



INDEPENDENT POWER TRANSMISSION OPERATOR S.A.
NTPD/ SPECIFICATIONS & EQUIPMENT SECTOR S/S – EHV S/S

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TECHNICAL DESCRIPTION TD-42/4
BACKUP POWER GENERATION UNIT
88kW/110kVA or 35kW/44kVA, 230/400V, 50Hz

I. SCOPE

This Technical Description covers the required technical characteristics and tests for Backup Power Generation units.

II. KEY WORDS

Generation unit (GU), diesel engine - generation unit.

III. USE

The power generation unit shall be used to supply low voltage DC for S/S and EHV S/S, i.e. three-phase and single-phase switch and disconnector motors, battery chargers and emergency lighting, in emergency situations. The required nominal power shall be determined each time in the Tender.

IV. STANDARDS

The power generation unit shall follow the standards:

ISO 8528-1, -2, -3, -4, -5, -6, -10

IEC 60034-1, -22 and

CISPR 11 (EN 55011)

V. OPERATING CONDITIONS

Installation:	In a covered area, on a stable mount
Ambient temperature:	-10°C to 50°C.
Minimum starting temperature:	-10°C
Relative humidity:	10% to 85%.
Altitude:	≤ 1000 m above sea level

VI. GU CHARACTERISTICS

Power data, load time, running time, fuel and lubricant consumption, etc., are given in standard reference conditions, i.e.:

Ambient temperature:	25°C
Relative Humidity:	30%
Altitude:	sea surface (1 atm pressure)
Nominal backup power (ESP - emergency stand-by power):	88 kW or 35 kW
Nominal power factor:	0.80 (over-stimulation)
Nominal reserve power:	110 kVA or 44 kVA
Nominal operating speed:	1500 rpm
GU Performance Class:	G2
Speed droop:	$\leq 5\%$
Speed deviation at steady state:	$\leq 1, 5\%$
Slow down on take-off of the maximum load:	$\leq 15\%$
Lifting speed of the nominal load when discharging:	$\leq 12\%$
Speed reset time at picking up or dropping a load:	≤ 5 s
Constant voltage deviation:	$\leq 2, 5\%$
Voltage damping on take-off of the maximum load:	$\leq 20\%$
Voltage rise during discharge of the nominal load:	$\leq 25\%$
Time to restore voltage during picking up or dropping a load:	≤ 6 s
Auto-start time and takeover of a nominal load after a network voltage interruption:	≤ 60 s
Run time at nominal power (ESP) without fuel in the integrated tank:	≥ 8 h
Starting method:	via a 12 V battery
Battery type:	VRLA
Charging the battery:	via a generation unit and charger
Generator insulation:	class H
Nominal temperature rise generation unit windings:	class H
Maximum negative intensity sequence I2 allowed during operation:	$\geq 10\%$ of the nominal volume
Voltage asymmetry in vacuum mode:	$\leq 1\%$
Harmonic stress distortion in vacuum (THD):	≤ 5

VII. GENERAL DESCRIPTION

The Generation unit (GU) consists of:

1. The diesel engine and the generation unit which are coaxially connected with a flexible metal joint and form a single and balanced unit. The whole assembly is

mounted on a strong anti-vibration base on a steel frame. The fuel tank shall also be integrated on the frame.

2. The Control panel for starting and monitoring the GU function and
3. The Switch and Power panel.

The GU shall be suitable for emergency stand-by, without functioning in parallel to the grid or another GU. Its ESP (emergency stand-by power) refers to a 200-hour operation per year, in accordance with ISO 8528-1. The GU shall have an auto-switching system to start and power the load automatically in case of network voltage loss. Switching shall be performed with open transition, long break. It shall also be suitable for continuous operation but with a lower prime power (PRP-prime power), set by the manufacturer.

VIII. REQUIRED DIESEL ENGINE CHARACTERISTICS

The engine shall be four-stroke, water-cooled, diesel-fueled at 1500 rpm. It shall be turbocharged. Additionally needs to be suitable for frequent startups and also for startups after long cool down periods. It shall also include an adequate exhaust silencer for noise reduction.

Its speed setting shall follow performance class G2, with a maximum droop of 5%. The frequency setting range shall be at least + 2.5% -7.5%, at full load.

The specific consumption of fuel and lubricant should also be provided. The built-in tank capacity should be calculated to allow operation at nominal standby power for 8 hours.

