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3.0				

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Contractor	HZI	TSD Lot Turbine Unit	
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Table of Content

1 Introduction with system description

General description: See “TII General Info and Technical Documentation Requirements” (TII-HZI-50060164).

HZI is building a new Energy From Waste Facility near Moscow in the Russian Federation. The plant is designed for the treatment of approx. 700’000 tonnes of waste per year with an average calorific value of 9.1 MJ/kg. The plant will process municipal solid waste and non-hazardous industrial waste with a nominal capacity of 29.2 tonnes of waste per hour and a calorific value of 9.1 MJ/kg.

This Technical Specification Document (TSD) defines the requirements, the scope of supply and services for 1 (one) Steam-Turbine-Generator Unit.

1.1 Definitions and abbreviations

Table 1: Definitions and abbreviations

Abbreviation	Definition
ACC	Air Cooled Condenser
AVR	Automatic Voltage Regulator
CCR	Central Control Room
Contractor	HZI’s contractor
DCS	Distributed Control System (i.e. centralised overall plant control system)
DIN	Deutsches Institut für Normung (German Standardisation Institute)
DNO	Distribution Network Operator’s (UKPN)
EfW	Energy from Waste
EHS	Environmental, Health and Safety issues/ topics
EIC	Electrical and Instrumentation & Control
EMCR	Electronic, Measurement, Control and Regulation
EN	European Normative
EPS	Emergency Power System
FSNL	Full Speed No Load (i.e. rated speed, but no grid connection, nor island mode)
Grid Code	The terms and conditions, codes, and requirements of the external electrical network company/authority/supplier (DNO) to which the plant is connected
HZI	Hitachi Zosen Inova AG
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
MTBF	Meantime between Failues
OEM	Original Equipment Manufacturer
OM	Operating Manual
O&M	Operation and Maintenance
P&ID	Piping And Instrumentation Diagram
PIRS	Project Information Retrieval System

Table 1: Definitions and abbreviations

Abbreviation	Definition
PMG	Permanent Magnet Generator
PSS	Power System Stabiliser
RIO	Remote I/O
SAT	Software Acceptance Test
STG/ STG-unit	Steam Turbine Generator Set (including all components such as gearbox, tanks, valves, etc.)
Supplier	HZI's sub-contractor
Sub-contractor	Suppliers of apparatus and plant components who are not Suppliers to HZI
TCS	Turbine Control System
TII	Technical Implementation Instruction
TSD	Technical Specification Document
UPS	Uninterruptable Power Supply

1.2 Brief description of the system

This “Technical Specification Document” (TSD) defines the requirements, the scope of supply and services (basic and detail engineering, construction, fabrication and manufacturing, works-assembly, quality control at the works and at site, delivery, transport to and unloading at site, complete erection, commissioning, trial and acceptance tests, documentation during the engineering phases and as built documentation), for

One (01) Steam Turbine and Generator Set

including all ancillaries and auxiliaries required for the unit, and as specified within the scope and limits of delivery and services.

The turbine will be part of an energy from waste facility, where the energy from waste is transformed into superheated steam in a boiler system for the purpose of electrical power production, and later district heating, by aforementioned turbine unit. As energy recovery from waste is very important, the turbine system shall be designed to achieve a high energy efficiency. Hence, the Steam Turbine and Generator set shall be designed to operate at its best efficiency within the specified load cases. Attachment 3 of this TSD reflects the process specifications and states the ratings of the various load cases

A part of the electricity will be used for on-site power, whilst the majority is fed into the public grid. For reaching a high level of efficiency the steam turbine shall be equipped with certain steam extractions for preheating purposes. The low pressure exhaust steam from the turbine will be condensed in an ACC.

2 Requirements

2.1 Design basics, function and operating conditions

2.1.1 General planning principles

For operating conditions, water-/compressed air-qualities, voltage levels, technical parameters of the unit etc see “TII General Info and Technical Document Requirements” (Attachment - 1a to TSD)

General design data are specified in attachment 3 "Technical Data Sheet".

The following guidelines are binding for the scope of supply and/or performance. However, they do not relieve the Contractor from the obligation of supplying a product built according to the latest state of the art (as defined in the TSD) even if some particulars are not mentioned. If the implementation recommendations cannot be fulfilled in certain cases, and/or if they introduce e.g. technical drawbacks or if construction defects are obvious, the Contractor has the obligation to report it to HZI and to manufacture the defined product after reaching a suitable agreement with HZI.

For the life time of the steam turbine unit refer to attachment “TII General Info and Technical Documentation Requirements”, document number 50060164, taking into account a continuous operation of the STG-unit and start-ups as defined below.

Table 2: Start-Up Categories and minimum required starts

Number of Starts	Type of Start	Definition of Start
100	Cold Starts	After shut-down of more than 72hrs (typically metal temperature below 40% of full-load value)
1000	Warm Starts	After shut-down between 10 and 72hrs (typically metal temperature between 80% and 40% of full-load value)
2000	Hot Starts	After shut-down of less than 10 (typically metal temperature above 80% of full-load value)

The contractor shall indicate components (e.g. high temperature bolting, last stage erosion shields) having design lives of less than the required life time. The steam turbine unit shall be designed for continuous operation in idle and load mode.

2.1.2 Design data

Attachment 3, “Technical Data Sheet”, specifies the process data for which the STG shall be designed and be operating on a continuous basis and at maximum steam output.

The contractor ensures that the design of the turbine complies with the requirements for bleed pressures specified in the technical data sheet. Following conditions for the entire operation range of the turbine generator unit shall be considered and fulfilled:

- The turbine must be capable to accept the swallowing load case without pressure increase at the turbine inlet. Bidder may propose/ suggest increased turbine inlet pressure in case of efficiency loss due to this load case.
- In case of a sudden failure of the grid connection or the local distribution network, the unit shall automatically switch to Island Mode and thereby supplying all internal consumers with power for an unlimited period. For given scenario the reverse power shutdown shall be bypassed.
- The automatic controls shall maintain a stable operation in the event of abrupt load shedding from any load to island load conditions without nearing the over-speed trip limit of the turbine. Neither opening of the GCB, nor trip of the STG shall happen under such circumstances.

- The STG control system (Open Loop, Closed Loop, Protection) shall be designed for fully automated operation, allowing start-ups, operation, shut-down and emergency operation as well from the CCR as well as the local control panel for the entire STG-unit.
- Local grid codes and requirements shall be fulfilled.
- Turbine operation shall be safe under all conditions, even in the event of a complete AC-loss (black-out). Hence time-critical, safety and protection related signals shall be executed hardwired, whilst other signals are allowed via profibus interface. Provisions shall be taken to prevent mechanical damage of the STG-unit or its auxiliaries in the event of a black-out.

The electrical output from the steam turbine generator unit shall supply the necessary plant and site auxiliary power requirements with the balance of the electricity being exported to the local Distribution Network Operator's (DNO) distribution network via the DNO metering circuit breaker and a cable circuit to the Grid Substation.

2.1.3 Regulation and Standards

General rules and the most important applicable standards, regulations and norms as well as country-specific ones are listed in the TII „Regulations and Standards". As for electrical standards, the document "EIC Standards and regulations" shall be considered (see Attachment 1a, List of General Attachments, Schedule A). The standards and regulations listed in these documents are not an exhaustive enumeration. In general the turbine and its equipment and sub-systems shall be manufactured according to the turbine supplier technical documentation accounting the requirements of the standards, regulations and codes effective in the Russian Federation and the regulations as mentioned in below (Table 3: Regulations).

