



**CEYLON ELECTRICITY BOARD
SRI LANKA**

INTERNATIONAL COMPETITIVE BIDDING (ICB)

**BID DOCUMENT
FOR
KELANITISSA GAS TURBINE PROJECT**

BID NO.: CEB/KGTP/PROC/01/Re

VOLUME 2 of 5

April 2021

Information Copy - Not for Bidding

**BID DOCUMENT
FOR
KELANITISSA GAS TURBINE PROJECT**

CEYLON ELECTRICITY BOARD

Volume 2

**Scope of work, Quality Assurance and
Testing**

FOR

**KELANITISSA GAS TURBINE
PROJECT**

BID NO: CEB/KGTP/PROC/01/Re

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1 Project Description

1.1 General

It is the intention of Ceylon Electricity Board, CEB, (hereinafter referred to as — The Employer); to install three (03) identical gas turbines having total net output in the range of 105MW to 130MW at maximum site ambient conditions in Kelanitissa Power Station.

The Project is named “**Kelanitissa Gas Turbine Project**”, (hereinafter referred to as — The Plant).

The gas turbines shall be connected to the transmission system via three nos of 132kV GIS bays at Kelanitissa 132kV Grid Substation, by means of necessary switchgear and two step-up transformers as appropriate. The gas turbines shall be able to operate on Dual fuel; Lanka Auto Diesel (LAD) and Re-gasified natural gas (RLNG). The plant will be located at Kelanitissa Power Station premises close to the city of Colombo. The intension of adding this plant to the CEB grid is

- a. to restoration of power to Colombo city and suburbs in a total power failure situation within a very short time by operating the plant.
- b. to operates as a system peaking power plant and it shall also be capable of operating as a base load power plant.
- d. to operate as the primary/secondary frequency controlling plant of the system, when it requires.

The given net output power of 105MW to 130MW should be for Liquid Fuel (LAD).

The Plant shall be carried out in accordance with the requirements of the Contract and this Specification, which provides for the design, manufacture, factory testing, supply, delivery, off loading at site, installation & commissioning , site testing, setting to work and attending to defects, compliance with local and national consents, regulations, standards and legislation on a turnkey lump sum contract basis, including all related civil works, and such other works as the Employer may require, for the power station at the site (hereinafter referred to as — Site).

The Plant shall be new, modern, proven latest version and safe, and shall be designed for the highest availability factor, start reliability, efficiency and flexibility of starting, within an offer that is commercially attractive.

1.2 Role of Technical Specification

The role of the specification is to define the minimum functional requirements of the Plant and to provide site-specific data to the Contractor. The Specification also serves to define the environmental and regulatory constraints within which the Plant must operate and comply.

It is the intention of this specification to provide the Bidder the maximum freedom to provide the most competitive offer based on the Bidder's standard plant and equipment though with the design optimized for the particular scope of the project and taking the Employer's

requirements into account.

The Bidder shall furnish all technical details including a statement of work methods, equipment, personnel, schedule and any other information as stipulated in technical specification and guarantees and technical particulars, in sufficient detail to demonstrate the adequacy of the Bidders' proposal to meet the work requirements and the completion time. For major items of plant and services as listed by the Employer in guarantees and technical particulars, which the Bidder intends to purchase or subcontract, the Bidder shall give details of the name and nationality of the proposed Subcontractors, including manufacturers, for each of those items. In addition, the Bidder shall include in its bid information establishing compliance with the requirements specified by the Employer for these items. Bidders are free to list more than one Subcontractor/Manufacturer against each item of the plant and services in the Technical Schedules. If more than one subcontractor/Manufacturer is offered by the Bidder, Employer shall have the right to select the preferred service provider or make/brand out of offered at the signing of the Contract Agreement. Quoted rates and prices will be deemed to apply to whichever Subcontractor is selected by the employer, and no adjustment of the rates and prices will be permitted.

The Bidder shall be responsible for ensuring that any Subcontractor proposed complies with the requirements of Clause 4 and 5 of Section 1.2 of Volume 01.

2 Scope of work of the Plant

2.1 Summary of scope

The scope of work includes the design, manufacture, supply, workshop testing, transporting, construction, installation, commissioning, training, acceptance testing, warranty provisions and repair during the defect liability period and all work incidental thereto whether specified in detail or not, necessary for the safe and efficient operation of the Plant.

Generally, the main supply shall include, but not be limited to, the following:

- i. Three (03) identical gas turbines having total net capacity of 105MW to 130MW at site conditions (30°C, 1.013 bar, 80 % relative humidity) complete with all necessary auxiliaries.
- ii. The gas turbines shall be capable of operating on dual fuel (LAD and RLNG). The gas turbines shall have combustion system with Wet Low Emission (WLE) to meet the environment standards in Sri Lanka for both fuels.
- iii. Synchronous, 3 Phase, 50 Hz, 0.80 power factor generators with adequate capacity, driven by the gas turbine and complete with all auxiliaries, having following capabilities;
 - a. complete with Static type Generator Excitation system having fast voltage response
 - b. capable of absorbing charging currents of feeder cables while restoration of Colombo city and suburb power supply following a system failure (Isochronous mode)
 - c. soft start excitation (dead bus) capability when black starting
- iv. Grid frequency control facility combining all these generators and sharing the load by setting a joint load reference set point.
- v. Interconnection to National System Control Center (NSCC) through existing SCADA gateway for plant monitoring and control purposes.
- vi. Respond to NSCC Automatic Generation Control (AGC) commands to support grid frequency controlling.
- vii. All necessary Medium Voltage (MV) Switchgear including Generator Circuit Breakers with synchronizing capability.
- viii. Identical three Generator step-up transformers with Onload Tap Changing facility and Automatic Voltage Controlling (AVR) facility, connected to three bays of 132 kV GIS at Kelanitissa
- ix. Interconnection to the three 132kV GIS bays at Kelanitissa Grid Substation
- x. All necessary auxiliary systems shall include, but not limited to, the following:
 - a. Lanka Auto Diesel (LAD) conditioning equipment (Fuel Oil Treatment Plant) including all pumps, filters and etc.,
 - b. RLNG equipment including compressors, regulators, coolers, pumps etc.
 - c. Water treatment plant for inlet air chilling and water injection to the gas turbine required for NOx controlling.

- d. Inlet air chilling system (if required).
 - e. Off line and/or Online compressor washing systems.
 - f. Lubricating oil system including all pumps, filters, heaters, Coolers.
- x. Specific Systems required remaining Gas Turbine units at full Speed No Load condition after full load rejection or 132kV grid breaker opening due to a full or partial system failure.
- xi. Ventilation and air conditioning
- xii. Fire detection and protection system suitable for gas turbines operating with Diesel and RLNG, generators, transformers, Central control room, control cubicles, switchgear buildings/cubicles, Standby diesel generator for emergency & Black start situation,
- xiii. Compressed air system for instrumentation.
- xiv. Tools and equipment for maintenance, including special tools, suitable for all routine maintenance and major overhauls.
- xv. Exhaust stacks exhaust gas online monitoring system to satisfy environmental regulations in Sri Lanka
- xvi. Auxiliary transformers to allow the plant to supply its auxiliaries connected to a common bus.
- xvii. All necessary auxiliary electrical systems including, but not limited to, the following:
- a. Switchgear
 - b. LV and DC auxiliary supplies systems
 - c. Batteries, chargers and uninterruptible power supplies (UPS)
 - d. Standby diesel generator for emergency & Black start situation
 - e. Earthing and lightning protection system
 - f. Protective relays
 - g. Lighting and small power installation system for entire plant.
- xviii. An integrated Distributed Control System including all necessary control, local/remote monitoring and emergency shutdown/protection systems, instrumentation and individual metering for the gas turbine/generators, common services, electrical systems and all auxiliary equipment, central control room facilities, GPS station clock system, Data logging and retrieval system.
- xix. All civil and structural works associated with the above equipment including, but not limited to, the following:
- a. Any confirmatory site topographical surveys required
 - b. Any confirmatory site investigations required (geotechnical, meteorological, soil resistivity).
 - c. Data collection (including verification of design data provided in the Specification including transmission system technical data).

- d. Removal of abundant switchyard structures and foundations.
 - e. Demolition of existing Canteen building construction of a new building for canteen
 - f. Site clearing and preparation, including removal/treatment/avoidance of subterranean obstacles, local leveling, filling, retaining walls and grading to finished site levels.
 - g. Foundations and associated work, including gas turbine, generators, transformers and auxiliary equipment etc.
 - h. Auxiliary transformer foundations, steelwork, ground works, slabs, firewalls and finishing works
 - i. Central Control Room (CCR) including Engineering Station
 - j. Electrical switchgear and control equipment compartment
 - k. Pipe and cable bridges/racks, service ways, ducts and trenches
 - l. LAD and RLNG supply pipelines as necessary
 - m. Galleries, staircases and landings for access to the Plant
 - n. Ancillary and temporary buildings (including offices for the Contractor and the Employer)
 - o. Roads and paved areas – access/maintenance ways from existing roads to plant areas.
 - p. Storm water drainage, effluent collection and reticulation system
 - q. Fencing and gates
 - r. Site lighting
 - s. Site finishing works
- xxi. Temporary fencing, lighting and guarding and all other materials and services necessary for the safety and security of persons and property at the Site or such other areas used for storage during construction;
 - xxii. All consumables (including lubricants, chemicals, filters etc. though not including fuel) necessary to complete the Plant and operate the Plant, until taking over the plant.
 - xxiii. Special Tools as described in this Specification
 - xxiv. Factory testing, commissioning, Tests at Completion and Acceptance Testing and performance testing
 - xxv. Commissioning of the plant for both fuels (LAD and RLNG). If RLNG is not available before the date of handing over, commissioning of the plant for RLNG need to be agreed by the parties to perform when RLNG is available at the site.
 - xxvi. Design, procurement, transportation, engineering and project management services
 - xxvii. All plans, approvals, permits, authorizations, licenses etc. in order to complete the Plant and any costs associated with such approvals, etc., except as noted under Regulatory Approvals herein. The Contractor shall be responsible for submitting

- all statutory and design code calculations for third party verification, and obtaining such approvals as required.
- xxviii. Comprehensive training of Employer's operations and maintenance (O&M) personnel.
 - xxix. As-built drawings and comprehensive, fully cross-referenced O&M manuals
 - xxx. Warranty as described in the Contract.
 - xxxi. Provide services of qualified Resident Warranty and Service Engineer during the defect liability period to assist the local engineers to ensure the smooth operation and maintenance of the Plant by assisting for troubleshooting any defect, undertaking overhauls and major repairs etc.

