outdoor installation), which shall ensure anti-corrosive protection. The noise level of the set shall be limited within the values of the human physiological and psychological withstand capability within a closed room, where personnel is present without individual ear protection. The noise level shall not exceed 85 dBA at a distance of 1 m from any point of the canopy. The canopy shall have intake air and discharge air grille (for protection against rain) openings. It shall also have doors for inspection and maintenance, as well as properly protected prefabricated openings for cables and pipes connections, silencing systems connections etc.



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### **7.4 Characteristics**

Each Emergency Diesel Generator set (EDG) shall be able to operate continuously at its rated power with a load power factor equal to 0.8 and shall also be able to operate at 110% of its rated power, during 1 hour, at a continuous operation of 12 hours. Each Emergency Diesel Generator set (EDG) shall be 3 phase (400 Volt) at 50 Hz to provide electric power at 400/230 Volts in the event of failure of the main supply.

Each set shall be arranged to start automatically by signal from the Automatic Transfer System (ATS). The ATS shall be installed inside the Main Low Voltage Switchboard (MLVS) and shall be included in the MLVS Supplier's scope of supply.

Each set shall be able to start and accept full rated load within 20 seconds of initiating the start signal.

Each Emergency Diesel Generator set shall include the following:

- Diesel Engine and three phase generator coupled with a flexible coupling and fully assembled on a common baseplate, with vibration isolators
- Engine mounted gauge board with instruments
- Local control panel with all accessories required for the operation of the set

Each EDG shall be capable of carrying continuously any load between no load and full load. It shall be supplied complete with its radiator cooling system, lube oil system, instrument gauge panel, alternator, generator control panel, batteries, battery charger etc. Soundproof cover shall also be supplied, in case that EDG is installed outdoors.

### **7.5 Diesel Engine**

The Diesel Engine of each Emergency Diesel Generator set shall be fitted with the following accessories completely assembled, piped and wired:

- Air intake system with dry type air filter
- Lubrication system with main oil pump, oil filter, oil cooler and auxiliary oil pump with timer and starting equipment for pre-lubrication of the diesel engine when it is in stand-by service, in order to assure initial lubrication during quick starting



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- Engine fuel system with fuel pump, double fuel filter, injection system and solenoid valve
- Closed cooling system with water pump, radiator, temperature control valve and thermostatically controlled pre-heating system suitable to permit fast starting and loading of the engine with the coldest ambient temperature
- Heavy duty industrial flywheel
- Electronic speed governor
- 24 V electric motor starter
- Exhaust gas system with flexible pipe and industrial silencer
- Gauge board including:
  - Oil pressure indicator
  - Water temperature indicator
  - Revs counter
  - Hour -meter
- Lead acid battery, 24V, adequate for at least ten (10) consecutive starts
- Generator for charging the battery while the engine is running

### 7.6 Generator

The generator of each Emergency Diesel Generator set shall be three phase, synchronous, brushless, self-excited and self-adjusted.

It shall have the following characteristics:

- Voltage : 400V
- Frequency : 50 Hz
- Power factor : 0.8 lagging
- Speed : 1500 rpm
- Insulation class : H
- Interference protection : class N



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Generator output voltage shall be controlled by an automatic voltage regulator of the solid state type capable of maintaining the voltage regulation from no load to full load at any power factor between unity and 0.8 lagging to within  $\pm 1\%$ .

Total Harmonic Distortion shall be lower than 2%, without load.

An anti-condensation heater for 230 Volt single phase 50 Hz shall be provided in the generator, if necessary to meet cold start requirements.

### **7.7 Base Frame**

The requested/specified arrangement is for the engine and generator to be accurately aligned, coupled and mounted on a robust fabricated steel base frame, and this base frame then supported via anti-vibration mountings by a robust and rigid under-base or bed frame fabricated from heavy gauge steel sections complete with lifting lugs and with provision for fastening down to a reasonably flat reinforced concrete surface without special preparation.

### **7.8 Instrumentation, Switchgear and Control**


Complete and proper instrumentation, switchgear and control equipment, including that for alarm and protection, shall be provided for the safe and reliable operation of each generating set and its auxiliaries.

This equipment shall include all that is necessary to start the set automatically on mains failure. Manual start shall also be provided.

All alarm and status signals shall be annunciated.

