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SPECIFICATION

Four (4) ÷ Six (6) Independent, Self Supporting, Portable and Mobile Gas Turbine Units each rated 10÷15 MW (ISO), for a minimum total rating of 60 MW ISO, for Grid Support in Emergency Situation.

1 PURCHASER: The Israel Electric Corporation Limited.

2 NAME OF PROJECT: Mobile Gas Turbines Units for Grid Support in Emergency Situation.

3 LOCATION OF PROJECT: All the territory of Israel with altitude not exceeding 1000m.

4 SCOPE OF WORK:

The scope of work includes Equipment and Supervision Services for independent, self supporting, portable and mobile Gas Turbines Units, as specified herein.

The scope of work shall include, but shall not be limited to the following:

4.1 Scope of Engineering and Supply

Design, develop, engineer, manufacture, preserve, pack and furnish with export packing, mobilize, erect, assemble, tune, test, and handover (complete turnkey project) of the following:

Mobile Gas Turbines Units, including complete electrical and control systems, which will allow autonomous (black) start and continuous operation when connected to 33 (22) kV grid (all mobile modules on wheels).

The mobile unit consists of one or number trailers. In addition to the trailers, Contractor shall supply tools as required.

The trailer(s) shall consist of the following components:
A suspension trailer(s) shall be standard or supporting by IEC and used to transport the main components, suitable for emergency

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mobilization and outdoor stationing, using Israel's highways and main roads, including the approval of the Ministry of Transport and approval Israel Police, capable of independent start-up. Landing legs shall be provided to support and level the equipment at the jobsite and during storage.

Gas Turbine
The Gas Turbine (GT) firing the specified Distillate Oil shall be equipped with a stainless steel mesh screen in the inlet air stream for "last chance" protection against foreign object damage. The GT shall be shock mounted for shipping and shipped in position, with the exception of the coupling spacer, which shall be removed for shipment.

Generator
The generator shall be air-cooled fully encapsulated, 50 Hz, 0.85 PF lagging and 0.9 PF leading and shall include all the accessories detailed henceforth. Neutral and line side cubicles shall be included. The generator shall be hard mounted to a base on the trailer and includes generator air inlet filtering and air silencing.

Main Power System
Gas Turbine, Transformer, Generator Circuit Breaker, 33KV SF6 switchgear, Unit Auxiliary transformer, Start-up Diesel Generator, connection cables to medium voltage overhead lines. All equipment shall be hard mounted to a base on the trailer.

Unit Enclosure
The equipment package shall be supplied with a weatherproof acoustic enclosure for the unit. The enclosure shall be completely assembled and mounted over the equipment prior to testing and shipment. Provisions for turbine removal and personnel access shall be included. The turbine compartment shall be fully ventilated by redundant ventilation fans (provided on the trailer).

Fuel Systems
The package shall be equipped with a liquid fuel system without water injection, but with option for future modification for water injection operation. All necessary pumps, control and shutoff valves, flow meter, piping and instruments between the Trailer Skids connections shall be included.
Lube Oil System

The equipment package shall be supplied with lube oil systems; for the gas turbine and for the generator. The oil reservoirs and piping are all made of stainless steel, and the lube oil system valves shall have stainless steel trim. The lube oil system shall have pumps, duplex filters, necessary valving and instrumentation, and thermostatic-controlled electric heaters. A dual fan, single core fin fan cooler shall be provided to cool turbine, generator lube oil and hydraulic oil. The cooler and the rest of the lube oil systems shall be mounted on the trailer(s).

Starting System

The equipment package shall be supplied with a starting system including BLACK START.

Fire Protection System

The equipment package shall be supplied with an installed fire protection system complete with hydrocarbon sensing and thermal detectors, piping and nozzles in the engine compartment. The fire protection system shall include cylinders containing CO2 mounted on the trailer. All alarms and shutdowns are annunciated at the fire protection control panel. An alarm shall sound at the turbine if the gas detectors detect high gas levels, or if the system is preparing to release the CO2. When activated, the package shall be shut down, and the primary CO2 cylinder shall be discharged into the turbine compartment via multiple nozzles, and the ventilation dampers automatically close. After a time delay and if required, the reserve supply of CO2 shall be discharged.

Fin Fan Cooler

The equipment package shall be supplied with a 100% redundant dual fan, single core cooler with separate coils for the turbine, generator lube oil and hydraulic oil. The cooler shall be equipped with all interconnect piping and instrumentation necessary for the three circuits.
Turbine Ventilation Silencer

A turbine ventilation silencer shall be provided with the package and shall be mounted on a rail system to slide into position at the jobsite. The silencer shall be bolted to the side of the turbine enclosure opposite the exhaust collector and an expansion joint and fire damper shall be provided.

Foundation

All equipment supplied shall not require any foundations and shall be mounted on trailers.

Control room

The equipment package shall be supplied with a control house which will enable the control of the entire train after installation and commissioning. The control room shall be equipped with air conditioner (cooling and heating), automatic fire detection and a hand held fire extinguisher. The control room shall be used to package the equipment listed below.

a. Digital Control System

The control system shall feature an integrated electronic fuel management system with a PLC/microprocessor based programmable sequencer, vibration monitor, automatic fire detection system monitor, digital revenue meter, and digital generator and Unit protective relay modules. A desktop with separate workstation and chair shall be provided for HMI control. Alarm and shutdown events will be displayed on the HMI automatically. A dedicated 24V DC battery system shall be included with dual 100% capacity chargers to power the control panels.

b. Unit Protective Relays

The equipment package shall be supplied with Unit protective relay modules, mounted in the turbine control panel. Protective relay system shall include all the functions necessary for Unit protection.

c. Unit Motor Control Center

A freestanding lineup of motor controls for package motors shall be supplied. The motor control center shall be installed in the control house and shall also include a lighting and distribution transformer. The MCC shall feed all the Unit loads.
d. Battery and Charger System

The equipment package shall be supplied with:
- Battery system and charger for the control and protection system
- Battery system and charger for the fire system
- DC switchgear
- backup generator lube oil pump motor.

The battery systems shall be fully wired and mounted in racks and shall be installed in the control house along with the chargers.

Cables

The contractor shall supply all the electrical power, control, instrumentation cables needed to interconnect all contractor supplied systems on and between the trailers. The cables connecting the trailers shall have plug-in connectors for rapid and easy connection.

The Contractor shall also supply (4x100) m 30(45) KV rated flexible cables rolled on drums for connection of the 33KV Switchgear to the grid.

Air Filtration System

A two-stage filtration system for both ventilation and combustion air with panel type pre-filters housed in hinged doors and high efficiency bag barrier filters. Vane separators shall be installed in front of, and behind, the filtration system and include inlet silencers. Ventilation fans for the turbine enclosure shall be installed on the trailer. Three 50% fans shall be installed and shall be equipped with back draft dampers. All of the items listed shall be housed in the filter house that is complete with access doors and lighting for maintenance, separate air paths and turning vanes and the necessary instrumentation.

Exhaust System

The trailer shall be equipped with an expansion joint for trailer connection to the main trailer exhaust collector flange. An exhaust transition with access hatch, a exhaust silencer, a 90° exhaust elbow, and a vertical stack shall be also included. The stack shall be lifted into position at the jobsite.
4.2 **Special Equipment, Tools and Instruments**

4.2.1 Contractor shall provide all special equipment, tools and instruments required for safe operation and maintenance of Equipment provided under this Contract. Said equipment, tools, and instruments should be / are listed in Contractor's Proposal where it should be / is clearly stated which are provided on a loan basis and which are included in the Contract Price.

4.2.2 Maintenance equipment and tools provided under this specification shall be new and of best quality. They shall be shipped to the job site in a suitable separate box, clearly marked with the name of the equipment they are intended for.

4.3 **Contractor Services**

The Contractor shall provide the services listed in the following sub-articles as part of the basic Scope of Work or as Purchaser’s option, at the per diem or lump sum rates, all as stated in the Summary of Prices and Delivery Schedule, Annexure “C1”. Field personnel provided by the Contractor shall be capable and qualified to perform the required duties to the satisfaction of the Purchaser. They shall be vested with authority to make decisions that could affect the status of the Equipment and which are binding on the Contractor.

4.3.1 **Erection Services:**

Contractor shall provide the services of competent advisors to direct and instruct Purchaser's personnel during erection, including, without limitation, identifying the equipment, unpacking, intermediate storing, erection sequencing and erection checking as may be required to assure proper and successful erection and installation of the Equipment provided under this Specification.

4.3.2 **Commissioning and Start-Up Services:**

Contractor shall provide the services of competent advisors to direct Purchaser's personnel and assure proper, complete and successful commissioning, starting, combustion tuning and placing into service of the Equipment provided under this Contract with the balance of equipment at the related power station Unit(s).
4.3.3 Training:
Contractor's personnel shall conduct a thorough training course on site pertaining to the equipment furnished under this Specification, for Purchaser's personnel, covering, without limitation, correct start-up, safe operation at all modes of operation, safe shutdown and general maintenance. The Contractor shall verify that the trainees are completely familiar with all phases of such procedures and are capable of operating and maintaining the equipment successfully.

4.3.4 Field Performance Test

Contractor shall delegate at its own cost, qualified test engineer(s), to witness Equipment field performance tests necessary to establish compliance with this Specification, and to satisfy that the Equipment fulfills the performance guarantees, and other Contract requirements.