The Contractor's scope of supply shall include all equipment and services required for a fully functional plant within the limits of this Contract. 'Fully Functional' thereby means that, additional services beyond those listed in this section shall be provided by the Contractor, in as far as – they are implicitly part of the plant and equipment listed in this section. They are necessarily required to make listed equipment or services functional for the intended use in the proposed power plant. They are required for the plant to meet Contractual Guarantees. They are required for the plant to meet national, local codes, standards and Regulations as defined and specific requirements as imposed by local authorities.

2.2 Terminal points

Each gas turbine shall operate as a stand-alone power plant with its own independent systems to ensure security of supply.

The power plant shall have the following interfaces:

- 132kV interface to the three Generator Bases in the 132kV GIS in Kelanitissa.
- LAD interface to the existing LAD header in the existing fuel tank farm of Kelanitissa Power Station
- RLNG interface to the proposed RLNG header (outside the scope of this project)
- Remote control and monitoring interface to CEB SCADA system
- Communication link with National System Control Center (NSCC)
- Water requirement for the plant from the existing river water channel of necessary Kelanitissa Power Station
- Plant access road from existing road to the plant

2.2.1 Terminal point design, management and coordination

The Contractor shall be responsible for the design of all its terminal points and the complete management of all its interfaces.

To ensure adequate coordination, the Contractor shall arrange a dedicated interface meeting with the Employer and all other interested parties as soon as possible after the contract is awarded, but not later than three weeks after Commencement Date of the contract. At this meeting all terminal point locations, design parameters and physical tie-in responsibilities shall

be determined and agreed in writing. The contractor is required to submit its understanding of the terminal points as mentioned in the bid.

2.3 Provision of services during construction

The Employer shall perform or provide the following services to agreed quantities:

1. LAD/RLNG for plant commissioning and testing purposes only.
2. CEB shall provide employers' operation and maintenance staff to gain familiarity with the installation but the Contractor shall remain fully responsible for safe Operation of all equipment in his supply during the commissioning periods, and until the taking over certificate is issued.

Electricity supplies for construction will have to be obtained from CEB at the contractor's cost on submission of an application. If the contractor needs a reliable supply, he may opt to use on his own supply. Town water is not available at site but contractor shall obtain a town water supply from National Water Supply and Drainage Board of Sri Lanka, at the contractor's cost.

2.4 Quality of water for concrete production and potable water

It shall be the Contractor's responsibility to obtain and treat all water required to ensure it is suitable for concrete production and for use in as potable water.

2.5 Regulatory approvals

The Employer has obtained the environment clearance from Central Environment Authority (CEA) of Sri Lanka for the installation of new gas turbines. Contractor shall comply with the laid down conditions in the clearance. Requirements of the Central Environment Authority (CEA) is attached as Appendix D.

This Specification has been written to capture the intent of all conditions imposed by the environmental clearance by CEA whilst reserving the Employer's desire to achieve flexibility for the site as a whole. However, the Contractor shall comply with the relevant requirements arising due to environment regulations of Sri Lanka.

The Contractor shall be responsible for securing all permits, approvals, licenses, certification etc. from relevant Institutions/Authorities, necessary to complete the Plant and the Employer shall assist the Contractor to secure approvals as the work progresses.

2.6 Codes and standards

The codes, standards and specifications referenced in this Specification shall include addenda and amendments in force at Notice to Proceed and shall govern in all cases where references to them are made. Other equivalent international standards may only be used with the written agreement of the Employer.

The Contractor shall comply with all Laws and Regulations of Sri Lanka. All apparatus and material supplied, and all work carried out and matters arising in fulfillment of the Contract shall conform, at the Contractor's expense, in all respects to all the laws and regulations, by-laws and requirements of national/local or other authorities which are applicable to the Plant.

Applicable Codes and Standards shall be those codes of practice, standards, guidelines and references that are:

- (i) pertinent, consistent and appropriate to the design, construction and/or testing of a particular element, or whole of, the facility, as appropriate, and
- (ii) published by the following:
International Standards Organization (ISO); and
International Electrotechnical Commission (IEC)
- (iii) Applicable organizations
- (iv) Professional bodies from countries such as US, France, UK, Germany and Japan whose codes and standards are recognized internationally, provided that the Company can demonstrate that such codes and standards are applicable, appropriate and equivalent to those published by the organizations listed under (i) and/or (ii) above.
- (v) Recognized professional bodies from Sri Lanka, provided that the Company can demonstrate that such codes and standards are applicable, appropriate, equivalent and no less stringent than those published by the organizations listed under (i), (ii) and (iii) above. Rules, Codes and Regulations issued by Public Utility Commission of Sri Lanka (PUCSL).

The Plant shall be designed, constructed, and commissioned in accordance with Local and International Standards. Where no appropriate Local Standard exists, an alternative Internationally Accepted Standard may be used, subject to the agreement of the Employer.

In the event that a conflict arises between codes and standards of practice nominated in the Contract, the more stringent criteria shall govern. Should the difference not be resolved on the criteria of stringency, the Employer shall decide which provision shall apply. The Contractor shall be obliged to comply with all such decisions without any variation to the Contract.

The Contractor shall not depart from the agreed Standards without the written acceptance of the Employer. The Contractor shall provide information regarding their proposed standards in response to this requirement.

All units of measurement and symbols shall conform to the Système international d'unités (SI units) for basic and derived units or names of units, unless otherwise agreed in writing by the Employer.

SI units shall be used in all correspondence, documentation, calculations, drawings, measurements etc. If reference has to be made to non-standard items, the SI units shall be quoted followed by the non-standard units in brackets.

3 Plant Design Criteria

3.1 General

The plant will generally be operated to meet the daily peak demand with frequent starts/stops but the plant shall be able to operate at base load with an expected availability factor not less than 95% throughout the 30-year expected life span. However, at times it will be required for flexible operation (partial load and isolated operation) and shall be designed accordingly.

The gas turbines shall have black start capability and shall be able to commencing island wide system restoration from Colombo in the event of a total system failure. The gas turbine plant must be capable of withstanding following conditions that are expected during a total failure restoration commencing from Kelanithissa.

- a. Ability to withstand momentarily high inrush currents following the initial closing of line circuit breakers and energizing the hitherto de-energized underground cable network.
- b. Ability to operate and maintain stability at sufficiently leading power factors to absorb reactive power expected to be generated along the standard total failure restoration route consisting of UG cables.
- c. ability to operate at low loads for extended times.
- d. Ability to withstand high load fluctuations that is expected during a total failure restoration when feeder breakers are closed. As the generator would be lightly loaded at the time, the per unit load variation is high and hence significant rate of change of frequencies (df/dt) could be experienced unless the generator has sufficient inertia or other control interventions.
- e. e. Ability to regulate frequency when operated in isolation and upon gradually synchronizing other generators to the system.

The Gas Turbine & Generator shall be capable of synchronizing within 12 minutes from the start command, to the CEB grid. Especially these gas turbines shall be able to control load frequency by combining all three generators and sharing the load by setting a joint load reference set point.

Each unit shall be specified to be capable of operating down to 50% of its base load rating within the guaranteed emission limits. This requirement is intended to ensure that the power plant can operate throughout the load profile within the environmental limits for the plant on LAD and RLNG. There shall be no limitation on starts up of the gas turbine subsequent to a tripping when there are no persisting faults (No lockout when there is no fault other than window for a critical speed during coasting).

The control system and auxiliary systems shall be designed and set up to ensure that all gas turbines shall remain on FSNL if GTs were on operation during system failure or in the event of the loss of the Kelanitissa 132 kV transmission grid. This is to ensure that all gas turbines

remain at FSNL to re-synchronize or close on dead bus when system control center demands. The plant shall comply with the Grid Code of Sri Lanka and electrical generators shall be capable of continuously supplying their rated output power at any point between the power factors of 0.8 lagging and 0.9 leading, in accordance with its performance and capability curve and a voltage variation of $\pm 5\%$ from rated voltage at the generator terminals. Each generator shall also be capable of supplying its rated output at rated voltage and rated power factor at a frequency which may vary between 47 Hz and 52 Hz.

The capacities of the generators, transformers and auxiliaries shall be selected in a way not to restrict maximum output of the gas turbine within specified all ambient conditions.

3.2 Availability criteria

The Plant shall be designed for an Equivalent Availability Factor (EAF) of not less than 95% as defined by IEEE 762-2006, assuming the allowances for Planned Outages is zero and Equivalent Seasonal Deratings are not considered.

The Plant shall be designed for a Starting Reliability (SR) of at least 99%. In this context, a successful start is achieved when a unit is started and reaches the required load within the time for that type of start (normal and fast).

The design shall incorporate adequate redundancy to achieve these goals by incorporating redundant equipment and components with automatic start-up of the standby item in the event of failure of the duty item.

3.3 Site and layout

The site for the Plant is located at Kelanitissa Power Station. The layout map of the site withing the Kelanitissa Power Station is shown on the Appendix G. The Contractor shall verify on site all dimensions and levels shown on the drawings and shall inform the Employer of any discrepancies.

The bidders are invited to offer its optimized standard design considering the indicative layout and the details given below:

- the existing plant and equipment
- the incoming road to the site

The final layout shall allow sufficient space for equipment accessibility and laydown during maintenance activities.

The plant shall be provided with adequate laydown areas with sufficient access for the mobile crane and aisle ways adjacent to equipment necessary for major maintenance and plant overhaul of the gas turbine generator units and auxiliary equipment etc. The Contractor shall provide general arrangement drawings clearly identifying the outline of all major plant equipment, their weights and associated floor loading capacity and lay down location.

The Contractor shall specify the heaviest maintenance lift equipment item and rating for

each mobile crane. The laydown areas for the GT generator units and auxiliary equipment shall have adequate room for direct heavy transport truck and trailer access and mobile crane access.

The Contractor shall provide general arrangement drawings to illustrate the Gas Turbine and Generator rotor withdrawal requirements. These areas are to be kept free and clear with no installed piping or electrical equipment.

The Contractor shall demonstrate in the layout plan and the design of systems how these goals have been achieved, to the Employer's satisfaction and agreement. The final layout shall be to the approval of the Employer.

3.4 Site conditions

The following information on local conditions is supplied by the Employer. The Contractor is hereby in no way relieved from his duties of carrying out the necessary investigations required to confirm satisfactory performance of his works.

The Site lies just outside the Colombo city limits in the tropical region. Ambient temperatures are in the range between 19.9°C(min) to 35.5°C(max).

The site average temperature is 28.2°C. The total annual rainfall varies between 1000-1500mm with a maximum of 2803.0mm during last five years, with a mean of 1300 mm. The maximum hourly rainfall recorded in site area was 113.3mm while 162.0 mm of maximum rainfall per day during last five years. These figures are indicative only and bidders shall verify the accuracy thereof and make allowances for any discrepancy. Bidder shall be required to consider rainfall pattern in preparing project programme to ensure scheduled completion of works.

Relative humidity is high throughout the year which the average varies between 46-98%.

The average number of bright sunshine hours per day is eight throughout the year.