The design/execution of the equipment and the safety devices for the production, final assembly and operation of the systems are subject to the prevailing national standards, legislation and directives of the country in which the plant is built. More detailed information is given in Terms und Conditions of Purchase; clause 4, Legal and other requirements. The most important applicable standards, regulations and norms as well as country-specific ones are listed in the "TII Regulations and Standards" (see List of General Attachments – 1a, Schedule A). The list is not an exhaustive enumeration.

The design of the Turbine-Generator-Set has to comply with the latest edition of the following Regulations as a minimum requirement:

Table 4: Regulations

Short form	Long form
2006/42/EC	Machinery Directive
TR CU 010/2011	Technical Regulations of Customs Union On safety of machinery and equipment
2006/95/EC	Low voltage Directive
TR CU 004/2011	Technical Regulations of Customs Union On safety of low voltage equipment
2014/68/EU	Pressure Directive
TR CU 032/2013	Technical Regulations of Customs Union On safety of equipment working under pressure
IEC 60034	Rotating electrical machines
IEC 60045	Steam Turbine and Components – Specification
IEC 60953	Rules for steam turbine acceptance tests Part 1: Method A. High accuracy for large condensing steam turbines Part 2: Method B. Wide range of accuracy for various types and sizes of turbines
IEC 61064	Guide to acceptance tests for steam turbine speed control systems

Table 4: Regulations

Short form	Long form
DIN 1943	Thermal acceptance tests of steam turbines (VDI rules of steam turbines)
DIN EN 1991-1-1	Eurocode 1: Actions on structures
DIN EN 1992-1-1	Eurocode 2: Design of concrete structures
ISO 1101	Geometrical Product Specifications (GPS) – Geometrical tolerancing – Tolerances of form, orientation, location and run-out
ISO 2768	General tolerances. Tolerances for linear and angular dimensions with individual tolerance indications
ISO 7919-1	Mechanical Vibration of non-reciprocating machines – Measurements on rotating shafts and evaluation :General guidelines
ISO 7919-2	Mechanical Vibration of non-reciprocating machines – Measurements on rotating shafts and evaluation: Land-based steam turbines and generators in excess of 50MW
ISO 10816-1	Mechanical Vibration – Evaluation of Machine Vibration by Measurement on non-rotating Parts: General guidelines
ISO 10816-2	Mechanical Vibration – Evaluation of Machine Vibration by Measurement on non-rotating Parts: Land-based steam turbines and generators in excess of 50MW
DIN EN ISO 3746 VDI 2713 API RP521	Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane
DIN 45635-1	Measurement of noise emitted by machines; airborne noise emission; enveloping surface method; basic method, divided into 3 grades of accuracy
VGB-R 450 L	Directive for Boiler feed water, Boiler water and steam characteristics
NFPA	
GOST 24278	Stationary steam turbines for electric generators at thermal electric stations. General technical requirements

2.1.4 Arrangement

- The arrangement is on a turbine table/Package unit on steel frame/turbine table - optional with spring elements.
- The direction of the exhaust duct is axial and connected to an ACC.
- The oil unit can be integrated in the package or provided as a separate unit according to supplier concept. In both cases measures are to be taken for retaining oil spillage of the entire oil unit.
- The electrical cabinets shall be located in a container/ E-house (to be provided by OEM).
- All control cabinets shall be located in the container and an additional control panel in the central control room.
- A local control cabinet shall be located in the container and an additional control panel in the central control room.
- The layout of the cabinets inside the E-house is in the responsibility of the contractor; however the layout shall be submitted to HZI for approval to ensure inerrability in the selected E-houses.
- The layout and routing of all cables and communication busses from the turbine local control panel close to the turbine to the cabinets, installed inside the E-house, is within the OEM's scope of supply (distance appr. 50m). The supplier shall submit the cable routing layout to HZI for approval / changes before execution.

2.1.4.1 Design Tool/ E3D Arrangement

The turbine generator set including all auxiliaries, pipes and steel structure needed for maintenance shall be planed and arranged in AVEVA E3D (Version 2.1/ Fix 12; or compatible PDMS version). No STEP-Files are allowed due to the file size. Full KKS-labelling according to submitted P&ID shall be reflected in the E3D-model, where the structure shall be setup according to provided HZI technical specification.

- The E3D-Model must be fully KKS labelled according to the P&ID's submitted by HZI.
- The E3D model structure has to be designed according the technical specifications from HZI.
- For integration purposes, submission of the latest model each Thursday is required via exchange routines to be defined latest at order date of the package
- Regular clash detection by HZI and STG-supplier is foreseen in the course of execution, whereby submitted models shall be collision-free and consistency-checked.
- All descriptions and information in the E3D model shall be in English
- All Drawings and E-mails will be exchanged with HZI PIRS Web Portal. This will request an introduction of the system of approximately 1 day via go to meeting or in ZH. See also PIRS Portal Guide (document TVENG036 in attachment in 1a) for document handling.

2.2 Technical guarantees

The contractor guarantees the technical data in accordance with this specification.

The CONTRACTOR guarantees

- That the implementation of his design and workshop drawings results in complete, functional and reliable equipment, "fit for purpose". This also applies to the design of individual components
- That the equipment has been engineered and designed in such way as to ensure reliable control of all start-up and shut-down operations, operational problems, emergency shut-down and all hazards that may occur during operation of the equipment.
- That no components will be used which are prototypes or first-of-its-kind products, but will all have proven references.
- That the turbine generator set is designed to operate continuously within the load area which is outlined in the load cases specified in attachment 3.
- That the suitability of installed materials with respect to corrosion, erosion and stress is given, taking into account the design specification and the operating conditions that have to be expected.
- That the STG will be designed for operation in an atmosphere precipitation exposure protected building at the minimum ambient air temperature of 1°C (one degree Celsius). The ultimate relative humidity shall be 80% at 25°C.

2.2.1 Availability

The Contractor guarantees the availability of the T/G-set against, unplanned outages for which the Contractor is responsible for, for a period of time of 104 weeks starting at PAC. The turbine and generator unit must be available and fully functional in the entire load range during the operation time.

Availability factor (time period basis) without service contract	98.5	%

The availability factor (time period basis), as per VDMA guideline, is defined as:

$$AF = (1 - \frac{UHO}{PH}) x 100\%$$

- AF: Availability factor (time period basis) in %
- UHO: Unplanned outage hours because of failures for which the supplier is responsible
- PH: Period hours (101 weeks beginning with PAC)

The works must be available in the entire load range during the operation time as per above defined availability factor.

Outages or operational problems due to defects for which the Supplier is or might be responsible shall be reported immediately to the Supplier's service department. Such report shall contain information about the nature and the extent of the defect.

The average MTBF of the STG-unit including all its equipment supplied along shall be at least 5 years.

Begin of the outage:

Moment of the Supplier's receipt of the above mentioned report about the STG outage.

End of outage:

Moment of successful completion of the repair of the equipment which caused the forced outage of the STG-unit.

The STG-unit will be considered as available during an outage of the full incineration plant.

Minor inspections or maintenance activities are possible but must occur during scheduled shutdown periods of the entire incineration plant, respectively during shutdown periods for which the contractor is not responsible.

The interval between two planned maintenance operations must be at least 12'000 operating hours. No components may be used, whose operation life is less than the interval of at least 12'000 operating hours. Major overhauls, requiring an opening of the turbine by removing the upper body casings, shall be at least 6 years. Although it is not important whether the components are used in the continuous or partial operation.

Outages which are caused by test activities not part of the ordinary operation introduce increased operational risks and shall therefore not be considered as unavailability.

Obligations of the Purchaser:

The Purchaser shall keep in storage the spare parts recommended and optionally offered by the Supplier (Spare Parts for 3 years Operation) during the period of the availability guarantee and the Supplier shall have the right to use said spares for his rectification work.