IX. REQUIRED GENERATOR CHARACTERISTICS

The generation unit is three-phase, synchronous, brushless, with star-wound connection. The generation unit shell shall have an IP 23 degree of protection and the insulation of the windings shall be class H. The accepted level of generation unit winding temperature shall follow Class H for both BR (base continuous rating) and for PR (peak continuous rating, $\Delta\theta = 150K$, $\theta = 40^\circ C$) according to IEC 60034-22 and ISO 8528-3. The base continuous rating of the generation unit (BR) corresponds to the prime operating power of the GU (PRP), while the peak continuous rating of the generation unit (PR, operation 200 hours per year) corresponds to the nominal backup power of the GU (ESP).

The generation unit voltage is 230 V phase and 400 V polar, adjustable at least $\pm 5\%$. The frequency is 50 Hz. There shall be three phases and a neutral output, as the generation unit shall be able to handle also single-phase loads. The neutral shall be directly grounded. The voltage setting, as well as the transient behavior when picking up and dropping loads, shall follow the performance class G2.

The generation unit shall have been tested for radio interference according to Class A (or B), Group 1, according to CISPR 11 (EN 55011).

An automatic switch of a suitable nominal voltage to protect the generation unit from overload and short circuit shall be placed in a metal cabinet on the GU. It shall have a low-voltage overcurrent (short-circuit) element suitable for protection against short-circuit voltage of the generation unit.

X. DIESEL ENGINE START PROVISION

The engine shall start automatically when the automatic mode is selected from the panel. Startup assurance must be over 99%. To determine the startup assurance, 7 startups shall be taken as a basis. The panel automation shall include a provision for resumption of startup (3 startups).

The engine shall be equipped with a 12V DC electric starter, which shall ensure the required ignition speed and a startup time of 10 seconds.

The electric starter is powered by a 12V accumulator, the capacity of which is sufficient for seven (7) startups without intermediate charging.

This accumulator is charged by a suitable generation unit driven by the diesel engine, as well as by a charger permanently connected to the grid.

XI. CONTROL PANEL

The control panel shall be mounted on the GU. It shall be manufactured of steel sheet with a minimum thickness of 1.5 mm. The degree of protection shall be at least IP 40. The control circuits are powered by the same accumulator, which is also used to start the unit.

The panel shall carry the following instruments for monitoring the operation of the GU, which may be embedded in one or more digital devices:

- AC ammeter and selector switch of three (3) positions or three ammeters to measure the current passing through each phase.
- Two AC voltmeters of 0 - 500 V and selector switches of seven (7) positions for measurement of phase and polar voltage in the network and in the GU.
- One (1) voltmeter to measure the starter accumulator.
- A frequency meter 47-53 Hz with a selector switch of three (3) positions
Network - Off - GU.
- An engine cooling water thermometer.
- A lubricant oil pressure gauge.
- An engine operation meter (hours).
- An indicator light, signaling the risk of cooling water overheating.
- A network voltage availability indicator light.
- An indicator light for consumer power from the network
- An indicator light for voltage availability from the GU.
- A power supply from the GU indicator light.
- A starter accumulator charger failure indicator light.
- A low cooling water indicator light.
- A low fuel indicator light.
- A startup failure indicator light.
- A switch, STOP DANGER, to stop the engine in case of danger.
- The necessary switches or control buttons for the automatic or manual operation of the GU.

Remote signals through free-voltage contact shall be send in the following situations:

- Control in "Reserve" or in "Manual operation"
- GU in operation
- GU load

- Low fuel level
- General GU error, due to the following reasons:
 - Short circuit (overcurrent)
 - Overcharging
 - Off-bounds voltage
 - Frequency (engine speed) out of bounds
 - Low accumulator voltage
 - Charger error
 - Low cooling water level
 - Cooling water overheating
 - Low oil pressure
 - Failure to startup (after all attempts)

XII. POWER SWITCH PANEL

It shall be made of at least 1.5 mm-thick steel sheet. The degree of protection shall be at least IP 40. The switch panel may be integrated with the control panel. The switching system shall be type C, in compliance with IEC 8528-4. It shall bear two four-pole contactors K1 and K2, class AC-1, which shall have a mechanical and electrical interlock, to exclude simultaneous power supply of the panel from two electrical sources (grid and GU). Alternatively, four-pole electric load switches may be used.