The Site elevation is approximately 2m – 3m above sea level and the following climatic data design conditions shall be used.

The plant shall be required to operate over the temperature range of 20 °C to 38°C with corresponding humidity of 46% to 95 %.

The Site is located in an equatorial area. The environment shall also be tropical and humid. Materials used shall be suitably selected to resist the environment.

The Contractor shall carry out any air sampling necessary to determine the quality of the ambient air and use this information in the design of the filtration system for the gas turbines and elsewhere in the design of the plant as required.

The Contractor is responsible for confirming the accuracy of all data on climatic conditions at the site.

For performance measuring following Site conditions will be considered.

Parameter	Value
Inlet air temperature	30 °C
Mean humidity	80%
Height above sea level	2m to 3m

3.4.1 Topography

A topographical map showing the topography of the Plant site is attached in Appendix G.

3.4.2 Soil Conditions

It shall be Contractor's responsibility to investigate soil conditions and other information necessary to verify for the design of the Plant. Previous sample soil investigation reports within the Kelanithissa Power Station premises are included in the Appendix F.

3.4.3 Seismic conditions

It shall be the Contractor's responsibility to investigate and verify the specific seismic requirements of the Plant site and design its civil structures, supports as well as the plant equipment accordingly.

3.5 Fuel

Information regarding the Lanka Auto Diesel (LAD) to be consumed on Site is included in Appendix B. RLNG will be available to the site boundary in near future. The design parameters of the RLNG at the site boundary is as follows.

- a. Operating Temperature: Minimum 10°C.
- b. Operating Pressure: 60 bar
- c. Maximum pressure at Kelanitissa under no flow condition 70 bar.

3.6 Water management system

3.6.1 Water supply

The water supply for all plant requirements shall be taken from the supply of National Water Supply and Drainage Board except demineralized water and fire hydrant water. Contractor is required to provide Water Treatment Plant to cater Demineralized Water requirement. Untreated water requirement for water treatment plant and Fire hydrant system can be obtained from existing river water channel.

3.6.2 Clean storm water

Clean, non-contaminated storm water shall be discharged to an appropriate location outside the plant boundary. The Contractor shall be responsible for the design and installation of the complete storm water system for the Plant.

3.6.3 Reject water

The Contractor shall design and install a complete reject water system for the Plant, including a collection pit system to collect the reject water runoff. The design shall be complete with an interception system capable of separating any oil contained in the reject water prior to the water being discharged off-site. The collection pit system shall also be sized to capture, retain and process a total oil spill from the largest oil containing vessel from within each gas turbine unit and any associated fire protection or storm water captured with the oil.

3.7 Potable water quality

The Contractor shall be responsible for providing potable water for his employees and Employers staff during construction, which shall meet current World Health Organization (WHO) Drinking Water Guidelines.

3.8 Cooling water

The Plant shall be cooled using closed-circuit heat exchangers and water for make-up purposes shall be supplied from the demineralized water plant proposed under this project. These heat exchangers shall be installed in a way that they should not obstruct the path of the intake air passage of the gas turbines installed in the premises and the gas turbines installed under this contract.

3.9 Environmental

3.9.1 General

The Contractor shall design and construct the Plant such that it complies with applicable environmental laws and regulations of Sri Lanka and meets the requirements of the Central Environmental Authority of Sri Lanka. All practicable measures shall be taken to prevent and minimize harm to the environment as a result of the construction and operation of the Plant.

Specific environment requirements are identified below.

3.9.2 Emissions to air from the gas Turbines

The concentration of air pollutants discharged from the stacks and effluents discharged shall not exceed the limits specified by the Central Environmental Authority of Sri Lanka – Attached as Appendix D. The Contractor shall provide information on all emissions from the GT stacks so that the Employer may complete any further modelling required. Such information may include typical UHC (un-burnt hydrocarbon) emission concentrations and masses such that the Employer may confirm that the stack height is adequate.

The Contractor shall design, built and supply the water injection system to control the NO_x emission below the limits specified by Central Environmental Authority (CEA) – Appendix D Sampling port/s for emissions from the stacks and working platform shall be made available with each stack. A real time continuous emission monitoring system shall be installed to monitor concentration of SO₂, NO_x, O₂/CO₂, TSP, opacity, temperature and flow rate the flue gas for regular management of the combustion process and flue gas control system.

3.9.3 Other emissions to air

All other emissions to air shall be minimized if it is not possible to contain them completely. The following minor air emissions are permissible:

Combustion products from the emergency/black start diesel generators: The emission of greenhouse gases shall be minimized. No offensive odors shall be emitted from the Plant. Such emissions to air shall comply with the regulations and standards in Sri Lanka.

3.9.4 Emissions of dust

Since there are some other gas turbines in operation in the site, the Contractor shall strictly control and monitor the emissions of dust during construction activities. There shall not be any hindrance to normal operations of these gas turbines by the construction activities.

The Contractor shall provide a plan and implement the measures to achieve no visible dust emissions from site. The Plant shall be undertaken in such a way as to prevent the release of dust from the site and shall be monitored using an agreed localized dust monitoring programme. The area of disturbance shall be minimized. Mobile water carts shall be used to dampen any areas of exposed soil.

3.9.5 Emissions to water

The Plant shall be designed such that they comply with the recommendations of the Central Environmental Authority (CEA).

Plant shall be designed in a manner that discharged water shall be free of oils and solids.

Oily waste water shall not contain oil or grease concentrations in excess of limit stipulated by Central Environmental Authority Sri Lanka at the point of discharge. Contractor shall provide suitable equipment to ensure the above requirement.

Contaminated or potentially contaminated waste streams shall be collected and treated prior to discharge. Contaminated waste water shall be treated so that the following Sri Lankan water quality standards are met.

If appropriate to the operation of the proposed plant, the effluent shall result in a temperature increase of no more than 3°C at the edge of the zone where initial mixing and dilution takes place. Where the zone is not defined, use 100m from the point of discharge only if there are no sensitive aquatic ecosystems within this distance.

The Contractor shall install equipment which shall monitor the quality of all liquid

discharges if there will be water discharges from these gas turbines. Additional facilities shall be provided to prevent the discharge of liquid effluents not meeting the requirements of this specification.

3.9.6 Hazardous and industrial waste

Hazardous or industrial waste shall be stored and disposed of in a manner to minimize its impact on the environment including appropriate segregation for storage and separate disposal by a waste transporter agreed by the Employer.

Hazardous or industrial waste shall be disposed following the CEA guidelines.

3.9.7 Noise

3.9.7.1 General

The Contractor shall design the Plant such that the CEA specified noise criteria are met under all operating conditions including start-up, shutdown, and normal operation and unit trips.

Warning notices shall be provided at all entrances to rooms or areas where the noise level may exceed 75 dB(A). The wording of these notices shall be subject to the agreement of the Employer.

All single frequencies generated may be significant and require abatement. Noise shall be free of tones, special audible characteristics or impulsiveness. Subjective assessment of such characteristics shall be supported by objective evidence (e.g., frequency analyses), where appropriate.

The Contractor shall identify the location of the nearest residential, institutional, educational location, etc. and establish the background noise level. The noise level including background and contribution from the new power plant during operation shall not exceed the limits or a maximum increase in background noise levels of 3 dB(A), consistent with the Sri Lankan ambient noise standards.

3.9.7.2 Noise design and reporting

The Contractor shall submit interim noise design reports to the Employer within two weeks of Notice to Proceed (NTP) demonstrating how the specified noise limits shall be met. Reporting shall include equipment noise levels, details of noise control measures and preliminary calculations for environmental and on-Site noise.

A final noise design report shall be submitted to the Employer within 4 weeks of NTC. This report shall include but not be limited to the following:

- All equipment suppliers' noise guarantees and supporting data.
- Test reports for all equipment noise tests.
- Details of all noise control measures.
- Calculations of in-plant and environmental noise level to demonstrate compliance with the specified limits.

3.9.7.3 Visual

The layout, building colours, architectural design, landscaping and finishing of the Plant shall be to the approval of the Employer.

3.10 HAZOP studies

The Contractor shall conduct hazards and operability (HAZOP) studies once the preliminary designs (including P&IDs, PFDs, control descriptions and SLDs) for all systems are completed. These studies shall examine the design of the Plant and determine whether the design during operation, including abnormal modes of work operation, complies with this Specification and Good Industry Practices in terms of HAZOP.

3.11 Table of key dates

The key dates for the submission of plans, drawings, O&M manuals, general information, training etc. shall be indicated in project programme.

3.12 Concurrent work

The Contractor shall acknowledge that in parallel with the Plant, the Employer has or shall have engaged third parties to perform other work.

The Contractor shall allow the Employer and the Employer's other contractors such access to the Site as may be necessary to perform all such other work.

The Contractor shall cooperate with the Employer to allow all such other work to be performed without hindrance and expeditiously.

4 Quality assurance, inspection and testing

4.1 General

4.1.1 General requirements

The whole of the Plant supplied under the Contract shall be subject to inspection and test by the Employer or where appropriate, and approved inspection authority should they so require, during manufacture, erection and after completion. Prior to inspection and testing the plant and equipment shall undergo pre-service cleaning and protection as specified in this Section of the Specification. The costs of all tests and inspection shall be borne by the Contractor.

Where no test is specified then the various items of plant, materials and equipment shall be tested in accordance with the relevant ISO, IEC, British or other National Standards acceptable to the Employer, where no appropriate standard is available, tests shall be carried out in accordance with the maker's standard practice which must meet with the prior approval of the Employer.

4.1.2 Responsibility for Quality

The Employer shall have the right to supervise and witness tests of all materials to be used and all workmanship employed in connection with manufacture.

This shall not relieve the Contractor from any liability or obligation under the Contract and he shall be responsible for the acts, defaults and neglects of any sub-supplier, his agents, servants or workmen as if they were the acts, defaults, or neglects of the Contractor.

4.1.3 Quality Assurance

For control of the quality of manufacture, material control and documentation, the Contractor and each main sub-contractor shall submit copies of his manufacturing programme and unpriced copies of all orders and sub-orders to the Employer within 14 days of each order being placed. These documents will be examined and classified according to the extent of expediting, quality audit or inspection required.

The Contractor, all Subcontractors and testing companies shall have Quality Systems that meet the requirements of the ISO 9001 standard or equivalent.

The Contractor shall prepare a preliminary version of the Quality Plan containing or referencing the applicable procedures, design verification plans and inspection and test plans required for the Work. The Quality Plan shall generally be in the form of the sample Plan in the Schedules. After incorporation of the Employer's comments, the preliminary version of the Quality Plan shall be updated and compliance with the Quality Plan shall be considered a requirement of the Contract.

The Quality Plan shall set out or reference all quality practices and policies to be applied to the project so as to comply with the intent of ISO 9001. It shall form the base reference

document for all project specific procedures and policies as required under the Contract.