Field performance tests shall be carried out by the Purchaser, using procedures provided by the Contractor and approved by the Purchaser, all as further detailed in Annexure "D" – Equipment Performance Guarantees.

4.4 Work by Others (Facilities and Services to be provided by the Purchaser). In performing its duties the Contractor shall not be required to provide facilities, services and equipment as detailed below.

4.4.1 Work by Others:
4.4.1.1 Supply of system connections from fuel source to defined terminal connection.
4.4.1.2 Mobile fuel oil storage with fill and supply connections.
4.4.1.3 Fuel for operation of the unit(s).
4.4.1.4 Local grounding grid and connections to Unit grounding buses.
4.4.2 Leveling and grading of ground according to Contractor's requirements (load spread plates or any other means of connection between ground and equipment to be supplied by Contractor).
4.5 Terminal Points and Terminal Connections

All terminal connections shall be "Plug and Play" technology.

Contractor shall terminate the Equipment provided under this Specification at the agreed upon terminal points at the boundary of the power island, at "on base" equipment outside boundaries (General requirements of Terminal Connections are presented in supplement 5.1.10).

In order to complete the definition of the terminal points and terminal connections, Contractor shall include in the Proposal a further definition of said terminals including location, size, type, movements, allowable forces and moments.

4.5.1 Mechanical Terminal Connections

4.5.1.1 Fuel oil system forward pumps inlet and outlet flanges including skid mounted equipment, all auxiliaries such as, valves, instruments, etc'. Fuel oil system at trailer connection.

4.5.1.2 Waste system at waste water storage tank outlet valve.

4.5.2 Electrical Terminal Connections

4.5.2.1 Electrical cables Connections from the mobile switchgear to 33-22KV high voltage utility grid as per the Purchaser's one-line diagram and as detailed herein:

- Line side of the electrical cables to the 33/22 high voltage grid by the purchaser. The other side of these cables shall be permanently connected to the high voltage Switchgear supplied by the Contractor.
- 0.4 kV terminals for external source connection (see one line diagram).
- Optional cable connection to the GTT neutral switchgear (see one line diagram).

5 SUPPLEMENTS

The following supplements are attached hereto and their requirements form an integral part of this specification - to the extent they are consistent and conform with the requirements specifically set forth herein. In the event of a variance between the requirements of the Supplements and the particular requirements set forth in the Specification, the requirements specifically set forth in the Specification shall take precedence.

5.1 Purchaser's general documentation, quality assurance and quality control requirements:
5.1.1 Standard 01-1E Standard Specification for Contractor's Drawing and Data Transmittal.
5.1.2 Q-APP-02-PR: Quality requirements from suppliers.
5.1.3 RAM requirements.
5.1.4 General requirements for Instrumentation:
5.1.4.1 Instrumentation.
5.1.4.2 Instrumentation data sheets (Supp. "A").
5.1.4.3 List of already approved Instrument Manufacturers (Supp. "B").
5.1.4.4 IEC Installation Standard, XXO/M3-006-CS0300-00 (Supp. "C").
5.1.4.5 Instrument Piping Code, XXO/M3-006-CS0002-00 (Supp. "D").
5.1.5 Electrical Supplements.
5.1.5.1 Principle One Line Diagram - GX0-E00-K00001-MP.
5.1.6 Reserved.
5.1.7 Fire Protection System Concept.
5.1.8 Reserved.
5.1.9 Reserved.
5.1.10 Terminal Points Concept.
5.1.11 Fuel Oil Analysis for Gas Turbines.

6 Standards and Codes
6.1 Standards and Codes referenced in this Specification and in the Supplements to this Specification form an integral part of this Specification - to the extent their requirements are consistent and conform with the requirements specifically set forth herein. All such Standards and Codes are to the issue, including all amendments, supplements, etc., current as of the date of the Contract, unless indicated otherwise. In the event of a variance between the requirements of the Standards and Codes and the particular requirements set forth in the Specification, the requirements specifically set forth in the Specification shall take precedence.

6.2 The Equipment to be provided under this Specification, including all appurtenances and accessories, shall be designed, fabricated, inspected, tested, stamped and preserved to the extent indicated in said referenced Standards and Codes. Where this Specification does not include such reference, The Equipment, or any of its components, shall be designed, fabricated, inspected, tested and preserved, as applicable, to comply with currently recognized
International and/or Contractor's Standards, whichever are tighter and more restrictive.

6.3 The Contractor may propose Standards and Codes as alternates for, or additions to those specified herein. A copy of each proposed Standard and code, if any, shall be submitted (in English) for Purchaser's approval. In case Purchaser's approval is granted, the Contractor shall remain responsible for the compatibility of the design and the physical interfaces between the supplied Equipment and the equipment supplied by others.

6.4 The Purchaser shall assist Contractor in identification of Israeli codes and standards applicable to the Work. In all cases Contractor shall adhere to and comply with the requirements of Israeli official standards found to be more restrictive than those specified herein.

6.5 Subject to the provisions stated above, the equipment shall be designed, manufactured, erected, tested operated and maintained in accordance with the standards, regulations, directives and publications of the following agencies and organizations:

- ANSI: American National Standards Institute, Inc.
- ASME: American Society of Mechanical Engineers.
- ISA: International Society of Automation.
- NEMA: National Electrical Manufacturer's Association
- NFPA: National Fire Protection Association
- SI: The Standard Institution of Israel
- DIN: Deutsche Normen
- EN: European Standard
- ATEX: Directive/Guideline

6.6 Furthermore, without derogating from the technical requirements stipulated in this specification, the items listed below shall be designed in accordance with the standards specified herein or their equivalents:

6.6.1 Reserved.
6.6.2 Fire detection and protection:

6.6.2.1 NFPA 37 – Standard for the installation and use of stationary combustion engine and Gas Turbines.

6.6.2.2 NFPA 850 - Recommended practice for fire protection for electric generating plants.

6.6.2.3 NFPA 72 - National fire alarm Code.

6.6.2.4 National Fire Protection Association Standards (NFPA) or British Standards (Great Britain).

6.6.2.5 VDE standards (Germany).

6.6.2.6 Israeli standard SI 1220 parts 1 to 10.

6.6.3 Electrical equipment

Well recognized international standards (IEC, IEEE) shall be used for design, manufacturing and testing of electrical equipment. List of main relevant standards:

- IEC 60034 - Rotating electrical machines.
- IEC 60439-1 - Low-voltage switchgear and controlgear assemblies - Part1: Type-tested and partially type-tested assemblies.
- SI-1419-1 - Low-voltage switchgear and controlgear assemblies.
- IEC 60044 - Instrument transformers.
- IEC 60502 - Power cables with extruded insulation and their accessories for rated voltage from 1 kV(Um=1.2 kV) up to 30 kV(Um=36kV).
- IEEE 383 - IEEE standard for qualifying class 1E electric cables and field splices for nuclear power generating stations.
- IEC 60228 - Conductors of insulated cables.
- IEC 60947 - Low-voltage switchgear and controlgear.
- NFPA - 
- IEC 60079 - Explosive atmospheres.

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7 QUALITY ASSURANCE AND QUALITY CONTROL

7.1 Without derogating from the provisions of the General Conditions, Contractor's quality system shall meet the requirements of Purchaser's Standard Q-APP-02-PR, "Quality Requirements", and of the requirements of the Inspection and Test Plan, all as further detailed in Annexure "M" to the Contract.

7.2 The Contractor and the main subcontractors shall be certified to ISO-9001-2000 by a certification body qualified to EN-45004 levels A or C or otherwise as may be acceptable to the Purchaser.

7.3 The Contractor shall submit upon request a copy of its Quality Assurance Manual including Quality Procedures.

7.4 Obligation to meet Israeli Standard SI 4295:
Contractor shall supply Purchaser with the certification of the Israeli Standards Institute that its Equipment conforms to Israeli Standard 4295. [Tender participants should include in their proposals a written undertaking to comply with SI 4295].

8 Deleted

9 SAFETY, NOISE, ENVIRONMENT, LOADING AND SITE REQUIREMENTS

9.1 Safety

9.1.1 The Equipment supplied under this Specification shall meet the U.S. "OCCUPATION, SAFETY, AND HAZARD ADMINISTRATION" (OSHA) requirements [Contractor shall submit with the proposal the relevant safety standards which the design was based on].

9.1.2 The Equipment shall be provided with all necessary mechanical, electrical and chemical means to protect operators from any danger.

9.1.3 The Unit shall be provided with all necessary means to avoid leaks and explosion during operation with low flash point distillates or natural gas.

9.2 Noise
9.2.1 The guaranteed sound pressure level at 1 meter of each equipment in free field over a reflecting plan shall not exceed 85 dB(A).

9.3 **Environmental Data**

9.3.1 The range of the ambient temperature for the Electrical and Control equipment located in open air shall be -10\(^\circ\)C to +50\(^\circ\)C and the relative humidity of the air may rise up to 100%. Part of the Electrical and Control equipment shall be located in air-conditioned rooms. However, during the periods the air conditioning unit is out-of-service, the ambient temperature may range from -10\(^\circ\)C to +50\(^\circ\)C and the relative humidity of the air may rise up to 100%.

The equipment shall be designed to operate without limitation under these conditions, with no reduction of its life expectancy.