The Purchaser shall operate, inspect and maintain the STG-set, as well as the installation parts outside this scope of supply, properly and according to the supplier's instructions. It is the purchaser's obligation to supervise and record the operation of the STG-set and its auxiliaries by keeping proper operating protocols showing all relevant operating details according to the supplier's instructions. Upon request, the supplier shall have the right to inspect these protocols and to delegate personnel for the purpose of observing the operation of the STG-unit and to make inspections. Such personnel shall have unlimited access to the operating records during the measuring period.

The Purchaser allows on-line monitoring via the I&C system of the STG-set after notification by the supplier as well as the installation of the necessary equipment for this purpose. For this purpose the Purchaser shall provide an internet connection (plug with DSL speed) free of charge to the Supplier.

If the STG- set is shut down for reasons outside the Supplier's responsibility, the Purchaser shall inform the Supplier. The Supplier shall have the right to carry out adjustments and modifications, preventive repairs and maintenance of the unit during such shutdown periods without this being considered as loss of availability.

The Purchaser shall use all reasonable endeavours to carry out work within his responsibility so that the actual deficiency can be corrected or overcome within the shortest possible time.

During the period of availability guarantee, the Purchaser shall keep record regarding the operation of the turbine generator set.

The record shall contain information about all circumstances that could be of importance for the calculation of an outage period. Such a record template shall be developed between Purchaser and Contractor ensuring that all required data will be reflected in the template.

In case shut-down and repairing causing by deposit of impurities, corrosion damage or stress corrosion cracking of supplied equipment (due to chemical impurities) and/or mechanical erosion of supplied equipment caused by mechanical impurities (in entering steam), then the Contractor is not responsible for shortfall in Availability Guarantee and Purchaser shall bear all the cost corresponding to repair of equipment and repairing time is evaluated as stand by.

Purchaser obligation is to provide steam quality according to EN12952-12 and VGB-R 450 L.

2.2.2 Sound pressure level

The noise emission and maximum A-weighted surface sound pressure level (considering 1metre distance) has to be determined according to DIN 45635, ISO 3746 and the local GOST R ISO 9612-2013. No positive tolerance is permitted for mentioned values which shall not be exceeded:

-	Turbine and Generator unit with sound enclosure	≤ 80 *1,2)	dB(A)
-	Auxiliary Equipment	≤ 80 *2)	dB(A)
-	Electrical supply in control room	≤ 60 *2)	dB(A)
-	Any other equipment	≤ 60 *2)	dB(A)

*1) – A sound enclosure for the ST and the generator shall be provided.
*2) - The allowable values for the measuring surface sound pressure level shall be established taking into account the work place regulations or as the result of sound engineering evaluation.

Steam Turbine / Gear / Generator Set or for each component separately

Turbine Generator Package Sound Power level Pref. = 10-12 W

f / Oct	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	∑A
dB									

The sound power level spectrum has to be filled in by the Supplier (Reference level po:2*10-5 Pa).

2.2.3 Special Guarantees

2.2.3.1 Basis for Guarantees

Two tests will be carried out, the turbine performance test and the plant performance test.

In the turbine performance test, the contractor has to prove, that the guarantees are fulfilled. The guarantee figures shall be demonstrated at the end of hot commissioning of the turbine. For the performance test the operating measurement instruments are to be used. The assessment of the performance (e.g. Measurement tolerances) shall be conducted according to IEC 60953-2 "Rules for steam turbine thermal acceptance tests Part 2".

The turbine performance test will be conducted without any third party institution. In case of a not passed test or questionable test results, the next test shall be conducted by a mutually agreed third party institution (e.g. TÜV).

The plant performance test will be carried out by a third party. The scope of measurement regarding the turbine performance will be defined in the measuring program. The contractor has to assist during the test and to analyse the measuring results.

All performance tests are carried out for the specified loads in accordance with the following codes and standards:

- IEC 60953-2 "Rules for steam turbine thermal acceptance tests Part 2: Method B – wide range accuracy for various types and sizes of turbines"

- EN 61064 “Guide to acceptance tests for steam turbine speed control systems” (BS EN 61064 equivalent EN 61064 equivalent IEC 61064)
- VDEW Richtlinien „Eigenerzeugungsanlagen am Niederspannungsnetz“.
- EN Norms and regulations and recommendations for electrical machines/equipment.
- EN and ISO/VDI regulations and recommendations for measurements

Reference Conditions:

- Power factor of 0.85 lag and 0.95 lead
- Grid frequency 50Hz +/-2%
- Rated voltage 10.5kV +/-10%
- Minimum short circuit ration of minimum 0.4 per unit
- Transition inductive reactance of minimum 0.35 per unit

Other Conditions:

- The thermal output (bleed & extraction steam) to the process consumers shall be measured by conducting adequate measurements of mass-flow, its temperature and pressure at the regular process steam measurement points, which are located near to the tie in points and calculated accordingly.
- All required correction curves (must be available at last two months before the performance test)

Correction of the Performance Test Results:

- The correction curves (or graphs) shall cope with all the deviations to the specified operating conditions.
- The scope of correction curves includes a minimum set of curves per Guarantee Value as follows:
  - Load Case
  - Live-steam pressure
  - Live-steam temperature
  - Live-steam flow
  - Bleed pressure
  - Bleed flow (if possible)
  - Bleed temperature
  - Exhaust pressure

2.2.3.2 Guaranteed Power Generation and Parasitic Loads

Guarantee load cases and conditions are defined in detail in Attachment 3 technical specification, which also contain the agreed Heat and Mass Balances. The following guarantee values are to be proven during the performance test:

Table 5: Applicable Guarantees as further detailed in Attachment 3

Applicable to LD	Name of Load Case as described in Attachment 3	Guarantee Value [kW]	MPL
Y	LC1_LPN	73’170	98%
Y	LC1n_BH_5MW_min9DG	72’441	98%
Y	LC1k_LPN_18DG	72’566	98%
N	LC3_LPN_1line	21’588	98%
N	LC11_Island	5’000	98%

Electric power consumption of all electrical consumers included in the steam turbine unit:

HZI	Load Point DC1_LPN	< 70	kW (el)
SUP	Load Point DC1_LPN	……	kW (el)

Supplier to provide the expected power consumption for its unit; HZI indicates the expected maximum value.

2.2.3.3 Vibrations

The STG shaft-line must have measurement instruments for both horizontal and vertical vibration. Following limits are to be respected:

Table 6: Applicable Vibration limits for rotating machines above 50MW installed power

Vibration levels at the bearings/shaft of the turbine generator unit not to exceed the following limits:		
a)	Vibrations of the bearing housing	-The vibration severity of the bearing housing of the steam turbine system in steady state and at all loads must not exceed zone A at any bearing, according to DIN ISO 10816-2. - The STG-unit and the gear box shall have a seismic vibration probe on each bearing. The control system shall handle the vibration signals in connection with appropriate alarm and trip level settings.
b)	Vibrations of the other fixed parts	The stationary parts of the steam turbine plant may show no resonance affecting interfere with their operation
c)	Shaft vibrations	The maximum deflections of the shaft relative vibration of the steam turbine system in steady state and at all loads must not exceed level (close to bearing) the peak-to-peak value in any measurement according to DIN ISO 7919-2, Zone A.
d)	Generator Shaft	The amount of permissible rotor shaft end float shall be stated. Necessary data to verify the lateral and torsional critical speed analysis of the complete generator sets shall be provided. The Supplier shall also deliver the short circuit torque equation for the generator.
e)	Steel Frame and other components	In case the Turbine Generator group is installed on a Steel frame. The steel frame shall be designed as resonance free relative to the mounted equipment. Its eigenfrequency shall be at least 15% lower than the ones of the Turbine Generator eigenfrequencies.
	The measurement and evaluation of the vibrations shall be according to ISO 7919-2 (GOSTR55263.2-2012) and ISO 10816-2 (GOSTR55265.2-2012). The vibrations are measured in - two mutually perpendicular directions on STG bearings and - three mutually perpendicular directions on generator and exciter bearings.	