Supporting procedures need not physically form part of the Quality Plan, but shall be referenced from it.

The Quality Plan shall address all quality issues including, but not necessarily limited to, the following:

1. Responsibilities and authorities
2. Document control
3. Design verifications
4. Subcontractor assessment and control
5. Calibration requirements
6. Traceability
7. Non-conformance control
8. Construction method statements
9. Inspection and test plans
10. Internal audits
11. Records
12. References to supporting project manuals (e.g., safety manual, start-up manual)
13. Storage and maintenance of equipment
14. Reference to project specific procedures encompassing but not limited to;
 - Compliance programme for Applicable Permits and Applicable Laws
 - Public relation programme and procedures
 - Emergency preparedness & contingency plans
 - Environmental programmes (e.g., oil interception)
 - Hazardous material handling
 - Waste disposal
 - Reporting of accidents and incidents
 - Safety tagging, lockout and release procedures
 - Foundation acceptance criteria
 - Tool certification programme
 - Instrument calibration programme and procedures

Two copies of the final Quality Plan for the Contract shall be submitted to the Employer for review and comment within the time specified in the Table of Key Dates in the Appendices.

Prior to the start of any work affected by the procedures, the Contractor shall revise all or any portion of the documentation not yet agreed to by the Employer, as required by the Employer and shall submit the amended documents for review. In all cases detailed procedures and plans identified shall be produced before the relevant work commences.

The Employer reserves the right to examine any procedures, records, or results of audits referred to in the Quality Plan and to audit the Contractor and/or Subcontractors against the requirements of the Quality Plan at any time.

The Quality Plan shall include the measures to be taken for storage and maintenance for the Works and Contractor's equipment prior to installation, as well as for the period between the completion of the installation and Handover.

The Contractor shall provide within the Quality Plan, a Site Quality Control programme including requirements for Site Quality Control surveillance.

4.1.4 Manufacturing Capacity

The contractor shall furnish evidence that he and his Sub-Contractor have supplied other equipment of a similar type and size that shall have been in commercial operation successfully for a minimum of five years.

4.2 Programme management

Within two weeks of the date of order to proceed (NTC-Notice to Commence) and before the Employer authorizes work to commence on Site, the Contractor shall forward to the Employer for approval four copies of a detailed updated and reissued Bid Programme covering the design, manufacturing, testing, shipping, civil works construction, plant erection and commissioning phases of the Project. If the programme of work is in computerized form, a copy of the computer program shall be provided to the Employer for his use (in addition to print-outs). After satisfactory review this programme shall become the Contract Programme.

Unless otherwise approved, this programme shall be in precedence diagram form set against a calendar base. For the site construction and erection phases, in addition to the duration of each activity in weeks, the labour resources in man weeks also shall be shown. The original contract Completion Dates shall be shown on the programme and shall not be altered. Once approved this programme shall not be departed from without the written approval of the Employer. If at any time during the execution of the Contract it is found necessary to modify the approved programme, the Contractor shall inform the Employer and submit a modified programme for approval. Such approval shall not be deemed to be consent to any amendment of the Contract Completion Dates.

If at any time revised Contract Completion Dates are agreed by the Employer, then these may be added to the programme. The Contract Completion dates are defined as the dates on which each complete generating set is Taken Over for commercial service. The Contract completion dates for all other works shall be the dates on which the last items of building, plant or equipment are finally taken over by the Employer.

The Contractor shall prepare a Construction Programme using critical path network analysis. The work shall be broken down into sufficient detail to enable a correct logical sequence of activities to be established. The issue of drawings shall be covered in detail with appropriate check points to cover design information interface events.

With the exception of procurement activities, activity durations shall not exceed four working weeks. Activities shall cover all aspects for which the Contractor and his Subcontractors are responsible.

Following the initial submission, the Construction Programme shall be analyzed weekly at such intervals as may be determined by the Employer. The Construction Programme shall not be altered without the Employer's agreement.

All programmes and progress reports shall be in Microsoft Project. Hard and electronic copies shall be supplied; monthly progress reports shall be submitted.

Erection schedules shall be submitted on the Monday morning of every week. The schedules shall indicate activities actually completed the previous week in relation to those scheduled, activities proposed for the current week and activities proposed for the following week. The

schedules shall differentiate between the major equipment and auxiliary systems and indicate details of activities such as position equipment, grout anchor bolts, coupling alignment, journal and shaft levels and inspection works etc.

The overall commissioning schedule showing the commencement and completion of commissioning activities including tests of each systems and plant shall be submitted to the Employer for agreement before commencement of commissioning activities.

The Contractor shall submit weekly commissioning schedules to the Employer on every Monday morning. These shall include details of expected fuel use and generation. In addition, daily commissioning schedules and reports shall be submitted to the Employer. These shall detail all activities carried out the previous day and all activities programmed for that day and the day after, along with updated fuel use and generation schedules.

4.2.1 Familiarization Training for Employer's Staff

a. Plant and equipment Familiarizing programme

The Contractor shall arrange a familiarization visit to a similar plant in operation for Employer's six (06) engineers to become acquainted with the following aspects of the power plant;

- Plant Layout
- P & I diagram of Gas Turbine and auxiliaries with plant numbering system
- Plant installation procedure
- Control system
- Generator, AVR and Excitation system
- Gas Turbine inlet chilling system if there is any

- Gas Turbine startup/shutdown procedures
- Water Treatment plant
- Fuel Oil Treatment Plant
- Liquid fuel system & LNG fuel system

It is preferred that the Gas Turbine plant to be a plant commissioned during last five years.

b. Job site training

The employer shall make available, free of cost to the contractor, a suitable number of staff members for the purpose of the on-the-job training at site. It shall be the responsibility of the Contractor to provide adequate training in a scheduled manner so that these members of the Employer's staff are capable of taking over the responsibility for operation and maintenance of the plant and equipment at the time of taking over of such plant and equipment.

The Contractor shall provide video aids slides and technical films for training purpose to the Employer's staff. Such materials shall become the property of the Employer without any charge. Written material shall be provided to each trainee.

4.2.2 Management reporting

A formal review of the status of the contract shall be undertaken jointly by the Employer and the Contractor in a weekly progress meeting, the timetable of which shall be agreed between the Employer and the Contractor.

This review shall be based upon the Contract Progress Report which the Contractor shall submit a minimum of three (03) days prior to the Weekly Progress Meeting.

The Contract Progress Report shall be prepared at a level of detail that is acceptable to the Employer and which shall typically include reference to following issues:

- Executive Summary
- Progress to date in narrative form
- Consents
- Design/Information Submission Status (Master Information Schedule)
- Procurement/Manufacturing
- Construction/Erection
- Commissioning/Testing
- Commercial
- Program
- Environmental Issues
- Health & Safety
- Quality Assurance
- Risk Areas / Responses
- Corrective Actions and rectification during the defect liability period

- Actions Outstanding
- Early Warning Issues
- Forward View (Work not yet started)
- On Site Resources

The Contract Progress Report shall include a copy of both the Overall Contract Programme - Summary Level 1, Level 2 and overall and discipline activity.

The Contract Progress Report shall be provided in hard copy format and electronically.

The Contractor shall supplement the contents of the Contract Progress Report as required by the Employer.

Following mobilization on site, the Contractor's site office shall submit weekly progress reports to the Employer, summarizing site activities, indicating numbers of the various classes of workmen employed on site, the plant and equipment on site and record any areas of concern and details of corrective action being taken. Daily activity reports shall also be provided summarizing the main activities to be undertaken each day, noting any special activities that require witnessing, together with full particulars and details of all obstructions, modified or additional work, incidents and the number of men employed in each of the several portions of the work in progress.

The Contractor shall provide additional reports at the request of the Employer, provided such requests are reasonable. Labour disputes shall be reported to the Employer immediately they occur.

4.3 Inspection Plan and Procedures

4.3.1 General

Within 45 days after the signing of the Contract the Contractor shall provide the Employer with details of his quality procedures and the scope of inspection required to ensure that materials as dispatched meet the specification requirements.

An inspection schedule shall be prepared by the Contractor and shall be approved by the Employer.

The Schedule shall include:

- ISO Standards, IEC Standards, British Standards or equipment National Standards.

For each of the following stages of the work, the acceptance criteria shall be stated. Stages of inspection shall cover the following: -

- i). Tests to review or approve certification of material.
- ii). Review and approval of manufacturing procedures.

- iii). Witnessing test or review and approval of certification of operator's qualification carry out the work required.
- iv). Visual and dimensional examination of components.
- v). Pressure tests on casings and vessels.
- vi). Non-destructive examination of materials in progress.
- vii). Functional tests on sub-assemblies, type tests on complete units, system performance tests and soak test.
- viii). Examination of painting, packing proposals and documentation for shipment.

The Employer will indicate the inspection requirements on the agreed inspection programme in accordance with the following paragraphs.

- i). Hold point which requires a mandatory inspection by the Employer. This inspection or test shall be witnessed by the Employer and further progress in manufacture shall not be made until the plant is approved by the Employer.
- ii). Inspection or test of material may be carried out by the Employer at his discretion.
- iii). Certification of material and functional test shall be approved by the Employer before dispatch from the works.

Independently, the requirements of the Third-Party Inspectorate shall be indicated in a similar manner prior to the submission of the inspection plan to the Employer for his approval.

The approval by the Employer of any such inspection and tests shall not prevent the right of the Employer to reject the plant if it fails to comply with the Specification when erected or give complete satisfaction in service.

4.3.2 Non-Conforming Material

Any material or equipment which fails to satisfy the acceptance criteria or Specification or which, in the opinion of the Employer, is unacceptable with respect to potential safety, reliability, interchangeability or workmanship shall become the subject of a non-conformance report issued by the Employer to the Contractor with copies for third parties concerned.

The non-conformance report will identify the following :-

- The Plant and its reference number.
- The Contractor and his order number.
- The manufacturer and his works reference number.
- The components and related drawings, reference numbers, etc.
- The defect and stage of manufacture with sketches if required, location in the works and the issuing authority.
- Suggested action for acceptance, for repair or for rejection and replacement.
- Approval by the Employer of action decided.

Any material or equipment which has failed to satisfy the acceptance criteria, shall, where

practicable, be separated from the work in progress and in all cases shall be suitably identified with a distinctive label which will only be removed when corrective action is complete.

Final acceptance by the Employer for the repaired component may necessitate re-inspection.

4.3.3 Quality Audit

The Contractor shall establish, document and execute a plan for quality evaluations which shall objectively audit and verify that he is complying with all aspects of the Quality Programme, operating procedures and Specification requirements.

The Employer may from time to time visit the manufacturer to carry out a Quality Audit to ensure that the manufacturer's quality organization is capable of discovering an error in drawing, production control and manufacturing components and equipment at an early stage and is taking adequate steps to correct the error and prevent a recurrence.