9.3.2 **Emission Requirements**

Equipment shall be design Low Emission State-of-the-Art for Oil #2 firing without water injection.

9.4 **Environmental Conditions**

The equipment must be able to operate reliable and available at all territory of Israel with altitude not exceeding 1000m.

9.5 **Wind Loads:**

The calculation of wind loads in Israel is governed by the provisions of the Israeli Standard SI 414 "Characteristic Loads in Structures: Wind Loads".

According to this Standard, the fundamental basic wind velocity is defined as the 10 minute average wind velocity, with an average return period of 50 years, at an altitude of 10 m above ground level at the site at flat open country terrain (Roughness Category II).

The fundamental basic wind velocity shall be taken from the velocity map which is a part of the SI 414.

For the sites of this object, the fundamental basic wind velocity indicated by the Standard is shown in Table above.

9.6 **Earthquake Loads**

9.6.1 The seismic design of buildings and structures in Israel is governed by the provisions of the Israeli Standard SI 413 "Design Provisions for the Earthquake Resistance of Structures".
According to this Standard, the seismicity of the site is expressed by the expected horizontal ground acceleration coefficient Z. The expected horizontal ground acceleration coefficient Z defined as:

\[ Z = \frac{a_{h,\text{max}}}{g}. \]

The expected ground acceleration is a forecast of the peak of the horizontal ground acceleration due to an earthquake, \( a_{h,\text{max}} \), expressed in m/sec², for which there is a 10% probability that a stronger acceleration will occur at least once within a period of 50 years. The gravity acceleration \( g = 9.81 \text{ m/sec}^2 \).

The expected horizontal ground acceleration coefficient (Z), per provisions of the Amendment No. 2 (2004) to SI 413 shall be consider as \( Z=0.29 \).

Earthquake resistance of structures shall be calculated in accordance with requirements of the Amendment No. 3 (2009) to SI 413 or, alternatively, in accordance with requirements of the latest revision of the Israeli Standard SI 413 issued later than May 2012. Currently, Draft of the Amendment No. 5 to SI 413 is published for public comments.

Site specific response spectrum shall be taken into consideration.

9.6.2 Seismic Environment for Electrical Equipment to be defined by ELECTRICAL ENGINEERING DEPARTMENT.

The seismic environment is defined according to IEC Publication 60068-3-3 ("Seismic test methods for equipment"), for "General seismic class".

1. For the Scope of Work the horizontal ground acceleration at the ground level shall be taken 3 m/s².

2. The value of the superelevation factor (K) shall be:
   - K=1 for the equipment to be mounted on rigid foundation or on structures of high rigidity;
   - K=1.5 for the installations rigidly connected to buildings;
   - K=2 for installations on stiff structures connected rigidly to buildings;
   - K=3 for installations on low rigidity structures connected to buildings.

The values of the super elevation factor are taking into consideration the actual location and installation modes of the different equipment.

3. The equipment shall comply with one of the following values of the Qualification Criterion, according to para. 4.3 of IEC Publication 60068-3-3:
- Criterion 0 for equipment which shall experience no malfunction either during or after a seismic event – Protection, Control, DC and UPS distribution, other equipment powered from DC system.

- Criterion 1 for equipment which may suffer a malfunction during a seismic event, but it is reverted to its correct state after the event – Equipment powered from AC Emergency System.

- Criterion 2 for equipment which may experience a malfunction during a seismic event and require resetting or adjustment after the event, but require no replacement or repair – All other equipment.

4. The manufacturer will indicate in the Proposal the seismic withstand capability of each electrical and control equipment (the level of the peak acceleration) and the Qualification Factor.

9.7 Load Combination

Design wind and design earthquake shall not be considered to act at the same time and their respective effects on the buildings and structures shall not be combined.

10 STORAGE CONCEPT

The bidder shall specify the storage requirements for long term storage of the Units, to maintain the high level of availability and reliability of the Units. The instructions shall include (amongst others): air condition and ventilation requirements, battery charging, size of external 0.4KV power supply, etc...

11 TECHNICAL DOCUMENTATION

The Contractor shall provide all documentation required by this Specification and by applicable Standards and Codes, in the required format, form and submission schedule.

11.1 Proposal Data

Proposal data must be complete and shall include all data required hereinafter in order to allow adequate evaluation by Purchaser. Partial proposals will be disqualified. Contractor shall indicate the completeness of his proposal data documentation by means of indicating (per item) if data is incorporated and it's specific location\section in the proposal.
1. Detailed scope of supply. Contractor shall confirm the supply of all scope items listed in paragraph 4.1 of annexure "B", one by one specifically.
2. Terminal connection list.
3. Technical features and description of power block equipments including information on materials used for the unit critical components.
4. General arrangement, including power generation block conceptual arrangement.
5. Conceptual mobilization of trailers and containers to place at site including navigation requirements.
6. Ground and leveling infrastructure requirements.
7. Flow and P&ID diagrams of main systems including limit of supply indications.
8. Emission data for Oil #2 firing without water injection for ISO conditions.
   \[ \text{NO}_x \text{ @ 15\% O}_2, \text{ ppm vd, mg/Nm}^3 \]
   \[ \text{CO \text{ @ 15\% O}_2, \text{ ppm vd, mg/Nm}^3} \]
   \[ \text{Particulate Matter (PM) @15\% O}_2, \text{ mg/dNm}^3 \]
   Noise data
10. Net Power Output for Oil #2 firing (ISO conditions).
11. Net Efficiency for Oil #2 firing (ISO conditions).
12. Correction curves for ambient air temperature and altitude.
13. Start up diagram.
14. Required maintenance intervals.
15. Required maintenance and maintenance intervals during long term storage.
17. Manpower and time for erection and disassembly of the power unit at the site.
18. Conceptual project execution plan including project organization chart, key personal involved in the project and their skills, description of major activities and their time schedule, i.e; design, manufacturing, QC, shipment, mobilization, installation, commissioning, testing and turnover.
19. List of sub-suppliers.
20. List of recommended spare parts.
21. List of special tools and instruments.
22. Relevant safety standards which the design was based.
23. Written undertaking to comply with SI 4295.

11.2 **Electrical and Control documentation**
- Electrical One Line Diagram
- Electrical three line diagrams
- Electrical and Control internal and external interconnection diagrams
- Electrical and Control schematic diagrams
- Electrical and Control cabling diagrams
- Control system configuration.
- Control system Input/Output list (including spares)
- Control system software print out
- Operation book
- Maintenance book

11.3 **Technical documentation after contract**

11.3.1 Detailed terminal connections list including name, location, diameter, configuration, media, parameters, allowable forces and moments – to be submitted one (1) week after letter of intent.

11.3.2 Ground and leveling infrastructure specific/detailed requirements – to be submitted one (1) week after letter of intent.

11.3.3 Detailed mobilization of trailers and containers to place at all sites including navigation requirements – to be submitted one (1) week after letter of intent.

11.3.4 Operation and maintenance instruction books for all supplied equipment (ten sets) – to be submitted eight (8) weeks after letter of intent.

11.4 Rest of the required technical documents and dates of submittals will be agreed upon before contract signing.

12 **SPARE AND RENEWAL PARTS**

The Contractor shall provide upon purchaser's request as purchaser's option spare parts at their itemized prices, subject to the applicable terms and conditions, all as further detailed in Annexure "C1"- Summary of Prices and Delivery Schedule.

13. **GENERAL DESCRIPTION AND REQUIREMENTS**

13.1 **Background**

Power reserve reinforcements for electrical grid support in emergency situation like earthquake or another type of a natural disaster.
13.2 **RFP general requirements**

a. Supplier shall quote its equipment for four (4) ÷ six (6) independent power units, for a minimum total rating of 60 MW ISO.

b. General Arrangement requirements:
   Compact footprint and portability.

c. Mobile Gas Turbine(s) equipment and auxiliaries shall comply with the following basic requirements:
   - Equipment shall be of the mobile and portable type, not requiring any foundations.
   - Equipment remaining life cycle of twenty five (25) years.
   - Mobile equipment suitable for long term storage, fast mobilization and installation.
   - Outdoor type equipment, suitable for the defined environmental conditions and noise requirements.
   - Mobile Gas Turbine(s) capacity within the range of 10-15 MW at ISO conditions, for a minimum total rating of 60 MW ISO.
   - Project main goal is power reserve flexible reinforcements for electrical grid support in emergency situation like earthquake or another type of a natural disaster. As such, Supplier shall strive to supply equipment which it's capacity is closest as possible to 15 MW at ISO conditions. Capacity differences between bidders will be evaluated as specified.
   - Full Oil #2 firing capability per fuel specified analyses.
   - Reliability and availability.
   - Specific unit price.
   - Time of mobilization and installation.
   - Manpower requirements for mobilization, installation and disassembly.
   - Cost of long term storage and required maintenance.
   - Price of On-Site Training programs.
   - Requirements of special equipment.
   - Emission performances.
   - Efficiency.

14 **PERFORMANCE REQUIREMENTS**

14.1 The Gas Turbine and its associated equipment shall be able to achieve stable, safe and reliable operation when firing Oil #2 without water injection at the rated capacities, temperatures and pressures, at any load.
14.2 The gas turbine shall include equipment for burning specified distillate Oil #2.