2.2.3.4 Range of Operation

Below tables define the maximum medium demand of turbine auxiliaries required for the turbine generator unit over the entire range of operation and load cases.

Following figures shall be fulfilled:			
-	Range of operation of the unit at the HP-steam flow rate range taking into account the base mass flow as per design case LPN	10 – 110	%
-	Maximum rotating speed increase at sudden 100% load shedding	max 10%	%
-	Duration of continuous island operation without deloading incineration lines	Unlimited	h
-	Idle operation after load shedding without reaching pressure or temperature limits at the LPT exhaust		
-	Idle operation (FSNL) during start-up prior synchronising the unit or entering island mode operation without reaching pressure or temperature limits at the LPT exhaust or any other operation limiter	>20	hours

Table 7: Maximum medium demand of turbine auxiliaries required over the entire range of operation and load cases

Steam				
Consumer	Required max flow rate [kg/s] **To be defined by Supplier**	Temp. [°C]	Press. [bara]	Remarks
Turbine Sealing System		430	<=0.5	HZI provide the steam to one single connection point at the turbine foundation. See chapter 3.3.1 for detailed interface location.
District Heating				
Heating Facilities	10 MW_{th}	70 to 115		
Cooling Water				
Turbine Lube Oil coolers		ΔT < 7	Δp < 0.5	Nominal 35°C cooling (inlet) / max. 40°C
Turbine Hydraulic Oil coolers				
Generator coolers				
Condensate				
Gland Steam		~20 - 40	< 6	HZI will provide one single interface point for the condensate consumers, from where the supplier needs to route its internal pipe accordingly.
LP Hood Spray				
Flashbox				
Instrument Air				
Valves		~20	6 - 8	HZI will provide one single interface point for the STG consumers, from where the supplier needs to route its internal pipe accordingly.

Table 8: Maximum design values for pressure (PS) and temperature (TS) at the STG interface points and for downstream systems

NOTE: If values mentioned in this table will be exceeded by the STG-supplier potential extra costs will need to be covered by the STG-OEM.

Steam				
Connection	**Interface Number**	**TS [°C]**	**PS. [bara]**	**Remarks**
Live Steam Inlet	0652	441	78	
Bleed 4	0654	210	12	No steam entrance (like glandsteam etc.) is allowed downstream the first loose supplied fitting of the STG-OEM.
Bleed 3	0657	160	6	
Bleed 2	0658	120	1.49	
LPT Exhaust	0660	120	1.49	Exhaust Diameter shall be DN4000

Flashbox to ACC	1052	120	1.49	

2.3 Applicable documents

The STG-supplier shall hand over to the Purchaser all execution, design, installation, operation and maintenance documentation related to the scope of supply. All documents, including data sheets, service logs, regulation system test as well as any quality documentation shall be provided in Russian language.

2.3.1 Technical regulations, instructions and templates

In accordance with the documents listed in “Attachment 1a List of General Attachments". The applicable documents are marked accordingly in the column of the purchasing lot and attached as an Attachment.

2.3.2 Flow diagrams, plans, drawings and parts lists

In accordance with Attachment 1b of this TSD: „List of specific attachments“

2.4 Equipment specific quality requirements

Not applicable.

3 Specification of the scope of supply and of performance

3.1 Scope of supply

The contractor is responsible to include all necessary scope to fulfil his obligations within his limits of supply and performance. The following specifications are minimum requirements.

The contractor must be able to support his design with extensive records of successful operational experience in conditions similar to this project with an identical or closely similar design.

Any deviation from this specification has to be agreed prior to contract. In case of contradictions between this TSD and attachment 3, the purchaser has the right to select his favourable term.

Any provided equipment for the STG-unit shall be transported and delivered preassembled as much as possible, without the need for disassembly on site during installation or commissioning. Like this efficient site work as well as equipment preservation until commissioning shall be guaranteed.

3.1.1 General

The STG-set (also termed as steam turbine unit or unit) shall be a single or double cylinder machine and designed for an operation life of 40 years, regardless of the component and process condition. Components having design lives of less than 220’000 hours (e.g. high temperature bolting, last stage erosion shields) shall be indicated by the contractor.

To ensure the minimum residual life requirements for the steam turbine of 40 years, appropriate maintenance and lifecycle replacement shall be provided by the employer. The steam turbine unit shall be designed for continuous operation.

The steam turbine is pressure-controlled, the live steam pressure being controlled at a fixed set point. In addition, the turbine is power/speed-controlled, allowing the unit to be used for frequency support of the existing network or operation conducted to generate the specified power, thereby allowing the turbine bypass stations to control the live steam pressure.

All instrumentation and control functions for providing fully automatic operation, including all functions as required, with the option of manual operator intervention for start-up or shut-down of the STG-unit shall be applied, considering that the STG-unit shall not trip the entire EfW-plant in case of malfunction or failure.

It shall be possible to control the steam turbine generator unit from the main control room via the plant control system (automated operation) and locally (fully automatic and manual, by sequenced steps). All the necessary signals, alarms and means of access for operation, monitoring, start-up, shut down, re-start and bypass operation shall be linked to the control room for operation by control room operators.

The Governor and AVR systems shall be suitable for both island and parallel operation with the DNO network.

The scope of supply also includes:

- All pedestals, platforms and staircases required to access and maintain equipment and instrumentation, as per O&M manual, installed on the steam turbine unit. This includes as well the platform around the STG-table while a distributed equal load of 1000kgf/m^2 shall not be exceeded.
- Required safety devices
- All required suspensions, supports and holders, while the ones applied shall match the overall plant design
- All the parts to be installed in concrete foundation (anchor bolts, etc.) shall be specified in a timely manner and shall be supplied by the contractor according to the agreed time schedule. Engineering integrates the parts according to the specifications. Responsibility for correct installation remains with the contractor, who also checks and carries out acceptance of the installed embedded parts.

- All the standard accessories and auxiliary equipment (within the contractors battery limits) that normally come with the delivery items
- Special tools and equipment required for operation and maintenance (including the calibration of measuring instruments), repair, and for changing system components.
- All items involved in restoring the original state, in particular if the supply and installation has resulted in the rules and standards no longer being complied with (e.g. missing baseboards, railings, gratings, surface protectors, etc.).
- The possible complete preassembly of the shipment at the plant (coordinated with the purchaser)
- In the case of parts where residual or standing water puddles can form due to steel facing, Finning or profiles that open upwards, drainage holes are to be provided at appropriate locations before the anti-corrosion coating is applied.
- All lifting lugs required to position the equipment including the relevant static certifications.
- First filling of operating supplies for commissioning of the system (lube oil, grease, etc.)
- Statement of all the required lifting tackle for service and maintenance purposes for all parts weighing more than 50kg.
- Piping in the scope of the contractor includes the layout planning, engineering, erection and commissioning. The piping system includes the supports, drawings for embedded parts, embedded parts, mounting system, expansion joints, insulation and any other parts necessary for a reliable and functional system. The STG-OEM shall provide all internal piping (i.e. piping connecting STG components) for bleed-lines, glandsteam, oil systems and as well cooling systems as shown in the P&IDs in Attachment 1b to this TSD.

3.1.2 Mechanical section

3.1.2.1 Steam turbine construction

The steam turbine shall be of modular construction type which shall have the advantage of utilising tested and standardised components in order to assure the required reliability and availability of the unit.