4.3.4 Measuring and Testing Equipment

At prescribed intervals, or prior to each use, all measuring and testing equipment used in inspection shall be calibrated and adjusted against certified equipment having a known valid relationship to nationally recognized standards. Where no national standards exist, the basis employed for calibration shall be to the approval of the Employer.

The manufacturer shall prepare a calibration schedule showing equipment type, identification number, location, frequency of checks, method of checking and action to take when results are unsatisfactory.

Each piece of equipment shall be labeled with its identification and current calibration status.

Calibration records for each for each piece of equipment shall be maintained at least for life of that piece of equipment and shall be available for examination by the Employer.

4.3.5 Preservation, Packaging and Shipping

The Contractor shall establish and maintain a system for the preservation, segregation and handling of all material from receipt through the manufacturing process and subsequent storage to prevent abuse, misuse, damage, or deterioration by corrosion through exposure to air or moisture.

Items for dispatch shall be suitably packed to the requirements of an approved national/international standard and additionally or otherwise protected from damage, deterioration, loss, mishandling and any deleterious effect of the environment during transportation, shipping and all necessary storage and handling before erection on site. Cases shall contain desiccants or gases where appropriate. Cases or items for shipment shall be suitably identified and addressed to contract requirements and have labels visible from more than one position when stacked.

4.3.6 Re-inspection following Non-Conformance

If a non-conformance report is issued as Clause 4.3.2 above or plant rejected as in 4.8.2

below, the Contractor shall reimburse the Employer for all costs (including time costs, travel, accommodation etc.) for both attending discussions on remedial matters and any reinspection that the Employer may deem to be necessary.

4.4 Places of manufacture and sub-orders

The Contractor shall identify the manufacturers and places of manufacture, testing and inspection before dispatch to Site for the various portions of the Works. There shall be no departures from this list without the prior written agreement of the Employer.

Selected Subcontractors shall not further subcontract any section of the Works without the prior written agreement of the Employer.

The Employer shall have access to the Contractor's and Subcontractor's Works to verify the status of design and manufacture.

4.4 Inspection and Test Plan (ITP)

The Contractor shall submit to the Employer an Inspection and Test Plan which shall include pertinent manufacture and inspection operations including test and inspection procedures. The scope of the Inspection and Test Plan shall follow the specific Employer requirements. The Employer shall select from these the nominated mandatory hold points for surveillance. Notwithstanding this, the Employer shall have access at all times to all places where materials or equipment are being prepared or manufactured for the Works, including the works of the Contractor, Subcontractors or suppliers of raw materials.

The inspection and test plan shall include specific criteria for acceptance or rejection, including criteria for any non-destructive testing inspections.

The Inspection and Test Plan may be of any form to suit the Contractor's system, but it shall as a minimum:

- Indicate each inspection and test point and its relative location in the production cycle including incoming, packing and site inspections;
- Indicate where Subcontractors' services shall be employed (e.g., Subcontractors for NDT, heat treatment etc.);
- Identify the characteristics to be inspected, examined, and tested at each point and specify procedures and acceptance criteria to be used;
- Indicate mandatory hold points established by the Employer which require his verification of selected characteristics of an item or process before this work can proceed;
- Define or refer to sampling plans if proposed and where they shall be used;
- Where applicable, specify where lots or batches shall be used.

The Contractor shall provide to the Employer at least 05 working days' notice in advance of

reaching a nominated witness or hold point. Work shall not proceed beyond a hold point without the written agreement of the Employer.

Works inspection by the Employer may include the following activities:

- Monitoring to confirm the effectiveness of and the Contractor's compliance with the established system procedures, quality plan and inspection of test instructions;
- Witnessing of inspections and tests and/or verification of inspection records to be carried out at the Employer's discretion covering:
 - Compliance of raw material with specified requirements
 - Compliance of manufactured parts, assemblies and final items with Specifications, drawings, standards and good engineering practice.
 - Inspection of Contractor's design, manufacturing, installation work and the production of progress reports.
- Witnessing of inspections and tests.
 - Packing for shipment including check for completeness of shipment, handling requirements, and case markings and identification.

The Employer shall endeavor to schedule the performance of inspection and tests so as to avoid undue risk of delaying the work. In the event of postponement, by the Contractor, of tests previously scheduled or of the necessity to make tests due to unsatisfactory results of the original tests, or other reasons attributable to the Contractor, the Contractor shall bear all costs for new tests and the costs incurred by the Employer in re-inspecting the nonconforming item or its replacement.

Acceptance or rejection of the equipment and/or components shall be made as promptly as practicable following any inspection or test involvement by the Employer. However, failure to inspect and accept or reject equipment and/or components shall neither relieve the Contractor from responsibility for such items which may not be in accordance with the specified requirements, nor impose liability for them on the Employer.

Three hard copies and an electronic copy of all appropriate quality records, as specified in this Specification and/or as required by applicable codes and standards, shall be submitted to the Employer for review and acceptability prior to, or concurrent with, shipment or as otherwise agreed to by special arrangement with the Employer.

The Contractor shall implement a system, acceptable to the Employer, which ensures traceability of all critical parts and components of the supplied plant and equipment and the associated quality records.

4.5 Training

The Employer's project engineers, plant engineers and operators may be unfamiliar with the Contractor's Gas Turbine plants and a comprehensive training program shall therefore be provided by the Contractor.

The Contractor shall provide all operations and maintenance training necessary to instruct the Employer's staff on the safe, reliable, and efficient operation and maintenance of the Works.

All operators training for major plant systems (Gas turbines, generators, Transformers, MV systems) shall be completed in order to support commissioning. The Contractor shall certify that the trainees have accomplished the goals of the training programme.

In general, site training shall be conducted at a location in Colombo, Sri Lanka, to be determined by the Employer.

Specific training courses for the Gas turbines, Inlet chilling system, fuel oil treatment system, generator, transformer, AVR & excitation system, control systems and protection systems shall be conducted at the Original Equipment Manufacturer's premises (not at the premises of a licensee). The Contractor shall provide full details of its training program with the bid including Basic Training, specific Operation & Maintenance training etc.

4.5.1 Training content

Training shall address at least the following areas:

- Gas turbine and its auxiliaries;
 - Generator;
 - Transformer;
 - Switchgear
 - Cooling system;
 - Control system (Governor & Excitation, maintenance and simple programming of PLCs etc.);
 - Electrical protection system
 - Fuel supply and transfer systems
 - Hazardous areas
 - High voltage systems
 - All auxiliary systems
 - Electrical system and utility interface
 - Interfaces
 - Routine operational checks
 - Preventive maintenance
 - Major Plant Outages
 - Environmental Protection
 - Power Plant Safety
 - Plant Control System
 - Water Treatment plant
 - Fuel Oil Treatment Plan
-
- Inlet chilling system

- Metering (Power, Fuel, Water etc.;
- Tools
- Spares Control/Inventory;
- Safety;
- Management

4.5.2 O & M training at manufacturer’s facility

The Contractor will bear the cost for overseas training at manufacturers’ works, including return air fare, accommodation, meals and allowance for employer’s staff.

Overseas training (to be at the OEM facilities, not at a licensee’s) is required as follows on manufacturing and maintenance of equipment at site: -

- Operation & Maintenance Training for Gas Turbine, Gas Turbine control system and auxiliary systems
- Maintenance of Plant control systems (DCS, instrumentation etc.)
- Generator, AVR and Excitation system
- Electrical Protection system
- Inlet chilling system

Item No	Training Description	No. of Engineers
1	Operation Training for Gas Turbine, Gas Turbine control system and auxiliary systems	06
2	Maintenance of Plant control system	03
3	Maintenance of Electrical Equipment (Generator/AVR/Transformer/Switchgear)	03
4	Maintenance of Mechanical Equipment (Compressor. Turbine, Auxiliaries, FOTP and water treatment etc.)	03
5	Generator/Transformer Protection	03

All trainees shall receive basic training about the plant layout, system operations and overall function prior to commencement of above specific training module.

Contractor shall submit their training schedule for the approval of Employer before starting the training. Cost of the above training shall be included in Schedule IE, Provisional Sum in the price schedule (Volume 5).

4.5.3 O & M training at the site

4.5.3.1 Program

Two months prior to the start of classroom training, the Contractor shall submit a training schedule and program and well-organized training manual materials, (covering Works start-up, operation, maintenance and repair) to the Employer. The Employer shall review, comment on and/or approve such program in writing within fifteen days of such submission by the Contractor.

If the Employer conditions its agreement on reasonable changes in the program submitted by the Contractor, the Contractor shall effect such changes at no additional cost to the Employer and resubmit the program to the Employer within five days of receipt from the Employer of such conditional agreement. The Employer shall have five days after each such resubmission to review, comment on, and/or approve the program resubmitted by the Contractor. Such procedure shall continue with the same five-day time periods until a program is accepted by the Employer.

The Contractor shall complete the start-up/testing/operational portion of the training program so the daily operation and control of the Facility can be assumed by Operator in good time to support the testing and commissioning program. Each trainee shall receive a full set of all training materials prepared by the Contractor.

4.5.3.2 Format

Operators, maintenance personnel, instrument technicians and supervisors will attend the training program. Trainees will have relevant background knowledge in power generation processes.

The training course shall include detailed instruction on maintenance and system administration of the plant control system. Training for all major mechanical, electrical and control equipment shall be performed by representatives of the Original Equipment Manufacturers.

Training shall include classroom and hands-on sessions. The classroom phase shall consist of at least two consecutive weeks of instruction in the project design, capabilities, component operation and procedures, and shall include a program for certifying Operating Personnel training. In addition, a minimum of one day hands-on training shall be provided for each system as it is being commissioned.

All training shall be conducted in English and by instructors fluent in the English language who are experienced instructors on equipment identical to the systems supplied, using materials (including video presentation) prepared by the Contractor that specifically have been prepared for the Works.

Lesson plans shall describe the objective of the lecture and tell trainees what they are expected to do or be able to do after applicable technical references and training aids to be used and include a detailed breakdown of the points of discussion to be addressed in the

training presentation. Each presentation on a plant system shall be accompanied by an in-plant inspection of the applicable system. Lesson plans shall be prepared for each system inspection that detail the key components to be viewed and the inter-system relationships to be emphasized during the inspection. Lesson content shall be based on the actual plant and equipment being supplied.

As many as 50 numbers of CEB staff would be allowed to attend the scheduled classroom lessons as well as introductions to the equipment as they are being assembled at project site. The Contractor shall arrange training at a place provided by the employer. The Contractor shall furnish all the equipment necessary to complete the training.

4.5.3.3 Training materials

The Contractor shall allow for each trainee to receive a full set of all material used in the classroom as personal equipment to be used by the trainee. Five additional sets shall be provided. All manuals and training materials shall be in English.