14.3 The Gas Turbine emissions shall correspond to Low Emission State-of-the-Art.

15. MECHANICAL REQUIREMENTS

Gas Turbine, Generator and GSU-Switchgear should be complete portable and mobile, not requiring any foundations.
The units to be supplied will be operated in parallel with other units or as an isolated and independent station.
The units shall be suitable for continuous operation without limitations. The unit should have the capabilities for full load rejection. Full load rejection capability will be dependent on I.E.C.’s auxiliary bus arrangement and whether AC power will be available to the unit in island mode.
The unit to be supplied should meet the following operational requirements:

- Base and Peak load mode of operations.
- No limited range from Minimum Load (the value shall be defined) to Base Load.
- Number of starts – not limited.
- Low NOₓ combustion capability – Oil # 2 without water injection.
- The major components (gas turbine and generator) of each unit shall consist of but not limited to the following:
  - Weatherproof enclosure, including inlet and exhaust with sound attenuation devices.
  - Lubrication systems.
  - Fuel control system.
  - Ignition system.
  - Starting system.
  - Fire protection system.
  - Ventilation and AC and DC lighting system.
  - Fuel oil system.
  - Vibration sensors and vibration monitoring system.

15.1 Air Cooled Generator and Excitation System, including but not limited to (refer also to Generator design requirements paragraph 16.1.5):

15.1.1 Lubrication and hydraulic system.
Lubrication System for gas turbine and generator including tank, pumps, coolers, filters, oil purification plant, stainless steel piping, heaters, valves, control and protection devices for lubrication and absorption of heat rejection during normal and emergency conditions.

15.1.2 A closed loop water cooling system, common to the gas turbine and generator, the system shall be designed for maximum ambient air temperature 50°C.
Location of all pumps and motors shall enable easy maintenance by providing necessary space for lifting devices.

15.1.3 Enclosure with sound attenuation.

15.2 Lubrication System
The Contractor shall provide a complete lubrication system.
Equipment shall include, but is not necessarily limited to, the following:

15.2.1 Oil reservoir made of stainless steel with oil level indicator, with high and low level alarm contacts accessible for periodic testing and a suitable, removable oil strainer.
The reservoir capacity shall be such that its content is circulated during normal operation not more than 10 (ten) times per hour. The reservoir shall store the complete oil system during shutdown.
The Contractor shall provide feed and drain piping connections, with all the necessary isolating valves.
The reservoir shall be fitted with a sampling pipe and valves at its lowest point and also at a point half-way up the tank.
The reservoir shall be provided with connections for oil heaters and connection for oil purifier (if required).

15.2.2 Oil bearing switches for Low pressure alarm.

15.2.3 The instrumentation and control of the oil unit will consist of, but will not be limited to the following:
- Oil heated automatic temperature control in order to maintain the oil tank temperature above the minimum required temperature.
- Temperature indicators at oil bearing outlets.

15.2.14 All pressure vessels shall be Israeli Standard SI 4295 stamped.

15.3 Fuel Systems

15.3.1 Liquid Fuel System including:

a. Liquid fuel forwarding skid with two (2 x 100%) full-size AC motor driven pumps for pumping fuel to the main fuel pumps including strainer and mass flow meter with local readout, totalizer and 4-20 mA output for Purchaser’s use.
b. Main Liquid Injection Skid with pumps for fuel injection to the turbine including stainless steel piping, control and safety relief valves, filters. The filters should be duplex filters with differential indicators and switches.

c. The forwarding and injection pumps must include isolating valves, check valves and safety relief valves.

d. Leak oil tank and pump.

e. Fuel treatment plant (if needed).

f. Fuel connection piping.

g. Fuel heater (if needed).

h. Distillate Fuel Oil Centrifuge System (if needed).

15.3.2 The Contractor shall supply, in addition to any high pressure fuel pump located within the unit, all necessary skid mounted fuel forwarding pumps, motors, strainers and valves to deliver fuel oil to the unit at the required pressure from Purchaser's gas turbine fuel oil tanks.

15.3.3 The fuel oil forwarding pumps, motors, strainers, filters, shutoff valves, check valves, safety or relief valves, pressure gauges, and other required controls shall be completely piped and mounted on a skid by the Contractor, and they shall be suitable for outdoor operation, in a corrosive environment. Fuel forwarding oil pumps shall be centrifugal type and have mechanical seals.

15.3.4 The fuel-oil forwarding supply pumps will be located near the fuel oil tanks. The pumps driven by AC motors shall be capable of supplying fuel-oil to the filter skid per specified distances. The Contractor will integrate forwarding pumps to power block control system and will provide required circuit breaker and starter.

15.3.5 The main fuel oil pumps shall be positive displacement type pumps. Pumps will be provided with disconnecting valves on inlet and outlet and check valves at the outlets.

15.3.6 Final fuel filters must be provided for filtering effectively down to 5 microns. These filters shall be installed in an accessible area as close as possible to the fuel control valves.

15.3.7 Fuel controller, solenoid operated fuel shutoff valves, modulating valve, fuel starting heaters (if necessary) shall be part of the fuel control system.

15.3.8 Fuel control shall be influenced at least by the turbine speed, inlet temperature, discharge temperature, and other parameters which shall ensure reliable, efficient and safe operation of the engine. Appropriate sensors and transducers shall be included.
15.3.9 **Fuel.**

The generating units shall be designed to burn Distillate Oil according to the ANSI/ASME B.133.7M-1985 and ASTM D-2880.

**Specification of Fuel Oil # 2**

- **Density at 15°C (60°F)**: 0.87 Max.
- **Flash Point (P.M. closed),°C**: 38-66
- **Sulphur content,%**: 0.1 Max.
- **Kynematic Viscosity, cst**: 6.0 - 2.5
- **Carbon Residue, Ramsbottom, %w**: 0.2 Max.
- **Mineral Acidity, mgKOH/g**: None
- **Ash content, %w**: 0.01 Max.
- **Water content, %**: 0.05 Max.
- **Sediment by extraction, %w**: 0.01 Max.
- **Diesel Index**: 53 Min.
- **Pour Point, °C**: 5 Max. (Summer)
  - 0 Max. (Winter)
- **Gross Calorific Value, kcal/kg**: 10,000 Min.
- **Carbon content**: 87.1% (wt)
- **Hydrogen content**: 12.9% (wt)
- **Trace elements**: vanadium 0.03 ppm, sodium 1 ppm, potassium 0.9 ppm, lead 0.5 ppm, calcium 0.02 ppm
- **Fuel Bound Nitrogen (FBN),%**: 0.02 wt

Additional data in Supplement 5.1.11.

15.4 **Inlet Air System**

Inlet air system should be capable of operating efficiently under all weather conditions at all the territory of Israel with altitude not exceeding 1000 m.
15.5 **Exhaust System**  
Exhaust System including carbon steel exhaust plenum with internal insulation, or stainless steel ducting, stack, 50 m/s gas velocity, silencer, portholes for duct testing equipment.

15.6 **Bearings**  
Each bearing housing shall be equipped with an oil baffle to prevent oil from leaking.

15.7 **Package Design**
15.7.1 The package design shall include all necessary stairways, ladders, and platforms with handrails. All stairways shall have non-slip grating treads. All exterior stairways, ladders, platforms, etc., shall be H.D. galvanized. All interior surfaces shall be finish painted except where natural finish aluminum is provided for the enclosures.

15.7.2 The steel structures shall be galvanized. The steel structures galvanized surfaces will not be painted.

15.8 Each housing and heavy external removable panels and parts shall be provided with lifting eyes, jacking pads, etc., to facilitate handling and erection.

15.9 All doors of housings shall be equipped with panic latches. Provision is to be made for Purchaser's padlocks on all external doors.

15.10 The Contractor shall furnish the interior lighting (AC) in all enclosures, and in all panels including electrical equipment. The Contractor shall also furnish an external lighting (AC) on the trailers.

15.11 Emergency DC lighting shall be provided in the enclosures as required for safety of the personnel. A separate DC circuit from the storage battery for emergency lighting shall be provided. Emergency lighting may have self-contained battery packs.

15.12 All electrical equipment, lights, and wiring shall be furnished in accordance with applicable U.S.A. codes wherever a hazard of fire explosion due to oil may exist (N.F.P.A.) or UVV/DIN. Class 1, Group D, Division 2 as applicable.

15.13 Enclosures shall be designed to permit all normal maintenance and inspection in inclement weather without the use of temporary shields or hoods.

15.14 Air conditioners should be removable from the outside of the control enclosure.

15.15 Outdoor electrical equipment Junction Boxes or panels shall be corrosion resistant material or anticorrosive coated and shall be listed as NEMA 4X, except turbine compartment which shall be NEMA 12. Only exterior junction boxes will be NEMA 4X. Other junction boxes or panels will be NEMA 4 or 1, according to Contractor's standard design.
5.16 All electrical equipment furnished by the Contractor shall be designed, constructed and tested in accordance with the requirements of the latest published recommendations of the ANSI, IEEE, ASME or ISO-2314 for American supplied equipment or IEC and ISO-2314 for European supplied equipment.

15.17 Arrangement
The Power Generation Block will be located outdoor.

15.18 Vibrations
The gas turbine and generator shall be capable of continuous operation over the full load range under the following conditions, without exceeding the specified by the Contractor generator allowable vibrations:
- Vibration at bearing cap, at rated speed, as defined and specified by the Contractor.
- Vibration on the shaft at rated speed, as defined and specified by the Contractor.
- Frequency variation 2%.