XIII. DESCRIPTION OF AUTOMATION AND PROTECTION

In order to automate the GU operation, the following provisions shall apply:

- Grid voltage monitor, which shall monitor the voltage of 230V between each phase and neutral and shall be activated when the voltage is outside the range of 196 - 253V.
- GU frequency monitor that monitors the frequency or speed of the GU and is activated when the frequency is out of $50 \text{ Hz} \pm 5\%$ with a time delay of at least 10 sec.
- GU voltage monitor shall monitor the 230V voltage of the generation unit and shall be activated when the voltage is outside the range of 196 - 253V with a time delay of at least 10sec.
- Accumulator starter voltage monitor shall be activated when the voltage is below 10.5 V.
- An electronic GU controller that shall process the signals received from the grid voltage monitors, GU voltage and frequency, accumulator voltage, overload and short circuit of the generation unit, oil pressure and cooling water temperature
- The operation of the controller shall be selected using a three-position selector switch: Engine hold - Manual operation - Automatic operation.
- When the selector switch of the regulator is in the "engine hold" position, automatic and manual operation of the engine shall be prevented and all auxiliary functions shall be disabled.
- When the selector switch of the regulator is in the "manual mode" position, the engine shall start and stop manually. It shall also manually transfer loads from the grid to GU and vice versa.

- In case of power failure or unsuitability (outside the limits of 196 - 253V), the grid voltage monitor shall be activated and after a time delay of 0-30 seconds, the regulator shall start-up the engine. Voltage fluctuations during intervals of time less than specified should not affect the regulator.
- After engine start-up, the starter shall be turned off.
- Monitoring devices must be connected with a time delay to prevent operation of the oil pressure monitor, GU frequency monitor and GU voltage monitor.
- When the generation unit reaches the rated speed (1500) and the voltage is within the acceptable limits (196 - 253V), the loads shall be automatically switched from the grid to the GU and signal "GU in operation".
- The starter device must be designed for three (3) continuous start-ups within one minute. If the GU is not started after the third attempt, there shall be a visual warning.
- When the grid voltage returns to 196 - 253V and the grid monitor operates for an adjustable time (at least 30 seconds), the generation unit contactor should open and the grid contactor should close and at the same time signal "Grid in operation" shall appear.
- After the loads switching to the grid, the GU shall continue to operate for an adjustable period of time, without a load, to achieve smooth engine cooling.
- When any of the following faults occur during GU operation:
 - a. Oil pressure too low
 - b. Cooling water temperature too high
 - c. Frequency (engine speed) out of bounds
 - d. Generator voltage out of bounds
 - e. Generator overload
 - f. Short circuit.

there shall be an appropriate "hazard" signal and simultaneous activation of the automatic GU controller, which shall disconnect the loads from the GU and command a direct engine shut down.
- When there is a fault in the engine or generation unit or the grid monitor was operating but the startup was unsuccessful and the grid has returned, then the loads must be switched to the grid.
- When, in case the engine is running without loads, the grid is out of bounds and this lasts beyond the set time, the grid monitor must not give a startup command before shutting down the GU.
- When the accumulator voltage is below 10.5V, the accumulator voltage monitor shall signal "damage".
- The voltage drop during startup shall not activate the monitor.
- When the fuel level in the built-in tank is lowered during the operation of the GU, a filling pump shall be activated from an external tank and shall stop when the fuel level reaches the specified upper limit. The drop of the fuel level at the lower point shall be signaled as "danger". The filling pump is not included in the GU although the pump control and startup circuits are included.

XIV. TESTS

All series of test certificates for the parts of the generation unit shall be delivered from the respective manufacturing plants, i.e. the engine, generator, charger, voltage regulator, control device, etc. These should include test certificates for performance class G2.

Upon receipt of the GU, a full ISO 8528-6 test (ISO standard functional test) shall be performed. The test involves measuring the nominal values and verifying the performance class of the GU. The duration of GU performance at peak load during the test shall be 1 hour. The test also includes operational control of the switching system. A corresponding test certificate shall be provided by the GU manufacturer.

In addition, before and after the operating test as well as after the generation unit has cooled down, the insulation resistance of the stator winding of the generation unit to earth shall be measured.

XV. SPARE PARTS

Additionally to the offer, prices for the following spare parts and tools shall be submitted:

Type	Quantity
Diesel filter	3 pcs
Oil filter	3 pcs
Air filter	3 pcs
Fan belt	1 pcs
Toolbox with the following: - a series of German keys - screwdriver - cross slot screwdriver - filler	1 set

For the spare parts, a price per item shall be submitted separately from the price of the GU, whereas a price for the Toolbox and the tools shall also be submitted. The Buyer reserves the right to buy some of them, all or none. Also, for the servicing, maintenance and smooth operation of the GU, the required tools to be provided shall be listed in detail in the offer.