For each lecture or presentation, each trainee shall receive a copy of the applicable operations procedures, a lesson plan, and copies of any drawings, overhead projections, etc. used in the training session.

Within four weeks of the conclusion of the classroom training, the Contractor shall provide the Employer a course summary manual that includes the schedule employed in the conduct of the training, copies of the training materials (lesson plans, drawing, overheads, etc.) used in each session.

4.6 Special tools

The Contractor shall supply a complete set of tools and other equipment necessary for routine maintenance and the dismantling, inspection re-erection and adjustment of the plant. For clarity this will include all work required for major overhauls as well as non-routine maintenance on plant that could reasonably be expected to occur within the 30 year of the plant.

This shall include any special lift jigs, frames and stands necessary to remove and support the major items of plant.

All interrogation and testing software required to maintain plant and software shall be provided. If these special tools include application software, the Contractor shall provide an unrestricted license to the Employer for the use of such software in relation to the Works. These special tools shall include special interface equipment and/or special interface cabling. Wherever hardware or software keys are necessary to perform maintenance for electrical and control and instrumentation equipment the Contractor shall provide the software password and one sets of hardware keys.

Licensed soft copies in form of compact disc/memory sticks of system software and operation software used for plant/equipment of the power plant shall be provided. Any firmware which required installing the above software in PCs or notebook computers shall also be provided.

Where any of the control system is microprocessor-based, all hardware and software for monitoring, setting, tuning, testing, trouble-shooting, graphic displays, simulation and modification shall be provided.

The tools provided shall be in new, adequately labeled as to their use and contained in stout and suitable padlocked boxes. Any special slings required shall be provided and clearly marked by embossed labels to show safe working loads.

Test certificates shall be provided where applicable.

Contractor shall indicate cost of special tools requirement as specified in Clause 2.3.2 of Section 02 of Volume 03 in the price schedule (**Schedule 3 of Volume 5**). This cost shall include cost of labeling and conveniently storing all tools in racks provided by contractor in ready to use manner.

4.7 Spares

The contractor shall state spare parts with prices in the **Schedule 5 of Volume 5** which are;

- recommended by OEM required for 02-year operation at 50% plant factor,
- First combustion inspection (CI)
- Hot gas path inspection and (HGPI)
- Major inspection of the gas turbine (MI)

Contractor shall state the mandatory spares in the **Schedule 2 of Volume 5**, Mandatory Spares of volume 3.

- Complete set of fuel nozzles, one complete set of fuel check valves, one flow divider, one AC fuel forwarding pump with motor, one DC fuel pump with motor, one fuel control valve and one fuel stop valve for each Gas Turbine
- One complete set of flame scanners for each Gas Turbine
- One AC lube oil pump with motor, one DC lube oil pump with motor, one AC hydraulic pump with motor and one shaft driven hydraulic pump with motor for each Gas Turbine
- One AC jacking oil pump with motor and one DC jacking oil pump with motor for each Gas Turbine for one Gas Turbine
- One AC atomizing air compressor with motor and one shaft driven atomizing air compressor for each Gas Turbine
- One repair kit and spare impeller for each type of pump
- One spare motor for each type of motor installed in GT except listed above
- One complete set of bearings for each Gas Turbine and each Generator
- At least one expansion seal and one bellow from each type installed in the plant

Following mandatory spare parts shall also be included in the spare part schedule 2,

Mandatory Spares in volume 5.

a). Generator and Generator circuit breaker (GCB)

- One set of RTDs for generator except the RTDs installed in generator winding
- A set of manufactures recommended spare parts for 5-year operations of GCB
- One synchronizer and synchro-check relay for GCB
- One set of meters, push buttons, indication lamps installed in synchronizing system

b). 6 kV CBs

1. Complete set of Circuit Breaker with operating mechanism for each type and rating
2. Tripping coil and closing coil - 04 Nos of each type
3. Two sets of interface/control modules for circuit breaker

c). DC chargers, UPS and Battery bank

1. One PCB of each type installed in battery chargers and UPS systems
2. One set of power thyristors, diodes installed in a battery charger and UPS system
3. One DC breaker for each type installed
4. Ten (10) fuses from each type and rating installed
5. One AC and DC, MCB form each type and rating installed

Following spares parts for low voltage switchgear shall also be included in recommended spares for 5-year operation.

- Complete set of Circuit Breaker with operating mechanism for each type and rating
- One MCCB of each type with operating mechanism for each type and rating
- One or 10% spares of the installed of circuit breaker interface/control modules
- One AC and DC, MCB form each type and rating installed

Recommended spare parts for following systems and equipment shall be included Recommended Spares for 5-year operation.

- Gas turbine and Generator
- Power transformers
- Emergency diesel Genset / black-start Genset
- Starting means of GT
- Inlet chilling system
- Water treatment plant

4.8 Plant performance

4.8.1 Guarantees

Bidder shall state and guarantee the technical particulars listed in the Schedules of Guarantees and Technical Particulars. These guarantees and particulars shall be binding and shall not be departed from without the written permission of the Employer.

Bidders are free to list more than one Manufacturer against each item of the plant and services listed in the Schedules of Guarantees and Technical Particulars. If more than one Manufacturer is offered by the Bidder, Employer shall have the right to select the preferred service provider or make/brand out of offered.

Acceptance of the plant equipment which departed from guaranteed values specified in the schedules shall be entirely at the discretion of the employer and subjected to the bidder accepting the deduction of contract price specified in the of particular conditions in Section 2.2 Appendix to the Bid of Volume 1.

If the actual value recorded in the site plant performance test is equal or below the guaranteed values, contractor will not be entitled to any premium in respect of reduction of guaranteed values.

The Contractor shall further guarantee that equipment supplied complies with the Contract Documents.

The tolerances permitted in ISO Standards, IEC Standards, British Standards, or equivalent National Standards shall apply unless otherwise stated.

4.8.2 Rejection of Plant

If the guarantees are not met and/or if any item fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or during the maintenance period, the Employer may reject the complete item, or a defective component thereof, whichever he considers necessary.

After adjustment or modification as directed by the Employer, the Contractor shall submit the item for further inspection and/or test. The repair procedure shall be to the Employer's approval. In the event of a defect on any item being of such a nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item shall be replaced by the Contractor, at his own expense to the entire satisfaction of the, Employer.

Any item of plant repaired to an approved procedure shall not be accepted as a part of the Plant as a permanent solution or replacement unless the Contractor guarantees in writing that the repaired plant or component shall have the same service life and efficiency as the component originally manufactured.

4.9 Sub-Contractors

The Contractor shall be responsible for the timely transmission of the relevant and appropriate sections of the Specification to the sub-contractor and other suppliers and the proper execution of all tests on work or plant or materials carried out or supplied by a sub-contractor, wherever such tests may be carried out, to the same extent as if the tests on work, plant or materials were carried out or supplied by the Contractor himself. The cost of all tests and including any repeated test or inspection carried out at sub-contractor's works is deemed to be included in this Contract.

There copies of all order and sub-orders placed by the Contractor and Sub-Contractor, shall be submitted to the Employer for approval and all copies of sub-orders shall be marked clearly with the Main Contractor's name and the following reference: -

CEYLON ELECTRICITY BOARD KELANITISSA GAS TURBINE PROJECT
CONTRACT NUMBER: CEB/KGTP/PROC/01/Re

This material shall be subject to inspection and test by the Employer, with whom contact shall be made before commencing manufacture to agree inspection procedures and visits.

4.10 Tests at manufacturer's works

4.10.1 General

Where no specific test is specified then the various items of plant, materials and equipment shall be tested in accordance with the appropriate ISO or IEC recommendations. Where no appropriate standard is available, tests shall be carried out in accordance with the manufacturer's standard practice, subject to the prior approval of the Employer. In all cases, works tests shall include electronic, electrical, mechanical and hydraulic tests in addition to any tests called for by the Employer to ensure that the plant being supplied fulfils the requirements of the Specification.

All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Employer prior to commencement of the work. An inspection/test schedule and test specification shall be used for this purpose and the Contractor shall prepare the details of the schedule and submit these to the Employer for approval at least 2 weeks prior to the scheduled commencement of acceptance tests.

The Contractor shall submit the method statement of factory acceptance tests for the inspections by the Employer. The method statement shall be checked and approved by the Employer. If the factory acceptance test is carried out without the Employer's approval, the result of the test is invalid and the Contractor shall carry out the retest according to the approved method statement. The cost of the retest shall be borne by the Contractor.

The inspection by the Employer for the Factory Acceptance Tests of the following plant and equipment is mandatory and shall not be limited to the same. However, Employer has the right to attend or waive the invited tests.

- Gas Turbines

- Generators
- AVR and Excitation systems
- Step up Transformers and Auxiliary Transformers
- Generator Circuit breakers and MV Switchgear
- Electrical Protection system
- Inlet chilling system, if any
- Plant Control system
- MV and HV cables
- Fuel Oil Treatment Plant
- Water Treatment Plant

It must be ensured that adequate relevant information on the design code/ standard employed, the manufacture/fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Employer. The Employer will inform his intention to attend or waive the invited tests, or inspections upon receiving the invitation for Factory Acceptance Tests.

Before the commencement of any test, copies of all relevant drawings, specifications, test result and operating instructions shall have been submitted to the Employer and approved.

A minimum of 14 days' notice in writing, of the readiness of plant for test or inspection, shall be provided to the Employer by the Contractor in accordance with the following: -

The Contractor shall submit to the Employer sequentially numbered applications for inspection which shall contain the following information.

- Contract number
- Contract title
- Contractor's name
- Inspection application number
- Manufacturer's name, address, telephone, Fax and Email numbers, plus name of manufacturer's staff responsible for the testing and manufacturer's works order number
- Location of tests
- Date of tests
- Description in full of work offered for inspection (Contractor's order references alone are insufficient and unacceptable)
- Section of the work for which Plant is allocated
- Schedule of tests to be performed and standard to be applied
- List of the approved drawing numbers appropriate to the Plant offered
- Sub-order number

The subject items should remain available for Employer's inspection and test up to a minimum of 14 days beyond the agreed date of witnessing the test.

Every facility in respect of access, drawings, instruments, and manpower shall be provided by

the Contractor and his Sub-Contractor to enable the Employer or his designated representative to carry out necessary inspection and testing of the Plant.

Functional electronic, electrical, mechanical and hydraulic tests shall be carried out on the completed plant after assembly in the Plant in accordance with the Test Plan and Procedure Document described above.

4.10.2 Purpose of Tests

The tests are intended to demonstrate that the individual hardware units and items of software where appropriate comply with their individual specifications and that they are compatible when assembled into a complete system and will operate together over an extended period with and acceptably low outage time in the environmental conditions specified.

4.10.3 Material Tests

Representative sample of all plates, bars and pipes etc. which from components of the plant shall be tested as required by the relevant standard or code or at the request of the Employer.