15.19 Reliability Requirements
The Contractor will demonstrate that, for the total design, he established quantitative reliability and maintenance performance parameters. The reliability of the critical items significantly affects the ability of the turbo-generator system to perform its overall function or safety, which is in consideration. Equivalent availability as desired by NERC shall be stated numerically with confidence levels, in terms of mission success or hardware meantime between failures. Initially, equivalent availability may be stated as a goal and a lower minimum acceptable requirement.
Equivalent Forced outage Rate (EFOR) ≤ 0.01.
Actual Unit Starts/ Attempted Unit Starts ≥ 0.999

15.20 Gas Turbine Design Requirements
15.20.1 The gas turbine will use the Contractor's design standards of power plant equipment, with special attention being paid to maintenance facilities. The Contractor shall indicate how maintenance access is achieved. Contractor will provide his standard connection system to be used to connect the Gas Turbine to the Generator.

15.20.2 Anti-condensation heaters shall be provided in the gas turbine enclosure.

15.20.3 Compressor, Combustion System and Turbine.
The design of the unit critical components, in particular compressor blading and turbine hot path components should be based on advanced heat-resistant and corrosion-resistant materials and coatings. Full information on materials used for the unit critical components should be included in the Proposal documents.
15.20.3.1 The Contractor will describe, in detail, the on-site and factory maintenance, inspection, and overhauls required to maintain the compressor, combustion system and turbine available for operation.

16. **ELECTRICAL AND CONTROL REQUIREMENTS**

The contractor, with respect to the basic and optional scope, shall supply, design, develop, engineer, manufacture, preserve, assemble, tune, test, pack, furnish, erect and commission the following electrical and control equipment. The proposed equipment shall be based on the attached Principle One Line Diagram GX0-E00-K00001-MP.

The Gas turbine Unit shall have black start capability, using a Diesel generator supplied by the Contractor, and shall have the following mode of operation capabilities:
- Dead bus (Isolated)
- Synchronized parallel to the 22KV or 33KV grid.

All the equipment shall be hard mounted and fixed to a base on trailers. All doors of housings shall be equipped with panic latches. Provision shall be made for Purchaser's padlocks on all external doors. All the electrical and control equipment shall be outdoor or enclosed by suitable enclosure according to Bidder's design.

The Bidder shall supply all necessary electrical drawings like One Line diagram, Three Line diagrams, schematics, wiring connections, control, etc… of the all supplied equipment.

16.1 **Electrical Power System**

The attached Principle One Line Diagram (see dwg. GX0-E00-K00001-MP) represents the Purchaser's reference. The Contactor shall include in the Proposal a one line diagram based on his own conceptual design which fully answers to the requirement of this Specification.

16.1.1 **Main Power System**

16.1.1.1 The Mobile GT shall be designed, manufactured and tested according to one of the well known international standard (e.g. IEC, IEEE, DIN). This Specification is based on IEC standards, if not otherwise mentioned.

16.1.1.2 The Mobile GT will be connected to MV grid (Main) of 33kV or 22kV (both voltage levels shall be available). The Mobile GT is intended for autonomous operation either in island mode (when no other power source is available) or in parallel with the grid (Main available).
All the voltage levels needed for startup, operation and safe shut-down of the unit will be generated inside the unit (Contractor Scope of Supply).

16.1.1.3 The main data of the grid (Main) are the followings:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>33 kV</th>
<th>22 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated system voltage</td>
<td>33 kV</td>
<td>22 kV</td>
</tr>
<tr>
<td>Normal voltage tolerance</td>
<td>±10%</td>
<td>±10%</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50 Hz</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Normal frequency limits</td>
<td>49÷51 Hz</td>
<td>49÷51 Hz</td>
</tr>
<tr>
<td>Maximum three-phase short-circuit current</td>
<td>8 kA</td>
<td>12.5 kA</td>
</tr>
<tr>
<td>Rated duration of short-circuit</td>
<td>1 sec</td>
<td>1 sec</td>
</tr>
<tr>
<td>System neutral</td>
<td>Solidly grounded or via Petersen coil or occasionally solidly grounded</td>
<td></td>
</tr>
<tr>
<td>Maximum phase-to-ground voltage in case of earth fault</td>
<td>36 kV</td>
<td>24 kV</td>
</tr>
<tr>
<td>Maximum duration of earth fault</td>
<td>7200 sec</td>
<td>7200 sec</td>
</tr>
<tr>
<td>Maximum THD in voltage</td>
<td>8%</td>
<td>8%</td>
</tr>
</tbody>
</table>

16.1.1.4 Three-phase auto-reclosing is used on the MV grid. The automatic reclosing is performed in two stages, typically after 0.3 sec and 75 sec. The Contractor shall inform in the Proposal if the offered units were checked and can withstand to the mechanical stresses resulting from this kind of automatic reclosing.

16.1.1.5 In normal operation conditions the unit shall be able to operate in the frame of voltages and frequencies of the grid (see para. 16.1.1.3). In abnormal conditions the frequency limits may reach 47÷52.5 Hz. The unit shall be tripped after a delay of at least 1 sec. at 47 Hz and 0.2 sec. at the higher end of the frequency range. The Contractor shall inform in the Proposal about the unit capability (continuous or limited in time or output) to operate in this range.

16.1.1.6 The three-phase short-circuit current contribution to the MV grid shall not exceed: 4 kA for the 33 kV grid and 6 kA for the 22 kV grid. The Contractor shall calculate the impedance of Gas Turbine Transformer (GTT) to meet the a.m. criterion. The recommended impedance of the Gas Turbine Transformer (GTT) is 10% or less.

16.1.1.7 The main characteristics of the proposed unit (inertia, generator and main transformer reactance, excitation, protection and control system) shall be well coordinated in order to assure a good steady state and dynamic stability.

16.1.1.8 The ratings of all equipment shall match the maximum continuous output of the unit in all operating conditions and ambient temperatures. Ambient conditions, when exceeding the levels stated by the relevant standards, have to be considered in order to avoid operability limitation resulting from them. The Contractor shall include in the Proposal a composite curve showing the Gas Turbine output, the generator and the GTT capability versus the ambient temperature (as indicate in para. 9.3).
16.1.1.9 The insulation level of the equipment shall be well coordinated in order to assure a high reliability level. The influence of the neutral connection shall be considered.

16.1.1.10 The over-excitation (V/Hz) capability of the GTT and UAT shall be coordinated with the generator capability. A minimum capability of 110% continuous over-excitation shall be assured.

16.1.1.11 Neutral connections:
   a. The GTT neutral will be grounded as follows:
      - When operating in parallel with the Main the grounding method will be identical to the grounding method used in the Main. For this an optional cable connection between the GTT neutral to the ground switchgear of the Main shall be laid. When this connection is not practical, the Unit will be solidly grounded.
      - When operating in island mode the neutral will be solidly grounded. A Loss Of Main (LOM) protection shall be provided in order to identify island mode of operation. The LOM will operate in 0.2 sec.
   b. The generator neutral shall be grounded through high impedance.

16.1.1.12 Energy metering shall be provided at the Point of Common Coupling with the distribution network.

16.1.2  Auxiliary power system
16.1.2.1 The auxiliary power system will be based on 0.4 kV voltage level. The 0.4 kV system shall have solidly grounded neutral.

16.1.2.2 The auxiliary power system shall supply all consumers of the Power Plant and shall assure the correct operation of the Power Plant in all operation modes.

16.1.2.3 The auxiliary power system shall have three supply sources:
   - through GTT and UAT
   - from the Diesel Generator (part of Contractor Scope of Supply)
   - a 0.4 kV external source, mainly during long term storage

16.1.3 Site testing
All electrical equipment shall be site tested at commissioning which shall take place at a randomly chosen site for the first operating. Site testing is part of the Scope of Supply. Failed parts shall be immediately changed/replaced.

16.1.4 Equipment – general
Auxiliary contacts in the protection and measuring circuits will be available for the Purchaser use.

16.1.5 Generator
16.1.5.1 Three-phase alternating current, turbine-driven synchronous, brushless self-excited, automatically regulated, air cooled, fully encapsulated. The design of the generator shall take into consideration the foreseen operation modes of the Unit (both short and long time operation, a large number of start/stops, sudden load variations, prolonged periods of storage) and provide high availability (MTBF/(MTBF+MTTR).

16.1.5.2 The Generator shall be designed, manufactured and tested according to well known international standards like IEC 60034 and IEEE C50.13.

16.1.5.3 Generator rating:
   - Rated voltage – according to manufacturer practice
   - Rated frequency – 50 Hz
   - Rated power factor – 0.85 lagging and 0.9 leading. These values could be changed according to manufacturer practice however the unit shall have reactive capability both lagging and leading.
- Rated power – The rated power of the generator shall exceed the turbine capability in all operating modes, over the whole range of ambient temperatures (see para. 16.1.1.8).

- Other ratings and capabilities according to the a.m. Standards.

16.1.5.4 All auxiliary systems of the generator including but not limited to:
- excitation
- Automatic Voltage Regulator
- cooling
- control, monitoring and alarming
- protection and metering
- synchronizing

16.1.6 33 kV switchgear for grid connection

16.1.6.1 A 36 kV single busbar, compact SF6 gas insulated switchgear (GIS), according to the attached one line diagram, shall be provided. The enclosure shall be appropriate for outdoor installation in environmental conditions specified in para.9.3.