All facilities required for samplings, boroscope inspections, inspection openings, shall be provided for undertaking mechanical checking, acceptance testing and on-going maintenance.

The unit shall be designed to enable complete drainage of water, oil and cooling water up to the defined battery limits.

Provisions shall be made to allow 100% steam flow though the turbine steam inlet valve (ESV) during blow-out, with similar allowable forces at interface. A blow-out device/insert shall be part of the scope of supply, to allow steam deviation during the blow-out operation, and remain at site for potential future blow-out tasks after maintenance works executed on the boiler. After successful completion of the steam-blow the valve shall be rebuilt for operation by the supplier.

In the event of a turbine trip or shut down with a total loss of AC supplies for an indefinite period, the machine shall coast down without any damage. The contractor shall detail any particular procedures to be observed on subsequent restarting with the machine in the hot, warm or cold condition in the corresponding document mentioned in Attachment 2 (Start-Up & Shut-Down-List).

3.1.2.2 Casings and Pedestals

Casings, pedestals and supports shall be designed to withstand all normal and emergency service loads, piping forces and moments, and movements caused by temperature. The casing design shall minimise thermal stress during operation and service.

The turbine casing has a centre line symmetrical support in order to maintain proper alignment. Casing and supports are designed to prevent excessive stress caused by temperature differences. Casings shall have a horizontal split-line remaining tight for a minimum period of 50,000 hours of operation without attention.

It is preferred that wherever the casings are alloy steel casings, wrought steel type extensions shall be welded in the works to all pipe connections to the casings. Each extension shall terminate in a cylindrical portion of equal diameter and thickness to the pipe work that is to be attached to welded in situ.

The LPT casing shall feature a rupture disc for the maximum expected flow and open at 1.2bara.

3.1.2.3 Rotor

The rotor shaft, discs, blades and attachments are to be of proven design, and materials are to be consistent with the temperature and stress levels encountered.

The assembled rotor shall be statically and dynamically balanced to a high degree, consistent with the speed of rotation and mass of the rotating assembly. Dynamic balancing shall be carried out as per DIN ISO 1940-1. The balancing shall be done in the presence and to the satisfaction of the PURCHASER and the Employer in accordance with the Contract. The contractor is to ensure that the STG shafts will be dynamically balanced as per VDI 2060, grade G2.5 and to ensure that physical overspeed tests are be carried out on the turbine up to at least 110% for 3 minutes of the nominal speed to ensure the mechanical integrity of the shaft and blading.

Rotors shall be fully capable of safely withstanding a 20% over speed at 15 °C throughout their design life and a three phase short circuit of the generator at 100% voltage (based on a short circuit torque equal to five times full load torque).

The Contractor shall be responsible for full torsion lateral analysis of the complete turbine/generator rotor system. The critical speed of the rotating element of the complete unit shall not lay within the limits of min. 15% above and min. 15% below the nominal running speed.

Coupled critical speeds shall be outside the range 90-110% of the nominal speed. The turbine rotor is machined from a solid forging of alloy steel as mono bloc construction. Welded rotors will be accepted provided that the constructor has a proven record in the operation of similarly constructed rotors of similar rating to that offered.

3.1.2.4 Blades

Blading shall be designed and constructed to avoid the possibility of damage from vibration whether synchronized or not.

The blades at the low pressure end shall be provided with an additional edge protection where necessary. Turbine blades exposed to droplets shall be protected against erosion, and an h-s diagram of, at least, the last stage blades (LSB) shall be part of the STG design documentation.

3.1.2.5 Valves – General Requirements

Valves shall wherever possible be positioned in horizontal steam pipework runs, and sloped in accordance with applicable codes to ensure proper drainage (in direction of flow) and prevention of water hammer. Measures for extraction, main steam, equipment isolation and drain valves as defined in VGB-R 103 and ASME TDP-001 shall be taken, so that no single failure of equipment results in water entering the turbine.

All valves installed in bleed lines shall feature spring-loaded actuators for quick closing in the event of a trip. In such an event the installed solenoid shall interrupt the air supply, ensuring that the spring-loaded cylinder closes the valve.

3.1.2.6 Trip Valve and Control Valves

The turbine shall be provided with a single combined stop and emergency stop valve.

The emergency stop valve

- Shall be capable of being tripped locally by hand at the turbine.
- must be designed according to the design pressure of the live steam pipe

- shall have a mechanism to perform on-line stroke tests verifying proper movement
  - without the need to deload the STG unit and
  - without opening the bypass valves

The design of the inlet valve

- ensures that the turbine efficiency will not be decreased too much at partial load (i.e. minimum number of internal valves to be considered)
- will minimize/avoid pumping effect at intermediate working points
- shall have a mechanism to perform on-line stroke tests verifying proper movement

The emergency shut-off valves of the turbine shall be designed in a way that makes it possible to carry out pressure tests (after steam purging) against it. If provisional installations are necessary, this shall be included in the Contract.

The pre-pressure control valve shall be able to keep the steam pressure constant.

3.1.2.7 Non-Return Valves

Each steam extraction or bleed line shall include at least one (01) pneumatically operated check valve and one (01) non-return valve for each extraction or bleed. Detailed information are reflected in 1b.

The design of the bleed valves (Non-return or Check) shall be as in the contractually agreed P&ID. These valves are within the supplier scope of supply. HZI will indicate in a later point in time the delivery destination as it may differ from the Site.

The turbine design shall prevent the ingress of water and reverse flow of steam from the bled steam, feed water and condensate systems, while all non-return valves shall be located as close as possible to the turbine. All non-return valves shall be provided with position indication (local and remote) to show correct operation and facilities for on-load test.

The bleed steam isolating valves shall be actuated and arranged to fail safe. The Supplier shall specify the closing time and pressure against which the isolating valve must close, which shall be reflected in the valve specification and demonstrated during commissioning. Under no circumstances however pressure-drops exceeding 1% of rated pressure or closing times greater 1second shall be tolerated for these valves.

Any safety related fitting or measurement required for the safety of the steam turbine unit shall be provided by the STG-OEM and handled in the TCS.

3.1.2.8 Vacuum Breaker

During the tender phase the Contractor shall advise the design of the required vacuum breaker valves for a safe operation or shut down of the turbine. The design has to be approved by the purchaser in regard to the overall plant operations and safety concept. The approved design has to be included in scope of Contractor.

The vacuum breakers are automated. Alternatively the vacuum can be broken via the exhaust system; the Contractor shall submit a proposal to be reviewed by the Purchaser.

3.1.2.9 General Valves

All valves and other equipment that are used in connection with automatic start, operation and shut down of the plant shall be equipped with the necessary electrical/ pneumatic actuators.

3.1.2.10 Steam Strainers

The turbine shall be protected against damage by foreign objects by installation of a solid steam strainer.

Permanent steam strainers shall be provided to prevent the entry into the machine of any foreign matter liable to cause damage. Each steam strainer may be either separate, or integral with the emergency stop valve. It shall be of robust design, and shall be arranged as to permit easy inspection and cleaning.

3.1.2.11 LP Turbine Exhaust and Exhaust spray cooling system

The exhaust system shall incorporate access provision required for maintenance and inspection of the turbine discharge and LP bearing areas, without dismantling of the casings. The access provisions shall ensure that no leakage occurs.

The exhaust system design shall minimise the pressure losses between the turbine discharge flange and the condenser. Additionally, the design shall be such as to minimise the noise levels produced by the exhaust system comply with the noise levels specified. The exhaust system shall be externally insulated and clad or suitably enclosed if required to meet the specified noise levels. The turbine exhaust system shall include a cooling water spray system as required for operation of equipment. The spray system will use condensate supplied by the condensate extraction pumps. All necessary interconnecting pipe work and fittings, filter, isolation and control valves, controls and instrumentation shall be provided by the STG-OEM.