All test pieces shall be prepared and supplied by the Contractor at his own cost. If any test piece fails to comply with the requirements of the specification for the material in question, the Employer may reject the whole of the material represented by that test piece.

Important forgings may be examined jointly at the maker's works by the Employer, together with the Contractor and representatives of the manufactures during forging and heat treatment at the Employer's discretion.

4.10.4 Test Reports

All test reports shall be prepared by the Contractor and shall contain the following minimum information:

- General statements about the kind of test
- Technical data of the tested equipment
- Description of the test type and method used
- Description of the evaluation method
- Comparison with the guaranteed values
- Summary and conclusions

Upon successful completion of the workshop inspections/tests the Contractor shall submit the workshop test report containing all relevant test sheets (signed off by Contractor's, Employer's staff) and the documentation as listed above.

The Contractor shall furnish the Employer with certified copies of all test reports, data and results (including calibration curves and correction data if required) in accordance with document distribution schedule. Upon approval of the test results by the Employer, the

equipment shall be packed ready for shipment.

4.10.5 Test Certificates

When all equipment has been tested the test certificates from all work and Site shall be complied by the Contractor into volumes and bound in an approved form complete with index and included in the appropriate Operation and Maintenance manuals.

4.11 Tests at site

4.11.1 General

Tests during installation and on completion of erection shall be carried out by the Contractor in accordance with the General Conditions of Contract and test sheets and testing procedures prepared by the Contractor to the approval of the Employer.

The Contractor shall submit a written programme of tests and checks for the approval of the site engineer. Test sheets and testing procedures shall be forwarded to the site engineer not less than two weeks in advance of the planned test.

The Contractor shall provide experienced test personnel and testing shall be carried out during normal working hours as far as is practicable. Tests which involve existing apparatus and outages may be carried out outside normal working hours only after having obtained approval from the Employer's operational staff. The Contractor shall give sufficient notice to allow for the necessary outage arrangements to be made in conformity with the testing programme.

The Contractor shall record the results of the tests clearly, in a form approved by the Employer and with clear reference to the equipment and items to which they refer, so that the record can be used as the basis for maintenance tests during the working life of the equipment. Site test results records shall be provided by the Contractor to the Employer as soon as possible after completion of the tests.

No tests agreed under the programme of tests shall be waived except upon the instruction or agreement of the Employer in writing.

The Contractor shall be responsible for the provision of supplies for the operation of test equipment. All consumables (including lubricants, chemicals, filters etc. though not including fuel) necessary to required tests, until taking over the plant shall be supplied by the contractor.

The Contractor's test equipment shall be of satisfactory quality, quantity and condition and, where necessary, shall be appropriately calibrated by an approved authority or standard at the Contractor's expense. Details of the test equipment and instruments used shall be noted in the sheets in cases where the instrument or equipment characteristics can have a bearing test result.

The testing requirements detailed under this Specification may be subject to some variation upon the instruction or agreement of the Employer where necessitated by changed conditions

at Site or by differing design, manufacturer, or construction techniques.

The bidder is required to submit proposals for site dielectric tests and include in his price the costs of such tests and of such equipment as deemed necessary.

4.11.2 Equipment Tests

4.11.2.1 General Checks

A general check of all the main and ancillary equipment shall be made and shall include a check of the completeness, correctness and condition of earth connections, labeling, arcing ring and horn gaps, clearance, painted, surfaces, cables, wiring, pipework, valves, blanking plates and all other auxiliary and ancillary items. Checks shall be made for oil and gas leaks and that insulator are clean and free from external damage. A check shall be made that loose items which are to be handed over to the Employer, e.g., Blanking plates, tools, spares, are in order and are correctly stored or handed over.

4.11.2.2 Pre-Commissioning Tests

Before being commissioned the Plant shall be subjected as a minimum to the following tests, as appropriate, and to such other tests considered necessary by the Employer.

Mechanical Plant:

- a). Routine hydraulic tests where required.
- b). Pipework in accordance with Section 4 of BS.806 or equivalent and associated valves.
- c). Tanks in accordance with BS.2654 or equivalent.
- d). Flushing out all pipework.
- e). Operation of all protective and alarm devices.
- f). Rotation tests.
- g). Calibration of all temperature, pressure, flow, level, speed, etc., devices.

Electrical Plant:

- a). Routine high voltage tests to the appropriate British Standard or IEC. Where none of relevant standard exists tests shall be agreed with the Employer.
- b). Insulation resistance tests on all electrical equipment, including 10/1-minute polarization indices on HV rotating plant.
- c). Phasing tests.
- d). Continuity and conductivity/resistance tests.
- e). Polarity tests on all single pole switches and socket outlets.
- f). Tests to prove correct operation of interlocks, tripping and closing circuits, indications, synchronizing systems, local and remote-control systems, auxiliary relays, time delay

- relays etc.
- g). Operation of all protective gear circuits by primary and secondary injection and system fault tests to check sensitivity and stability. Protective gear timing tests as may be necessary.
 - h). Black start/Emergency Gen Set Load Testing and other relevant Tests
 - i). Test operation of alarm and trip devices, including calibration of all sensors.
 - j). Rotational and Insulation tests on all motors.
 - k). Ratio, polarity and Insulation tests on CTs and VTs.
 - l). Oil tests to BS.5874 and additional tests (if required) as defined in BS148.
 - m). Earthing system and electrode tests
 - n). Ratio, Vector Group and magnetizing current tests on each transformer.
 - o). Calibration of instrumentation and metering, including transducers, winding and oil temperature devise.
 - p). Alignment of tap selector and diverter switch and tap changer continuity checks on all taps.
 - q). Vector group and phasing tests on VT circuits.
 - r). AVR tests, including measurement of output characteristic and response to a 10% voltage step change.
 - s). Magnetization current / voltage tests and winding resistance tests on all current transformers.
 - t). Lighting level tests, including certification of the emergency lighting system to BS2566.
 - u). Battery discharge tests.
 - v). Battery charger capability tests to prove float charge and boost charge on full station load.
 - w). Fire detector and alarms checks and extinguishing agent discharge test.
 - x). Ventilation/air conditioning system capability tests.
 - y). Functional tests on supervisory control system.

4.12 Trial Run and Initial Operation

- a. The start of the trial run shall mutually be agreed upon between the Contractor and the Employer after
 - Having satisfactorily completed all preliminary and functional tests on the various plant components or systems.
 - Having installed and satisfactorily tested the instrumentation and control

functions of the units and all auxiliaries.

- The test protocols of the preliminary and functional tests have been signed by all parties.
- b. The start of the initial operation shall mutually be agreed upon between the Contractor and the Employer after having satisfactorily completed the trial run of the plant (no shutdowns are permitted during trial run except those requested by the Employer or beyond the Contractor's responsibility) and the test protocol have been signed by all parties.
- During the initial operation period the plant shall be operated and tested by the Contractor as per the approved programme with the assistance of the Employer's staff under the Contractor's supervision and responsibility.
 - Within the initial operation, no shutdowns are permitted except those requested by Employer or occurred beyond the Contractor's responsibility.
 - The date on which the Contractor has successfully completed the initial operation shall be laid down in a protocol to be signed by the Employer and the Contractor. Simultaneously the Contractor shall inform the Employer by a written notice that he is ready to start the reliability test run.

4.13 Reliability Test Run

The plant will be operated by the Employer's staff under the supervision of the Contractor's representatives who will be fully responsible for the correct operation of all plant and be present at all times during the reliability test period. The Contractor will be allowed to make any minor adjustments which may be necessary provide such adjustments not in any way interfere or prevent the commercial use of the plant by the Employer or result in reducing the output or decreasing the efficiency. A certificate of handing over for Operational Responsibility only will be issued at the commencement of the reliability period but this certificate will not be acceptable for any payment purposes.

Should any failure or interruption occur in any portion of the plant, due to or arising from faulty design, materials or workmanship or due to omission or incorrect erection but not otherwise, sufficient to prevent the full commercial use of the plant during the reliability period, then the period will be cancelled and a new reliability period of thirty days shall commence after the Contractor has remedied the cause of the defect.

- a. After successful completion of the initial operation and receipt of the notice that the Contractor is ready for the reliability test run, the Contractor shall be allowed to start the reliability test run.

During this period the Plant shall be operated continuously at base load subjected to prevailing power requirement of the network. During this period no tests on components and systems shall be performed.

The Reliability Test Run of each generating unit and its auxiliaries or other equipment/installation shall last thirty (30) days if not otherwise specially agreed

upon or defined in the Contact Documents.

- b. No shutdowns are permitted during the reliability run, except if occurred owing to causes beyond the Contractor's responsibility, the later fact to be proven by the Contractor. If the reliability run has to be interrupted owing to reasons for which the Contractor is responsible, it shall be restarted from the very beginning after the cause of the interruption has been rectified by the Contractor to the entire satisfaction of the Employer.
- c. The use of and/or switch-over to standby equipment shall be allowed, provided that the Contractor informs the Employer prior to doing so and of the reasons therefore and assures that the cause for the use of the stand-by equipment is rectified within twenty-four hours. In case twenty-four (24) hours is exceeded in such case it will be considered as an interruption of the reliability run and the test will have to be restarted from the beginning.
- d. During the reliability run Employer's staff shall operate the Plant under the supervision of the Contractor's representatives under Contractor's full responsibility.

4.14 Performance Test

4.14.1 General

The performance Tests shall be designed to demonstrate that the units and the plant comply with the performance guarantees.

On the satisfactory completion of the reliability tests of the Gas Turbine at site the Contractor shall, within a reasonable time, notify the Employer that the performance tests may be carried out. The performance tests shall be carried out by the Contractor and witnessed by the Employer.

The tests shall be conducted in accordance with the latest ISO 2314 or ASME PTC 22 Performance Test Codes using previously approved correction curves and complying with the following special conditions unless otherwise specified.

The contractual performance guarantees shall be as defined in the "Guarantee Data" of Volume 1 and Volume 4.

1. Net power measurements of the turbines shall be made at the Generator terminals before the step-up transformer considering all unit auxiliary loads in to account (Form 17 and Form 18B of section 3.1 of Volume 01).
2. Generator performance shall be demonstrated at the performance test by operating the generator at its maximum stable limits of the capability curve of the generator. The operating points to be tested and the method of testing shall be determined mutually by the Employer and the Contractor.

Meter accuracy shall be as determined mutually by the Employer and the Contractor. The times to stabilize readings shall be determined mutually by the Employer and Contractor.

The date upon which performance tests are completed is defined as the date by which the Contractor has removed all test instrumentation, and returned the plant and equipment to its pre-performance test condition such that it can be used by the Employer for the commercial generation of electricity.