16.1.6.2 The equipment shall be type tested, based on IEC 62271 series standard.

16.1.6.3 The switchgear shall include the following equipment:
- Surge arrester for GTT protection (the GTT shall be in the protection zone)
- Circuit breaker
- Disconnecter switch
- Earthing switch on supply side
- Withdrawable line potential transformer
- Current transformers (not shown in the diagram)
- Neutral switchgear for GTT with motor operated disconnecter switch according to attached on line diagram

16.1.6.4 The switchgear will be metal enclosed type, type tested switchgear, SF6 gas being used as both insulation and arc quenching medium.

16.1.6.5 The insulation level of the GIS:
- Lightning impulse withstand voltage 170 kV peak
- Power frequency withstand voltage 70 kV rms

16.1.6.6 Plug in connection on both sides (GTT and grid, respectively) are in Contractor's Scope of Supply.

16.1.6.7 The surge arresters shall be of metal-oxide type (without gaps), single-phase, explosion – proof, based on IEC-60099-4 Standard.

Arrester main data:
- Rated voltage ........................... 45 kV
- Continuous operating voltage ........ 36 kV
- Nominal discharge current .......... 10 kA peak
- Maximum residual voltage at 8/20 μsec and at 5kA peak discharge current shall be less than 85 kV peak
- Arresters short circuit rating shall be at least 16 kA r.m.s.(for at least 0.2sec)
- Long-duration discharge class shall be at least 1.

16.1.6.8 The circuit breaker shall be able to successfully interrupt the system source short-circuit currents (see para. 16.1.1.3).

16.1.6.9 The potential transformer based on IEC-60044-2 shall have a rated voltage factor of 1.9 for 8 hours. The number of secondary windings will be chosen by the Contractor based on the protection and measuring systems adopted. Revenue metering is required.
16.1.6.10 Current transformers are not shown in the attached one line diagram. The number and rating of the current transformer shall meet the required protection and measuring systems, including revenue metering.

16.1.6.11 Manual permissive switch shall be mounted in the main control panel and will be incorporated in the 33KV circuit breaker close circuit to insure that all check outs with the Grid authority was complete.

16.1.7 Generator Circuit Breaker (GCB)
Generator Circuit Breaker (GCB) shall be provided connected between the generator and the GTT (see drawing GX0-E00-K00001-MP). The following equipment shall be include in the GCB:
- Withdrawable circuit breaker (CB), or circuit breaker in series with disconnector
- Earthing switches on both sides of CB
- Potential transformers on both sides of CB, as needed for protection and metering
- Surge arrester and surge capacitor
- Current transformers – not shown in the drawing – as required for protection and metering
- Tap connection to Unit Auxiliary Transformer (UAT)
The GCB shall correspond to IEEE Std C37.013A

16.1.8 Main Transformer
The transformer shall be three phase, two separate winding, oil immersed.
The high voltage and low voltage side shall be equipped with suitable bushings for "plug-in" cable connectors.
The transformer shall be equipped with protective and monitoring devices, current transformers, as required.
The transformer shall be equipped with two tap changers:
- Off load tap changer - for operation in different grids (22 or 33 KV)
- On load tap changer - for voltage regulation.

Transformer data
<table>
<thead>
<tr>
<th>Basic standard</th>
<th>IEC 60076</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Power</td>
<td>will be finalized by Contractor</td>
</tr>
<tr>
<td>Rated Power is defined for the following temperature conditions</td>
<td></td>
</tr>
<tr>
<td>- Average winding temperature rise:</td>
<td>55°C</td>
</tr>
<tr>
<td>- Maximum top oil temperature rise:</td>
<td>50°C</td>
</tr>
<tr>
<td>- Maximum temperature of the cooling air:</td>
<td>See Par.9.3</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Voltage Ratio at no load voltage</td>
<td>33-22/Ug KV (Ug- generator nominal Voltage)</td>
</tr>
</tbody>
</table>

Impedance Voltage ~10% (see par 16.1)
Vector Group YNd-11
Winding Material Copper
Cooling method ONAN/ONAF
Insulation Level – HV Side and Neutral
(Bushing/Winding):
Lightning Impulse Withstand Voltage 170/170 KV peak
Power Frequency Withstand Voltage 70/70 KV rms
Insulation Level – LV Side Highest level of Lightning Impulse for Ug shall be chosen acc. to IEC 60076.

H.V bushings Suitable for "plug-in" connectors
Neutral bushing Suitable for "plug-in" connectors
L.V bushings Suitable for "plug-in" connectors
High voltage neutral grounding Isolated or solid or Petersen coil

Auxiliary power sources 400 VAC (±10%), 50Hz, 3 phase
Service conditions as specified
External connection
HV line side to 33 KV GIS through cables
LV side to Generator circuit breaker through cables

Current Transformers as needed

Accessories
Oil Level Indicator including dry contacts
Pressure Relief Device including dry contacts
Local Dial Type Contact thermometer including dry contacts
Winding Temperature Indicator including dry contacts
Buchholz relay

Tap Changers
Off load: for high voltage switching to 22 KV or 33 KV,
On load: +/- 16 taps. The range of the tap will be finalized later.

Automatic Voltage Regulator
Is required mounted on the trailer

Special requirements
Maximum temperature of the cooling air see See Par.9.3. All accessories shall comply with above air temperature.
Continuous overexcitation capability 110%.
The transformer shall be hard mounted on trailer.
Oil pit shall be provided on the trailer under the transformer.
The volume of the oil pit shall be equal to 110% of the transformer oil volume at least. The pit dimensions shall extend over the transformer by 1 m in each side.
The pit shall be made of steel and may be partly removable for transportation, if shipping dimensions are exceeded.

Tests
Routing tests according IEC 60076
16.1.9 **Auxiliary Transformer**

**General.**
The transformer shall be three phase, two separate winding, oil immersed or dry type with outdoor housing, ONAN cooling.
The transformer shall be equipped with protective and monitoring devices, current transformers, as required, and off-load tap changer.

**Transformer data**
- **Basic standard**: IEC 60076
- **Rated Power**: By Contractor, as required for GTs auxiliaries
- **Frequency**: 50 Hz
- **Voltage Ratio at no Load**: Ug/0.42 KV (Ug - generator nominal voltage)
- **Impedance Voltage**: Typical value in accordance to the rated power
- **Vector Group**: Dyn-1
- **Cooling**: ONAN
- **Insulation Level – HV Side**: Highest level of Lightning Impulse for Ug shall be chosen acc. to IEC 60076.

**Service conditions**
- **External connection:**
  - **HV Side**: to Generator leads through cables
  - **LV Side**: to 0.4 KV switchgear through cables
- **Current Transformers**: as necessary

**Accessories**
- **Manufacturer standard**

**Tap Changer**
- **Type**: Off-Load,
  - Minimum range +/- 5%,

**Special requirements**
- **Maximum temperature of the cooling air**: See Par.9.3. All accessories shall comply with above air temperature.
- **Continuous overexcitation capability**: 110%.
- The transformer shall be hard mounted on trailer.
- If oil immersed transformer will be used, oil pit shall be provided on the trailer under the transformer for at least 110% of the transformer oil volume. The pit dimensions shall extend over the transformer by 1 m in each side. The pit shall be made of steel and may be partly removable for transportation if shipping dimensions are exceeded.

16.1.10 **Grounding**
All internal grounding of the mobile units shall be permanent and brought out to the grounding pads located on the trailer base. Each mobile unit shall be provided with 2 grounding pads at least. External grounding to the pads will be provided by the Purchaser.

16.1.11 MV Cable connections

The contractor shall provide MV cable connections between the supplied equipments and between the mobile GT and the Purchaser MV grid. The cable shall be copper, single core, screened, unarmored. Removable connections shall be provided by flexible cables. The cable size shall be calculated for ambient air temperature as indicated in See Par.9.3. Each cable shall be furnished with MV cable termination for fast connection. Mechanical protection of the cables shall be provided (cable trays, pipes, etc.)

16.1.11.1 Connection GT – GCB.
Permanent connection rated to the generator voltage. Manufacturer standard.

16.1.11.2 Connection GCB – Main Transformer.
Removable connection rated to the generator voltage. Flexible cable with Plug-in terminations on both ends. Cables shall be rolled on drums installed on GCB or Transformer Trailer. Minimum connection length 50 m.

16.1.11.3 Connection GTT – 33KV SWGR.
Permanent connection 30 (45) KV rated. Flexible Cable with Plug-in terminations on both ends.

16.1.11.4 Connection 33KV SWGR – Grid.
Removable connection 30 (45) KV rated. Flexible Cables. Plug-in terminations on 33KV SWGR side. Heat shrinkable terminations on the Grid side. Cable shall be rolled on drums installed on SWGR Trailer. Minimum connection length 100 m.

16.1.12 Synchronizing System
The Synchronizing System is intended to be used to automatically or manually synchronize the unit generator to the system. Supervising of the “paralleling” condition for the Generator circuit breaker shall be provided. The Synchronizing System will be used in AUTO – operating mode or in MANUAL – operating mode.
16.1.13 Unit electrical metering system shall include Electrical power transducers and modern meters. The metering shall be equipped with all necessary items and shall be completely wired and tested, including Flexitest switches, for current and voltage circuits and all the necessary AC/DC MCB’s equipped with tripping and signal auxiliary contacts. Current transformers for metering shall be class 0.2S. Voltage transformers for metering shall be class 0.5.