3.1.2.12 Gland steam sealing system

Turbine gland sealing steam shall be obtained from the live steam header or a dedicated auxiliary steam header, with an automatically controlled sealing steam system be provided. An injection cooler (attemperator), if necessary for reducing the sealing steam temperature, shall be supplied and be fed from the main condensate system.

A gland steam exhauster system, consisting of a condenser and steam ejector, shall recover heat and condensate to the feedwater system, while non-condensable gases are exhausted to atmosphere outside the turbine building. The condenser shall be of surface type low pressure heater, arranged in the main condensate line and designed for maximum pressure of the condensate pumps. For the steam-air mixture a single-stage jet-ejector, designed for the air-steam-mixture of the last chamber of the turbine, with end coolers shall be applied. Mentioned coolers shall be designed together with water chambers and non-removable tube bundles pf straight brass tubes, while the water chambers shall be removable.

Steam supplied into the labyrinth seals shall not be discharged into the turbine hall. It shall be possible to check the clearances in the outer labyrinth through a removable cover without removing the turbine casing.

Control Valves applied in the gland steam sealing system shall be provided with a 50% (minimum capacity) bypass control valve, and have upstream and downstream double isolation valves allowing maintenance work without the need to shut down any parts of the Works.

3.1.2.13 Drain System and Flashbox to ACC

A complete automatic (pneumatically actuated) drain system for the safe and efficient start up, shut-down and operation of the turbine with by-pass of the drains shall be provided, including a flashbox and expansion pipe which will be connected directly to the ACC. The by-passes shall be all together remote controlled with all necessary controls and instrumentation from the local and remote cabinet for opening and closing (e.g. turbine start-up).

Turbine drains shall be provided at all locations where condensate may accumulate within the turbine casing and within steam lines situated after the turbine stop valves.

Sufficient drains shall be provided to enable removal of all condensate generated during turbine operation including during start-up and low loads. In case the drain and warming connections are discharged to the condenser via a flashing vessel, individual drain lines shall be deployed.

When drains are taken from areas which normally contain superheated steam, automatic drains isolation shall be provided through actuated valves. Provision shall be made for both controls local to the valve,

and remote control together with indication. All drain valves are to have automatic open to override local and remote manual close.

The use of steam traps for turbine drains isolation shall not be accepted, unless coupled with bypass pneumatic valves.

Where drains are taken from areas which normally contain saturated steam, the drain lines shall be open flow type.

Manual isolating valves shall be fitted upstream of all flow control devices incorporated into the drain lines, including the powered isolating valves, to facilitate maintenance.

All drain pipes shall be routed to allow condensate to drain to the condensate tank by gravity and shall not rely on a pressure differential between the turbine and the condensate tank. Where it is not possible for condensate to be returned by gravity alone, drains shall be routed to a separate condensate tank and then pumped to the main condensate tank. Provision shall be made for any flash steam which may arise in such a tank due to condensate being collected at different pressures.

- Condensate collecting and pumping station shall be in the scope of supplier supply.

3.1.2.14 Turning device

The STG shall be provided with an AC motor driven turning gear arrangement, rotating the complete rotor system to limit thermal distortion of the rotor when not turning under steam. A fully automated operation during start-up and shut-down shall be ensured, while a synchronised self-shifting clutch will automatically disengage when the rotor speed exceeds the turning speed.

In the event of an AC-loss (power failure) the turning gear system shall be supplied from the STG-OEM provided UPS/ battery system for at least 2 hours. Local operation by means of a hand crank shall be possible, while operation without proper oil supply shall be interlocked for any operation of the turning gear system.

All necessary alarms indicating a turning gear trip or failure shall be provided.

3.1.2.15 Turbine Couplings

Turbine couplings shall be designed to withstand the highest anticipated torque at the coupling without risk of sustaining permanent damage to the components or relative movement of the coupled halves. All couplings shall be designed to withstand the maximum torque that is envisaged to occur during a short circuit fault of the generator. As a minimum this torque shall be modelled as minimum 3.5 times the nominal torque on the drive coupling

The load coupling shall be designed for ease of removal and replacement without the need for re-balancing. The design, shall, as far as practical, minimise windage.

All couplings shall be provided with guards.

3.1.2.16 Conservation System

At standstill of the STG-unit for longer periods, a dry-air conservation system shall be connected to it. Dry-air conservation equipment delivery including necessary nozzle pipes, connections, hoses/tubes, extension cables etc. shall be included within the supplier’s proposal. Available power connection onsite is 400V AC.

3.1.2.17 Forced Air Cooling (Accelerated Cooling)

Provision and equipment for forced air cooling of the steam carrying parts shall be foreseen allowing the turbine to be faster accessible for outage or repair works. Cool-down ejectors shall be designed for the turbine forced air-cooling and be of steam-jet-type without coolers.

3.1.2.18 Bearings

In general bearing shall be designed to

- dismantle the bearing seals without removing the turbine casing or dismantling the generator
- provide protection against the ingress of moisture and foreign matter, and oil leakage
- suitably ground installations preventing damage to bearings by any shaft currents which may occur
- indicate the lube oil temperatures in the supply and discharge lube oil pipes

Journal bearings shall

- be of the oil pressure lubricated type
- have be equipped with white lined metal/ babbit
- be designed to limit hydrodynamic instability
- have horizontal split line to afford ease of inspection, removal and replacement without removal of the rotor
- ensure stable running of the rotor under all operating conditions
- be equipped with thermistors (RTD or TC) permitting continuous temperature monitoring.

Thrust bearings shall

- Be of the double acting tilting pad design, and axially adjustable
- contain indications for excessive axial movement of the shaft due to thrust wear.

3.1.2.19 Lubrication and control oil system

The oil system shall be designed to adequately supply the requirements of the turbine and generator under all operating conditions. Components of the oil system which are not mounted on the turbine shall be supplied as an assembled module.

The lube oil reservoir shall

- be fabricated from carbon steel
- be equipped with the required connection to the oil purifier, level indicator and access opening
- be sized with sufficient working capacity, adequate retention time and proper rundown capacity and for at least 22 m^3
- contain a double wall or a retention wall for 110% of oil volume

The **lube oil unit** shall feature

- One 100% main oil pump AC-driven or directly driven by the turbine
- One 100% AC -driven auxiliary (backup) lube oil pump
  - for start-up, shutdown and excessive pressure drop conditions in the lube oil system
  - for automatic start in case of a drop in oil pressure
- One 40% DC –driven emergency lube oil pump for the event of an AC-loss
  - the control shall be electronically fail-safe
  - It shall be ensured by proper means that the pump shall always work in emergency cases.
- Means for online-testing of standby pumps such as auxiliary and emergency lube oil pumps
- Acid free oil with a flashpoint beyond 120°C
- Welded pipe connections between oil reservoir and bearing connection points
- Design consideration for preventing oil spillage onto hot surfaces, where physical obstructions shall be used as much as possible
- Thermostatically controlled heater(s) minimising the formation of carbonaceous solids on the one hand, while heating the oil at full rated purification flow rate to required oil temperature for operation
- Lube Oil Pressure at shaft centre line between 0.69 and 0.78barg (to be determined by the supplier)

- Turbine oil supply system shall be designed to operate on the turbine oil T-22 GOST 32–74, Tp-22 with additives GOST 9972–74, Tp-22C grade 1 or 2 TS 38.101821-2001
- The oil tank shall have installations for emergency discharge and tank emptying

The **control oil circuit** for driving the safety equipment shall feature

- A separate tank to the lube oil unit may be used
- If a separate control oil unit will be deployed, other oils may be used (subject to Owner's approval)
- 2x100% AC-driven main control oil pumps providing a system pressure of 137barg (to be determined by the supplier)

NOTE: Oils which will be used shall be manufactured in the Russian Federation.