4.14.2 Schedule for Performance Test, Test Procedures

The Contractor shall submit to the Employer, four (04) weeks prior to the performance test, the detailed procedure for execution of the performance tests for approval. The procedure shall include the following minimum requirements for such test or group of tests.

- a). The time/duration of each test at each load.
- b). The number of tests runs at each load.
- c). The sequence of tests to be conducted.
- d). A list of instruments that will be used for each test.
- e). Schematic diagrams showing all test points and cross references to the test instruments list.
- f). Required personnel for each test.

4.14.3 Test instruments (other than station instruments)

Prior to dispatch to site all test instruments must be tested by competent authority for accuracy of calibration. Test certificates must be submitted confirming the validity.

4.14.4 Station instruments

The instruments used will be those provided with the plant but in addition certain check instruments to be agreed with the Employer shall also be provided by the Contractor.

These check instruments will cover all the quantities listed in ISO.3046/11, Group 5, to be measured continuously over the test period but in addition sufficient instruments shall be provided to enable, by spot tests taken at intervals, the reasonable accuracy of all the working instruments provided to be ascertained.

All station instruments used for execution of performance test shall be calibrated to the satisfaction of the Employer.

An independently certified calibration curve shall be provided for each check instrument and in particular this must apply to the check instruments which are to be provided to measure the kWh generated and the fuel consumed. The Contract includes for the provision of any recalibration certificate which may be required by the Employer to be taken after the tests.

4.14.5 Summary of required tests

Preliminary and functional tests at site, shall be carried out on the individual plant components/Systems first on successful completion of those tests the total plant shall be tested.

The “hot” commissioning phase shall comprise.

a). Trial Run

- Duration: Three (03) days

b). Initial Operation

- Duration: Five (05) days

- Start: Earliest twenty four (24) hours after successful completion of trial run

c). Reliability Test Run

- Duration: Thirty (30) days

- Start: Earliest twenty-four (24) hours after successful completion of initial operation

d). Performance Test

- Right after Reliability Test Run: Latest three (03) months after the Reliability Test Run in accordance with approved procedures.

e). Beginning of Defects Liability Period

On the date of Taking Over of the Plant or parts thereof which is to be specified in the relevant TOC, the one-year (01) Defects Liability Period and operation under Employer’s responsibility shall be begin. The Plant or parts thereof will be handed over to the Employer, that means the Commercial Operation will be started.

4.15 Employer’s Right regarding Postponement/Rescheduling

The Employer reserves the right to postpone or otherwise re-schedule tests due to system load requirements, in which case the Contractor will be given a time extension to the contractual completion date.

4.16 Re - testing

Should the plant or any portion thereof fail under these tests to give the performance required, then any further tests which may be considered necessary by the Employer may be carried out in a similar manner but the whole cost of the repeated test shall be borne by the Contractor, except that if the retesting is carried out on the normal commercial load of the station then the fuel, water and lubricating oil used and the normal operating staff shall be supplied free by the Purchaser.

4.17 Additional tests

If additional high voltage tests on AC generator to be conducted on site, as specified in relevant standards, those shall be carried out by the Contractor immediately after completion of the drying out. Testing procedures and test instruments shall be provided by the Contractor.

In addition to tests relevant to the generator specified in Specification, tests shall be carried out to determine the short circuit and open circuit characteristics of the machines.

As no hot lockout limitation for the gas turbine units is permitted, contractor has to demonstrate the starting and re-starting time are within the specified values in the guaranteed particulars.

4.18 Noise tests

Noise measurement tests are to be made outside and inside the station, at points selected by the Employer, whilst each generating set is undergoing its efficiency tests. Readings are to be taken at each load at which the set is tested sound Level Meters and filters shall be in accordance with BS.3489/2475.

4.19 Test equipment

The Contractor shall ensure that all instruments and test equipment necessary for testing and commissioning the plant, including the following instrument are included as a minimum among those available at site for the use of the Contractor and the Employer. When all tests at site have been completed to the satisfaction of the Employer, this equipment remains the property of the Contractor.

- 1) Primary Injection Test Set (0-2000A range minimum)
- 2) Secondary Injection Test Set
- 3) "Ductor" Test Sets for microohm measurements (to cover range 1 amp to 600A).
- 4) Insulation resistance test instruments (500V, 1000V, 2500V and 5000V ranges with suitable long leads)
- 5) True RMS Digital Display multi-meters,
- 6) Phase Rotation meter
- 7) Insulating Oil Test up to 80 kV Set
- 8) Transformer Oil Moisture Measurement Instrument
- 9) Digital Oscilloscope with Memory recording
- 10) High Speed UV Recorder
- 11) Multi-range Clip-on Ammeter
- 12) Transformer Dissolve Gas Analyzer
- 13) Equipment for calibration of transformer winding temperature instruments
- 14) Vibration measuring instruments
- 15) Temperature measuring instruments
- 16) Stroboscope
- 17) High voltage d.c pressure test set (Range 0-50kV minimum)
- 18) High voltage a.c pressure test set (Range 0-50kV minimum)
- 19) Earth resistance test set

- 20) Equipment for calibration of pressure switches and thermocouples
- 21) Prospective short circuit current measuring instrument for small power systems
- 22) Noise level test instrument
- 23) Illumination Level Measuring Instrument
- 24) Phase shifter suitable for testing field failure protection relays
- 25) Distance Protection Test Set
- 26) Paint and Galvanizing Thickness Tester
- 27) Teat plugs to suit all relays and meters
- 28) Tachometer
- 29) Mackintosh probe
- 30) Torsiograph (Unless tests completed during works combined test)
- 31) Circuit breaker Analyzer

4.20 Rejection of plant

If any fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, installation or on completion at Site, the Employer may reject the item, or defective component thereof, whichever he considers necessary, and after adjustment or modification as directed by the Employer, the Contractor shall submit the item for further inspection and/or test.

In the event of a defect on any item being of such a nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Employer.

4.21 Test certificates

Sets of all principal test records, test certificates and performance curves shall be supplied for all tests carried out in accordance with the provisions of this Contract. These test records, certificates and performance curves be supplied for all tests, whether or not they have been witnessed by the Employer. The information given in such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference and headings as given above.

4.22 Taking Over Certificate (TOC)

- a) As soon as the Plant has been completed in accordance with the Contract (except in minor defects that do not affect their use for the purpose for which they are intended) and serve for the obligation of the Contractor according to the General Conditions of Contract (Defects after provisional acceptance), and having:

- Satisfied the requirements of the Reliability Test Run

- Schedule the performance tests at site
- Handed over the complete set of approved "As-built"-drawings,
- Completed the training of Employer's staff regarding operation and maintenance of the Plant,
- The approved Warranty Engineer on Site,
- Handed over the specified mandatory spare parts, consumables and special tools.
- Handed over a time schedule for remedy of all remaining minor deficiencies listed in the list of deficiencies to be annexed to the respective Taking Over Certificate and accepted by the Employer,

the Contractor shall notify the Employer in writing that he intends to hand over the Plant.

The Employer shall, after having verified and confirmed the status of the Plant to be as stated by the Contractor, prepare a certificate (herein called "Taking Over Certificate"(TOC)), duly signed by Employer and Contractor, in which he shall certify the date on which the Plant have been so completed. The Employer shall be deemed to have taken over the Plant on the date so certified, however the issuance of TOC shall not operate as an admission that the Plant have been completed in every respect and were accepted by the Employer. All deficiencies as per the list of deficiencies shall be remedied at the latest until the Project Completion Date.

The TOC shall be issued latest twenty-four (24) hours after the successful completion of the Performance Test under the condition, that the above requirements have been fulfilled by the Employer. If the Contractor has successfully completed the Reliability Test Run and the Employer ask to postpone the Performance Test, the Employer shall issue the TOC latest one (1) day after successful completion of the Reliability Test under the condition, that the above requirements have been fulfilled.

b) If by agreement between the Employer and the Contractor any portion of the Plant shall be taken over before the remainder of the Plant, the Employer shall issue a TOC in respect of that portion. For the purpose of this Clause, unless otherwise agreed in writing, the plant shall be sub- divided as follows:

- 1) Each Turbine Set
- 2) Each Generator Set
- 3) Excitation System with Excitation Transformer
- 4) MV Switchgear
- 5) Electrical Protection System
- 6) Main Step-up Transformers, Auxiliary Transformers, Earthing Transformer and Instrument Transformers
- 7) 400 V Switchgear and Motor Control Centers
- 8) Control Room Equipment and communication Equipment
- 9) Each Diesel Generator Set (Blackstart/Emergency) and its Auxiliaries

- 10) All Cabling and Earthing including interconnection 132 kV GIS
- 11) Metering and DC System
- 12) Fuel Systems (LAD and RLNG)
- 13) Lubricating Oil Storage, Treatment and Transfer System
- 14) Air Conditioning/Ventilation Equipment
- 15) Compressed Air System
- 16) Power Station Buildings, including Building Services & Small power lighting
- 17) Fire Protection System
- 18) Fuel Oil Treatment Plant
- 19) Water Treatment plant

c) If by any reason, including any action on the part of the Contractor, a TOC has not been issued in respect of the Plant or any portion within three (3) months after the time for completion Reliability Test Run or extended time as the case may be, the Employer shall be at liberty to use the Plant in respect of which a TOC has not been issued if and so long as the Plant so used as aforesaid shall be reasonably capable of being used, provided that the Contractor shall be afforded reasonable opportunity of taking such steps as may be necessary to permit the issue of the TOC. No aging tolerance will be allowed to the Contractor on any tests specified in the Contract for any reason.

4.23 Service of Resident Warranty and Service Engineer

The Contractor shall provide One (1) Competent Service and Warranty Engineer who has adequate experience in operation and maintenance of similar plant and based at the power plant for a period of not less than 12 months from the date of taking over.

The Service and Warranty Engineer shall have suitable experience of power plants similar to the plant and shall act proactively to ensure the best performance and availability of the plant is achieved. A CV for the proposed engineer shall be submitted for approval prior to the engineer taking up the appointment.

During warranty period the Service and Warranty Engineer jointly with Staff of Employer shall have to perform the operation & maintenance of the Plant. For this purpose, quarterly progress report of shall have to be submitted to the authority by the Service and Warranty Engineer showing the progress of safe & reliable operation and maintenance of the Plant. In addition, Service and Warranty Engineer shall responsible for

1. Identifies cause of failures and determines appropriateness of warranty part replacement.
2. Performs warranty claims from OEM of various equipment of the Plant.
3. Monitors performance trends, identifies specific failure modes and provides reports on trends.

4. troubleshooting of any defect identified in complex nature
5. Works closely with Employer to assure safe & reliable operation the Plant
6. undertaking major repair of all main equipment in the Plant
7. Any other work assigned as agreed upon by the Employer and the Contractor and

The Contractor shall provide accommodation, messing and flights inland transport and any other local facilities required for the Service and Warranty Engineer.

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