16.1.14 Unit Protection System

16.1.14.1 The Contractor shall provide a completely integrated system of fully redundant numerical protection equipment for the Generator, Gas Turbine Transformer (GTT) and Auxiliary Transformer (UAT).

The unit protection system shall comprise exclusively relays of modular design, numerical type and shall be supplied in Vendor's Standard cubicles. Bidder shall state clearly in the proposal the kind and model of the protective relays.

16.1.14.2 Unless otherwise specified, all equipment shall be designed, constructed and tested in accordance the requirements of the latest relevant published IEC standards and the following IEEE Standards:


16.1.14.3 The generator protection functions shall be subdivided into two groups, being independent and each of them capable of providing uninterrupted protection even in the case of one of the protection’s group failure (Redundant Generator Protections). Each of the two protection groups shall have its own independent auxiliary supply. Redundant digital relay panels may be provided.

In addition to the software programming facilities, a tripping matrix (if applicable) can be provided for collecting the external tripping commands and transfer them to the two tripping coils of the circuit breakers.

16.1.14.4 The Unit Protection System shall be suitable for direct connection to the generator and line circuit breaker’s tripping coils (two coils in each). The tripping logic shall also accept signals from external functions such as: Bucholz relay, pressure relief device of the transformers, GTT online tape changer, temperature devices, status of the circuit breakers, operating control unit, etc.
A lockout (to avoid re-energizing of equipment prior to resetting the protection) will be provided by a separate relay with manual reset. According to the equipment, the protection functions have to be latched separately for generator, GTT and UAT.

16.1.14.5 The Unit Protection System shall be set and controlled with the aid of a Personal Computer, with a suitable interface program system, via a serial or other interface. This shall be done locally by a PC (All necessary software for the calibrations shall be supplied).

16.1.14.6 The tripping signals for every protection function shall be freely allocated by software (or in a hardware matrix) to the individual channel of the tripping units. The tripping signal outputs should be sufficient in order to permit transmission of the protection function trip signal to different systems. Facilities for all trip circuit supervision arrangement, in conjunction to the tripping units, shall be provided.

The output signals tripping Generator Circuit Breaker, M.V Circuit Breaker, etc. shall be with voltage rating contact according to Bidder practice.

16.1.14.7 The Unit Protection shall provide all the functions required for the protection of the Generator, the Gas Turbine Transformer and Auxiliary Transformer. These functions shall be selectable from the library and provided completely in two independent protection systems. The functions will be provided according to the agreed gas turbine electrical one-line diagram and shall include, but not limited to the followings. The protection functions will be finalized during the technical negotiations.

a. Generator

<table>
<thead>
<tr>
<th>Protection Function</th>
<th>ANSI Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator differential</td>
<td>87G</td>
</tr>
<tr>
<td>Stator earth fault 95%</td>
<td>59N</td>
</tr>
<tr>
<td>Stator earth fault 100%</td>
<td>64</td>
</tr>
<tr>
<td>Under-voltage</td>
<td>27</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>59</td>
</tr>
<tr>
<td>Negative Sequence Protection</td>
<td>46 (two stages)</td>
</tr>
<tr>
<td>Loss of field (under-excitation)</td>
<td>40 (two stages)</td>
</tr>
<tr>
<td>Reverse Power (double)</td>
<td>32</td>
</tr>
<tr>
<td>Time over-current with voltage restraint</td>
<td>51V</td>
</tr>
<tr>
<td>Generator C.B. Breaker Failure Protection</td>
<td>(50/62 BF)</td>
</tr>
</tbody>
</table>
THE ISRAEL ELECTRIC CORPORATION LTD.
Engineering Division
P.O.B. 10, Haifa, 31000

ANNEXURE “B”
SPEC.: MG-1002
ISSUE: Request for Proposal

Dead machine                                                              50RE
Under/Over frequency protection                                          81

b. **Gas Turbine Transformer Protection (GTT):**

Transformer differential protection:                                    87T
Backup Ground Fault Protection:                                          51TN (on HV side)
Backup Ground Fault Protection:                                          59BNG (on IPB)
Over-current of HV side                                                  50/51,


c. **Unit Auxiliary Transformer Protection (UAT):**

Phase instantaneous over-current Protection:                            50AT
Phase over-current protection                                            51AT
Ground over-current instantaneous                                       50G
Ground over-current protection                                            51N

All the protection elements provided with the transformers should be connected to suitable tripping relays or circuits to provide the intended protection, and their alarm signals should be connected to the Gas Turbine Control and Monitoring System.

d. **Overall Protection**

Over-excitation                                                           59/81
Minimum impedance                                                         21
Overall (generator and Transformers differential)                         87U

Additional protection functions will be provided by the Contractor, if necessary. The relays shall incorporate all the protection functions specified, a variable programmable tripping logic, supervisions, signaling, and testing facilities as well as memory functions and transient event recording functions.

16.1.14.8 A detailed description of the Unit Protection System, including equipment characteristics and principal connection diagram shall be provided for Purchaser’s approval.
16.1.14.9 The digital protection system shall be provided with a built-in testing facility (password protected), capable of testing the protection circuits from the terminal of the measuring to the output tripping coils. The following tests shall be provided, as software test function features, by means of Human-Machine Interface:
- Test of the protection functions
- Test of the tripping outputs
- Test of the signaling outputs
In addition to the software test functions, facilities for secondary injection testing shall be provided (testing of the protection function behavior at simulated fault conditions).

16.1.14.10 The protection system shall be provided with communication capability which will allow in the future (not included in this scope of supply) the exchange of parameters, signals, measured values as well as remote parameter regulation commands via appropriate interfaces and serial communication channel to central process control equipment. The protection system communication shall comply with IEC-61850 protocol.

16.1.14.11 Setting of the unit protections and relay setting shall be sent to Purchaser for approval before FAT. The finalized settings and software logic shall be sent to field before SAT.

16.1.15 Loss of Mains Relay
A numerical relay will be provided for the case when the unit is running in parallel with a mains supply. The Bidder will state in his proposal the operation principle used in the proposed LOM relay. At least two different operation principles shall be offered. The solution will be discussed with IEC representatives.

16.1.16 Protection of 33KV switchgear for grid connection.
MV protection unit shall be a multi-function numeric device which support different protection functions, control, metering and communication features. It will be provided with an interface for the Fiber Optic data communication TCP/IP Station-bus with IEC-61850 protocol. The relay shall perform continuous self-monitoring and self-testing of hardware and software. In case of hardware fault the relay will be blocked and an alarm will be issued. In case of software fault the relay shall reset and restart. If the fault persists, the relay shall be blocked. The protective relay will include programmable logic scheme.
Setting of MV protective relay shall be selectable according to the grid rated voltage.

16.1.16.1 The protection unit shall include the following functions:
   a. Over-current time protection against phase to phase faults with time delay units and instantaneous units.
   b. Residual over-current protection instantaneous unit and time delayed unit against earth faults in a solidly grounded operation mode. Enabling of the protection will be done during the solidly grounded operation mode by means of an auxiliary contact of the transformer neutral point earthing switch.
   c. Sensitive directional earth fault (Wattmetric) protection - when in Peterson coil earthed operation mode. A separate core of the current transformer will supply the residual current. A voltage transformer will supply the zero sequence voltage (open delta). Setting of MV protective relay shall be selectable according to the grid rated voltage.
   d. CB breaker failure protection.

16.1.16.2 Loss of system earthing
The neutral point of GT mobile transformer shall be equipped with earthing switch for direct earthing or a Petersen coil. Any combination is possible. The protective relay will be equipped with the means to consider it in the logic for detection a "loss of earthing" for "unacceptable state of earhting system" and for "Leakage relay and wattmetric relay function".

16.1.16.3 Unacceptable state of earthing system
Mixed mode operation of solidly earth and Petersen coil earthed neutral points of GTT transformer in the electrically connected part is an unacceptable state of earthing system.
If an unacceptable state of earthing system is detected an alarm is issue to the local control room by an output dry contact signal from MV protective relay.

16.1.17 Revenue meters shall be supplied (ION-8800 or equivalent) to be connected on Gas Turbine Transformer output side. The energy measuring shall be performed in four (4) quadrants energy. Output dry contact shall be rated for 250VDC. The revenue meters shall be equipped also with communication protocol using MODBUS protocol.

16.1.18 Gas Turbine DC Systems
The contractor shall supply an adequate DC system needed to ensure personnel safety and to protect against:
- equipment damage during all normal operation modes of the Gas Turbine Unit -
during an emergency unit trip and/or loss of all outside power sources and to allow reliable operation of the Gas Turbine control system.
The DC System shall include Batteries, redundant chargers, and DC distribution panels.

16.1.19 Cables
The contractor shall supply all the electrical power, control, instrumentation cables needed to interconnect all contractor supplied systems on and between the trailers. The Contractor shall supply all the cable trays and conduits for cables. All the cabling system shall be supplied to be able connect different electrical and electromechanical systems quickly (plugin).