Supplier shall detail the instrumentation and control for the particular generating set offered, but the following indicates general minimum requirements for the set.

#### **7.8.1 Engine Mounted**

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The following shall be supplied, as a minimum, within a panel, resiliently mounted, in a convenient position on each generator set base frame:

- Start and stop pushbuttons controlled by key switch to allow starting of the engine in the event of a control panel failure
- Engine speed tachometer with integral hours run indicator
- Water temperature gauge
- Lube oil pressure gauge
- Manual engine speed control

#### **7.8.2 Control Panel Mounted**

The following facilities shall be provided, as a minimum, by equipment mounted in a free-standing generator control panel and switchgear of each generator set:

- Mains sensing by relays monitoring voltages between phases and phase to neutral
- Signal to the Automatic Transfer System for automatic closing of the incoming Circuit Breaker from EDG to Main Low Voltage Switchboard, if all necessary conditions are satisfied
- Controls to permit at least six attempts to start before lockout in automatic mode on mains failure
- Circuit breaker and protection devices to provide complete protection for the generator
- 4-pole power contactors
- Voltage and frequency supervising relays
- Protection devices to provide complete protection for the engine
- Engine "Low Oil Pressure" and "High Water Temperature" shut down relays
- Alarm contacts for fail to start and engine trip
- Alarm annunciation indicating lamps powered from the set battery and remaining illuminated until manually reset, for each of:
  - Fail to start





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- Electrical Trip
- Low oil pressure
- High water temperature
- OFF, HAND, AUTO, TEST, selector switch lockable in any position and with TEST simulating mains failure, and HAND allowing operation by engine start and stop push buttons
- Circuit breaker in the switchgear
- Emergency stop push button
- Voltmeter and voltmeter selector switch
- Ammeter and ammeter selector switch
- Current transformer and voltage transformer, if required for the above-mentioned instruments
- Frequency meter
- Automatic battery charging system
- Battery charging ammeter
- Indicating lamps, powered by mains supply, for:
  - Mains on (green)
  - Generator on (red)
  - Battery charger on (green)
  - Heaters (anti-condensation in generator and control panel and block, if necessary to meet cold start requirements) (green)

### 7.8.3 Control Panel

Control panel shall be of the free standing, metal clad, type with sheet steel enclosure to IP 42 (minimum) and bottom cable entry, incorporating instruments, indicating lights and controls on a lockable hinged door and housing all necessary circuit elements, switches, relays, terminals, wiring, glands, fuses etc.



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### **7.9 Fuel Tanks**

Each emergency diesel generator fuel tank together with all interconnecting pipework and valves shall be provided to an inlet connection.

The fuel tanks shall be equipped with level gauge, sludge cock, hand access holes and covers, level switches and transducers for signal to dial type fuel gauges on control panels, vent, drain, overflow pipes and interconnecting pipework to engine and return.

### **7.10 Nameplate**

Each emergency diesel generator shall have a nameplate. The nameplate shall be made of stainless steel and shall include the following information, but not limited to:


- Name of manufacturer
- Serial number
- Type of machine
- Insulation class
- Ingress protection
- Emergency diesel generator weight
- Nominal speed
- Nominal power
- Rated current
- Rated frequency
- Power factor

In a separate plate, mounted as to be easily read during operation, lubricating instructions shall be included.

### **7.11 Inspection and Testing**

Field and testing of emergency diesel generators shall be carried out by properly qualified and experienced personnel with calibrated test equipment provided by the Contractor.

Field inspection and testing shall also be witnessed by Client Representative.

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Inspection and testing shall be according to project documentation or / and applicable codes and standards. Minimum test requirements are described below.

Check and confirmation of all nameplate information of the emergency diesel generators for compliance with the manufacturer's recommendation and this document shall be provided.

Insulation resistance tests shall also be provided.

Vibration and noise shall be checked.

Starting, full load and sudden uploading tests shall be provided.

Protection devices ratings and settings shall be checked.

Functional tests (auxiliary circuits' tests, power electronics supply tests, Automatic Voltage Regulator tests etc) shall be provided.

A complete record of all tests that shall be carried out and their results shall be retained.

## 7.12 As-Built Documentation

At the completion of the works, a copy of all related project drawings, where all modifications and variations marked in red, shall be provided to Client Representative and as-built drawings shall be issued.