If positive displacement pumps are employed, pressure relief valves shall be provided in each case for the full flow quantity.

The different oil systems shall be easily distinguished by a clear arrangement and different colouring.

The oil which has been used for oil flushing shall be replaced by the first oil filling for operation of the turbine generator. Fine filters shall be used during oil flushing (provided by supplier). HZI reserves the right to take oil samples for analysis by 3rd party laboratory. Depending on the analysis results, HZI reserves the right to approve / refuse the used oil. All the facilities necessary for commissioning shall be provided.

A. Oil filters

Suction strainers shall be provided at the suctions of each tank mounted pump. Removable fine mesh strainers shall be provided in the oil tank to filter the return oil. Strainers or filters used during commissioning shall be replaced prior to the turbine being put into commercial service.

For the filters applied in lube and control oil system the following criteria shall be considered:

Element	Lube Oil System	Control Oil System
Filter	Duplex, 2x100%	Duplex, 2x100%
Filterelements	Replaceable elements or cartridges	Replaceable elements or cartridges
Online -Changeover	Yes	Yes
Supervision	Delta-P, alarms, local indication	Delta-P, alarms, local indication
Design features	• Online servicing possible • Easy removal of filter elements • No contaminant bypass during service works • Self-venting filters • Pressure-equalising equipment • Drain for clean and dirty oil side	

B. Oil Vapour Extractors

An oil tank mist extraction system completed with at least 1 x 100% extraction fans shall be provided to prevent back pressure building up in the oil drain system of the steam turbine and generator under all operating conditions. The system shall be designed for continuous operation at the maximum lube oil temperature and shall minimise oil carry over.

The mist extractor shall be self-cleaning, however also be washable in the event that it becomes saturated with contaminants. All oil mist retained by the extractor shall be returned to the lube oil tank. The ventilation opening at the mist extractor shall be routed into the direction of the base plate. A separate, removable drain collection device shall be installed to collect all oil which may escape with the exhaust.

C. Oil Purifier

A continuous oil purification system shall be provided for the STG-unit to ensure that the lubricating oil is maintained in a sludge and water free condition. The purifier shall contain all necessary accessories and special tools including a leakage collection tray and be designed to fit the following requirements:

- Minimum of 10% oil volume capacity
- Total Water Content in oil system < 0.05%
- Removal of any solid particulates above 5 micrometers
- Permanently connected to the oil system to be used when the STG is either running or shut down
- Parts liable to corrosion (during regular operating conditions) shall be made from stainless steel
- No removal of additives or inhibitors, if any , is allowed
- The entire purification system shall be portable and vacuum-type

3.1.2.20 Design conditions for Lube oil and Generator cooler

Below is a summary of the conditions as specified in attachment 3 "Technical Data Sheet".

One 2x100% oil cooler on top of the oil unit and suitable for online changeover shall be provided. Heat exchanger surfaces shall be removable for maintenance and along with provided accessories be suitable for satisfactory long term operation. Coolers shall feature:

- Tube or plate type cooler
- Valves for simultaneous oil and water changeover during operation
- Temperature and pressure gauges on inlet and outlet
- Thermal expansion valves located in safe zones
- The cooling water side pressure shall be greater than the lube oil pressure
- Vent and drain connections with manual valves on both, oil and water, sides
- Drain lines from valve connection down to collecting funnel (one single interface to HZI funnel)
- Heat exchangers shall be designed in accordance with the relevant standards/codes (ASME or DIN) and recommendations of HEI.

Oil cooler Specification as per below information:

Table 9: Oil cooler Specification as per AGK

Note that values given in table below are for reference, and subject to OEM design				
Parameter	Unit	Oil Side	Water Side	Remark
Nominal flow rate	[t/h]	30	120	
Nominal temperature Inlet	[°C]	55	37	
Nominal temperature Outlet	[°C]	45	44	
Nominal delta p	[bar]		<0.5	
Hydraulic resistance	[bar]	0.3	0.05	
Max Pressure	[barg]	19.7	11.8	Water pressure may exceed oil pressure by not more than 0.24bar

Cooling water shall be supplied to the turbine oil coolers in the volume of 120 t/h, as well as to the generator air coolers in the volume of 200 t/h. These values shall serve as reference and are to be defined during execution.

3.1.2.21 Thermal insulation

Insulation with an oil/ water-tight hard cover shall be provided for the STG-unit where surface insulation package is preferred. Heat radiation which might cause damage to the foundation shall be avoided. Asbestos insulating material shall not be accepted. Housing flanges shall be provided with reusable insulating sections.

Exception: Hot sections which cannot be insulated, such as observation openings, shall be provided with corresponding contact protection. (Exceptions must be agreed with the purchaser).

3.1.2.22 Turbine cladding acoustic hood

A turbine acoustic enclosure shall be provided which is to be installed on the maintenance platform. The Contractor shall be responsible for ensuring the satisfactory interface of the turbine acoustic enclosure with the enclosure of the generator package Additional acoustic cladding, if required, shall be provided for the cylinders and steam chests.

The enclosure shall feature the following:

- Allow maintenance to be carried out on the turbine with a minimum of additional work
- It should be possible to remove sections of the enclosure for maintenance access with minimum disturbance to pipe work
- Acoustic seals shall be fitted to all access doors, pipe work/base frame joints, service penetrations and internal wall joints
- Equipped with fire detection and fire fighting devices with cabling to a common junction box.
- Required fire protection equipment (supplied by others) can be placed at appropriate positions
- Appropriate lighting and escape illumination
- If the enclosure contains a roof
  - Ventilation shall be provided as required per applicable standards, Legislation and Department Building Control approval (usually 2x50%).
  - Fans must be accessible with the necessary safety provision for maintenance reason
  - Ventilation flue shall terminate inside the building and shall include all necessary supports and fixings.
  - STG-OEM to advise the expected heat rejection rate from the enclosure, discharge duct

The turbine body shall have a cladding equipped with doors to provide access to the turbine without removal of the cladding. The cladding is designed for the turbine aesthetic appearance, heat insulation, protection from damage, operating plant noise reduction, establishment of comfortable conditions for maintenance personnel work.

3.1.2.23 Turbine Generator Set Foundation Block

The steam turbine generator will be supported by a steam turbine table design, where the concrete structure will be provided by the Purchaser. The contractor shall provide sufficient arrangement drawings and loading information to enable the support structure to be suitably designed and constructed.

Scope of supply (Engineering)

Depending on the selected support type, the following documents shall be supplied as a minimum (to be discussed in details with Purchaser during pre-engineering phase):

Design criteria for civil detail design of the machine foundation should, at least, contain the following items which are related to specific input from the STG manufacturer:

- Structural and functional requirements
- Loading data: typology of loads, simultaneity of the different loads in normal operating and emergency (short circuit, blade loss) conditions

- Serviceability requirements regarding allowable deflections to prevent the rotor to be misaligned or damaged like, but not limited to, vertical/horizontal deflection limits of the rotor shaft axis and flexibility limits of bearing supports.
- Allowable settlement (max and differential settlement).
- Dynamic requirements like, but not limited to, natural frequencies range to be investigated and allowable vibration velocities (or displacements).
- Machine foundation design specific applicable code and standard (other than the usual ones like ISO, Eurocode or DIN where applicable).
- Supplier is required to submit an Analysis and Design report of the machine foundation (Concrete or Framed). This report shall detail both rigidity (integrity), and dynamical behaviour of the foundation in all operation modes (Nominal, Cold / warm starts, island, emergency stop, Blackout, etc.)