16.1.20 Lighting
The Contractor shall furnish the interior lighting (AC) in all enclosures, and in all panels including electrical equipment. The Contractor shall also furnish an external lighting (AC) on the trailers.
Emergency DC lighting shall be provided in the enclosures as required for safety of the personnel. A separate DC circuit from the storage battery for emergency lighting shall be provided. Emergency lighting may have self-contained battery packs.

16.1.21 0.4 kV Low Voltage Switchgears & MCC
The 0.4KV Low Voltage Switchgear & MCC shall be fed from the Unit Auxiliary transformer or Diesel Generator (EDG) or external power supply (in storage) see the one line diagram GX0-E00-K00001-MP.
Rated Operational Voltage (Ue)..................400 V
Rated Frequency ........................................50 Hz
All the proposed equipment of the Load Voltage Switchgears / MCC's shall comply with well known international standards (typically IEC-60439 or equivalent) and will be designed for the specified ambient conditions existing on site.
Automatic transfer shall be provided between UAT and EDG incomers, as necessary. The circuit breaker of the external supply shall be manual operated. Interlocks between the incomers shall provided.
16.1.22. **UPS System**
The UPS System shall provide a reliable, regulated, transient free supply of 230VAC, 50HZ, under normal or abnormal conditions for critical consumers as/if needed for control, measuring circuits, critical instruments, computers, fire protection panels and etc.

16.1.23. **Black Start Diesel generator (EDG)**
The Gas Turbine Unit is required to have the capability of black start, meaning starting the Unit without any external source of power, when operating isolated from the grid, on dead bus mode of operation.
The black start capability shall be achieved by using a Diesel generator (EDG) (contractor scope of supply) whose output voltage shall be connected to the 0.4KV auxiliary bus (see one line diagram GX0-E00-K00001-MP). The size of the EDG shall be calculated by the Contractor, according to the Unit load demand on starting and/or other relevant operation modes. The EDG shall be trailer mounted and shall include all the auxiliary systems to ensure its proper operation, including on base daily fuel oil tank.

16.2 **CONTROL**

16.2.1 Contractor shall provide the Gas Turbine Generator Unit with a complete and functional PLC/32 bit microprocessor based digital control system, including: sequencing, control, fuel control, protection and operator information for orderly and safe startup of the gas turbine, generator and auxiliaries control of proper loading and orderly shutdown procedures Gas Turbine Control and Monitoring System. It shall include an emergency shutdown capability which can be operated automatically, by suitable failure detectors, or manually. All the necessary interlocks and equipment for a safe shutdown procedure in abnormal conditions shall be included.

The Contractor shall provide the full description of his proposed system. The Contractor shall provide the full description of his proposed system. Contractor shall take care that the control and monitoring of all unit auxiliary electrical and/or electromechanical systems is integrated in the above Gas Turbine Control and Monitoring System. "Fire Detection and Extinguishing Systems" supplied by the Contractor for the Gas Turbine unit shall be interfaced with the Gas Turbine Control and Monitoring System. See "Fire detection" chapter.
16.2.2 **Mode of operation of the Gas Turbine Unit:**
GT shall be designed to be started, operated and connected through Generator Circuit breaker, Gas Turbine Transformer and 33KV SF6 switchgear to the grid:

a. in parallel (droop), synchronized with 22 or 33kV transmission system of the electric utility.
b. in dead bus condition, isolated from the 22 or 33KV transmission system mains.

16.2.3 **Starting, loading and shutdown:**
The unit shall have sequencing control systems, actuated by the operation of a single "start-up" button, which will automatically start, synchronize, and load the units to a pre-selected load level. The unit can be stopped by the operation of a stop pushbutton. The sequencing control system will ensure the safe shut down of the unit. The generating unit shall be capable of complete manual operation, including all auxiliaries and all phases of starting, warm-up, synchronizing, loading, unloading and stopping.

16.2.4 The control instrumentation layout shall enable a single operator to perform all the operations necessary to start, operate and shutdown the machine. The indications provided on the local control panel shall enable the operator to completely assess the behavior of each individual section of the gas turbine equipment and take appropriate action in the event of a fault condition arising.

16.2.5 Wherever hazardous location exists, electrical equipment and instrumentation shall be complying with the relevant standards.

16.2.6 The unit shall be ready to start at anytime, and to be loaded to any preset level, manually and/or automatically, from cold start condition.

16.2.7 The Contractor shall describe on a continuous time base the necessary periods of time for the unit to start from cold position to full speed no load and from synchronizing to full load.

16.2.8 The Contractor shall give the equivalent hours per each start for maintenance and overhaul purposes.

16.2.9 The Units shall be provided with all necessary control switches like Operating Mode Programming Switch, Start/Stop, Auto-Manual switch, Normal-Fast switch, etc., and back indication lights for sure operation of the Gas Turbine.

16.2.10 Normal shutdown shall follow an orderly safe, step by step procedure based upon the requirement of the machine. This shall be achieved by manual or automatic means. Means shall be provided to permit restart.
Restart will be dependent on the method of shutdown and whether AC power has been available at all times.

16.2.11 Emergency shutdown must be enabled in manual operation and must also occur automatically as a result of automatic operation of plant protection devices. The system must activate the fuel shut off valve to cut off the engine fuel supply. Means shall be provided to prevent restart without corrective action.

16.2.12 Automatic means shall be provided for isolating the generator from the system upon shutdown, in order to prevent motoring or reverse flow.

16.2.13 **Fuel control**

16.2.13.1 The fuel control system will in general be required to regulate either the turbine speed or the exhaust gas temperature from initial light-off to maximum conditions as well all accelerations, decelerations, speed control, load control.

16.2.13.2 The fuel control shall be able to manage liquid fuel.

16.2.13.3 The flow of fuel to the combustion chambers shall be determined by the setting of a fuel valve controlled by the governing, or fuel control system. The fuel system shall incorporate a high pressure fuel shut-off valve to admit or shut off fuel to the engine. The response speed of the governor system shall be such that the transient over-speed of the machine, on sudden and complete loss of maximum load coincident with loss of governing, shall remain within safe operating limits.

16.2.13.4 The rate of increase in fuel flow shall be regulated according to the compressor - combustion chambers characteristics to prevent surging, stalling, over-speed, or excess temperature due to over-fueling during acceleration.

16.2.13.5 Flam out should not occur at any load.

16.2.13.6 The governors shall operate without causing the turbine to race or hunt under any conditions of load from no load to maximum load.

16.2.13.7 The speed governing system shall be capable of isochronous speed control and in droop control.

16.2.13.8 The stability of speed governing and fuel control system shall be required between zero and maximum load while the turbine is operated in parallel with others or isolated. The Contractor shall state the stability limits. The governor systems together with other gas turbine characteristics shall prevent the gas turbine from reaching the turbine trip speed with an instantaneous loss of load up to rated load.

16.2.14 **Protection systems**

16.2.14.1 Over-speed - The rotor assembly shall be adequately protected against accidental over-speed which may arise following sudden removal of maximum load or failure of the control. For maximum system reliability, two separate pick-
up and shut down circuits shall be used. Such protection shall not require the existence of an external source of supply.

The main function of over-speed trip function shall be the cut off of fuel by means independent from the main governor.

Redundant electronic over-speed trip functions shall be supplied. Under-speed protection shall also be considered.

16.2.14.2 Fuel shut off - In addition to the fuel governor valve the fuel control system shall include a separate fast acting shut off valve or "stop valve" which stops all fuel flow to the GT on any shut down condition and which will not open until all permissive firing conditions are satisfied. The risk of fuel flow to the turbine into the GT after shutdown shall be minimized by means such as use of vent valves or redundant positive shut off valves.

16.2.14.3 Fire Protection Microprocessor based, dedicated equipment shall be provided for fire sensing and extinguishing in gas turbine area, and in all containers including electrical equipment. Time delay shall be used to delay the release of atmosphere friendly extinguishing agent to facilitate personnel evacuation.

16.2.14.4 In case of flame failure the fuel should be shut off.

16.2.14.5 Particular attention shall be given to ensuring that dangerous conditions cannot arise in the event of partial, or complete, failure of the control equipment. In general control and controlled devices should move to the safest operating conditions.

16.2.14.6 Necessary measures have to be taken for safe shutdown and slow roll cooling.

16.2.14.7 Alarm and shutdown system - The control system shall include a sensing alarm, shut down and screen display system (HMI) for conditions which could lead to damage or reduced life of the gas turbine or generator. An audible alarm shall be provided actuated by the alarmed shutdown system. An outdoor horn shall be also supplied. When the alarm function is specified in addition to the shutdown function, the alarm may be set to precede the shutdown so that corrective action may be taken by local operator. The HMI system shall clearly indicate which function caused the shutdown with a time stamp up to 10 msec. Critical, shut-down signals shall be collected through a "sequence of Recorder" system and displayed with a time stamp up to 1 msec. All alarm and statuses shall be printed.

16.3 A "Global Positioning System" (GPS) shall be provided by the Contractor and shall include at least an antenna, a receiver and a distribution box. The system shall include an "IRIG-B" protocol for clock synchronization of all control, protection units and data acquisition systems supplied under this Specification.
IRIG-B interface card shall be provided for all digital, control and computerize systems supplied by the contractor. GPS time signal shall be connected from the GPS distribution box.

17. **FIRE PROTECTION REQUIREMENTS**

See Supplement 5.1.7.

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