XVI. DESIGNS AND TECHNICAL MANUALS

Before the delivery of the material, the Supplier is obliged to deliver to PPC SA. five (5) sets of the following technical manuals and drawings (in Greek and English):

1. Instructions for installing the GU and the design of the concrete base on which to install the GU.
2. Operating instructions with a detailed description of its automation.
3. Maintenance instructions for the GU.
4. Schematic diagram for the Panel.

5. Electrical drawings of the relays and monitors used, as well as the connection diagram of the GU connection with the switchboard.
6. Installation plan of the GU with the associated dimensions.

XVII. GUARANTEE PERIOD

The warranty amounts to 400 hours of operation, limited to 2 years.

XVIII. PACKAGING

The GU shall be delivered covered with nylon and packaged in a fully enclosed wooden pallet box, at least 20mm thick, with a reinforced box base.

The accessories of the GU as well as any spare parts shall be delivered separately in a fully enclosed pallet-type wooden box, at least 20mm thick, covered with nylon.

ANNEX «A»
BACKUP GENERATION UNIT
88kW/110kVA or 35kW/44kVA, 230/400V, 50Hz

All bidders must complete the following information:

1. Manufacturer and GU type
2. Ambient temperature limits
for GU startup and operation°C
3. Ambient humidity limits
for GU startup and operation%
4. Maximum GU installation altitudem
5. ESP – emergency stand-by powerkW
.....kVA
6. PRP – prime powerkW
.....kVA
7. Nominal GU power factor
8. Temperature, humidity and pressure conditions
under nominal power levels
9. Power variation in relation to pressure.
10. Power variation in relation to temperature
11. Power variation in relation to relative humidity
12. GU performance class:
13. Manufacturer and engine type.
14. Nominal operating speedrpm
15. Number and layout of cylinders
16. Engine cooling method
17. Engine turbo-charger included?
18. Speed regulator method
(mechanical, electronic)
19. Fuel consumption at load:
100% ESPl/h
75% ESPl/h

50% ESP	.....l/h
25% ESP	.....l/h
20. Oil consumption at full power (ESP)	.....ml/h
21. Capacity of built-in diesel tank	.....l
22. Diesel tank dimensions (length–width–height)	.....
23. GU autonomy at full power (ESP) using built-in diesel tank	.....h
24. Speed droop:%
25. Speed deviation in steady state:%
26. Mean effective engine pressure, p_{me} at full power (ESP)	.....bar
27. Battery type (i.e. VRLA)	.....
28. Battery capacity	.....Ah
29. Is a grid-connected battery charger provided?	.....
30. Startup reliability.%
31. Starter power.	..... kW
32. Manufacturer and type of generation unit.	.....
33. MCR – maximum continuous rating, 150K/40°C.....kW	.....kVA
34. NCR – normal continuous rating	.....kW
	.....kVA
35. Nominal power factor of the generating unit at full load (ESP)	.....
36. Nominal efficiency of the generation unit%
37. Voltage deviation in steady state:%
38. Generator insulation class:	.....
39. Nominal temperature rise of generation unit windings	.....
40. Maximum negative sequence current I_2 during operation:%
41. Voltage asymmetry under no-load operation%

42. Harmonic voltage distortion
under no-load operation (THD):%
43. Generator excitation type
(parallel, excitation winding, PMG)
44. Manufacturer and type of voltage regulator
.....
.....
45. Subtransient direct axis reactance
of the generation unit (x_d'')%
46. Protection rating of generation unit (IP)
47. Class of GU radio interference as per
CISPR 11 (EN 55011)
48. Required time for automatic startup and
ramp-up to full load, after the
loss of the grid voltage:s
49. Is an automatic changeover system
provided?
50. Type and features of automatic changeover
switching devices
.....
.....
51. Type and features of generation unit
automatic protection breaker
.....
.....
52. Manufacturer and type of protection
and control unit
.....
.....
53. Are local signals and measurements
available, as per paragraph XI?
54. Are remote signals available,
as per paragraph XI?
55. Protection rating of control panel (IP)
56. GU noise level at 1m distance
indoors, as per ISO 8528-10 (L_{WA})dB(A)
57. GU weight.kg
58. GU dimensions (length-width-height)

59. Is GU packaging in compliance with
paragraph XVIII?

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