In addition the following information is required:

- Mechanical outline
- Foundation outline
- Foundation loads and masses (rotating and static) with center of gravity (in horizontal and vertical direction), and unbalance loads at rotating speed (for vibration velocity assessment).

The design criteria shall also include

- Additional information related to min. requirements for structural materials (concrete and steel)
- Definition of special load factors to be used in load combinations etc…
- Anchorage layout and embedment details drawings.
- Formwork and reinforcement drawings

Scope of supply (Hardware)

The contractor shall define general requirements for embedded plates (if applicable), angles, etc., which are to be provided in the foundation for the attachment of supports for pipes, cable trays, etc.

The contractor shall provide all required anchor bolts and embedded parts for the turbine generator and its main auxiliary units.

The contractor shall provide the necessary foundation hardware for all equipment items included in the scope of supply. The hardware shall include, but not be limited to, foundation bolts, nuts, washers, sole plates, anchors, guides, keys, and shims.

The delivery of foundation hardware as necessary shall be arranged to meet the requirements of the civil works program. The contractor shall approve the foundation before pouring concrete. The contractor shall check and approve the foundation after pouring but before installation of Turbine-Generator-Set.

3.1.2.24 Spring elements (option)

The Contractor shall provide an appropriate number of spring elements to prevent vibrations transmitted to the building structure. The contractor shall advise the purchaser where to position the spring elements. The Contractor should hand over installation and erection guidelines even if in case he is awarded the erection of springs.

3.1.2.25 Preheating and drying devices

The steam turbine generator unit shall be equipped with preheating and drying devices.

3.1.2.26 Special Tools

The contractor shall provide one complete set of all necessary special tools, instrumentation and equipment as required for site installation, start-up, commissioning, testing, operation and normal maintenance of the STG-unit and associated equipment. Below list reflects the minimum expectations and does not claim being exhaustive.

- **Turbine & Gear Box**:
  - Rotor coupling alignment equipment
  - Turbine, gearbox and generator assembly setting pieces
  - Control valve's insertion disassembly preparation
  - Valve cage disassembly preparation
  - Control valve cone disassembly screw bar
  - Emergency stop valve spring assembly preparation
  - Lifting device for dismantling of radial turbine bearings
- **Generator:**
  - Rotor withdrawal tools (lifting beams and ropes are not included)
  - Sliding plates
  - Rotor support shoe
  - Sliding pedestal

A complete list of special tools along with instructions and diagrams for tool use (where applicable) shall be provided.

3.1.3 Electrical section

3.1.3.1 Power supply

The equipment shall be complete in all respects and shall include all items which are necessary for safe and proper operation and maintenance. The list of approved Contractors can be found in the document "EIC List of Approved Products and Suppliers".

The STG-unit must be designed to operate in the electrical system shown in the single line diagram and which is operated as described in the "Electrical power system functional description" document no. 50060338.

The equipment and system must also comply with the requirements of the documents listed in Attachment 1a 'List of General Attachments' document no. 50061387 -1a.

The voltage levels are specified in the document 'TII General Info and Technical Document Requirements' and as per EIC specification (see Attachment 1a).

A to the STG dedicated complete independent UPS system shall be provided and installed in the STG-E-House to guarantee a safe shut down without causing any damage during a plant blackout.

The NFPA recommendations relating to Turbine electrical systems must be complied with.

Supply, design, routing and installation of all cables and communication BUS from the turbine local control panel close to the turbine, to the cabinets installed inside the E-house is within the supplier scope (appr. distance of 50m). The cable trays installation (from local control panel to E-house) is within Purchaser scope of supply. All LV process, lighting, power and control cables shall be low smoke, zero halogen (LSZH) rated, installed in accordance with the requirements of BS 7671:2008+A3:2015 (seventeenth edition of the IEE wiring regulations).

Supply, installation and testing of the control cabinets are part of Contractor scope of supply.

3.1.3.2 STG Control and Monitoring System

- **Instrumentation and controls**

Complete, permanently wired, analogue and binary signal preparation as well as processing equipment for the following of the STG-unit:

- Turbine control, protection and monitoring system for fully automatic start-up, operation and shut-down, automatic function groups, including remote monitoring and control
- Stator winding temperature monitoring and detection for alarm and trip functions shall be provided by means of embedded temperature detectors in at least six positions in accordance with IEC 60034. These shall be of resistance temperature detector (RTD) type (platinum type 100 Ohms at 0°C according to DIN 43760 or IEC 60751) and two per phase, embedded in the windings before impregnation.
- Synchronisation system
- Drain valves for automatic cold start-up
- Monitoring Equipment
- Emergency-off of the Turbine & Generator Unit
- Control of all ancillary and auxiliary drives
- Measuring-data interface
- Hardwired interface to MV-Switchgear and overall plant protection (trips) (according to scope of supply)
- UPS system for emergency oil pump and other required equipment (including charging unit)
- DC Pump starter unit
- Motor control centre for all consumers within the scope of supply (to be placed in the E-house)
- Soft starter units if applicable
- Earthing, cabling and Wiring according to TII Cable, Trays and Wiring
- Bearing metal temperature (including thrust bearing) with two sensors installed (one spare)
- All instruments, instrument systems and I/O shall be designed to fail safe in accordance with process consideration for the safety of personnel and to maintain the integrity of the plant and equipment
- All transmitters shall be rated for IP65, while field instruments and control devices shall be IP55 minimum
- Process pipework to connections to instrumentation shall have lockable isolation valves fitted; for instrumentation hook-ups, valve manifolds (3 way or 5 way) shall be provided upstream the individual field instruments enabling testing and venting

➢ **Local and Remote Instrumentation**

Scope of supply is the complete instrumentation for local and remote indication, according to PI&D (follows later) for the entire STG-unit and as required for safe operation and also trouble shooting of the Works. Hardwired instruments (i.e. measuring instruments, actuated valves) shall be connected to common junction boxes except PT100 and thermocouple sensors.

Pre-assembled units shall be furnished completely with all electrical and instrument installation and cabling.

As a minimum the following shall be provided:

- Temperature gauges and probes for inlet, outlet and extraction lines
- each temperature probe location shall have a duplicate empty thermowell (with blanking plug) for insertion of a sensor for verification of instrument readings unless a local temperature measurement is provided already
- Pressure gauges and transmitters for inlet, outlet and extraction lines
- Level gauges and transmitters duplicated with safety sensors at the water trap upstream the inlet

Temperature detectors and indicators of approved type shall be provided for measuring the maximum internal temperature of the generator and the cooling medium temperatures (cooling medium waterside is not in the scope of the Contractor). The positions shall be subject to agreement and provision should be made for the following requirements as a minimum:

- Stator windings, between coils in slot,
- Cooled air from coolers,
- Hot air from generator,
- Bearings (generator and exciter),

Spares on terminal board for test purposes need to be foreseen (Test purposes for temperature probes on generator for air and bearings: 2nd Pt 100 element will be connected to the spare terminals in cabinet. Winding temperature of generator: 3 spares will be used for test purposes, connected to the cabinet).

- **Steam Turbine Control & Governor**

Digital turbine control shall consist of, but not be limited to:

- Speed governor
- Frequency control
- Load governor
- Steam bleed pressure control
- Main steam inlet pressure control.
- Cos (Phi) controller

An electronic turbine governing system, capable of providing safe operation of the turbine, shall be employed. The frequency-power characteristic, including the governor valves, shall have a response sensibility of less than 0.03Hz of the rated frequency.

The permanent variation in speed between no load and continuous maximum load, (droop) shall be normally 4%, with on load and off load adjustment between 1% and 8%, in steps of not more than 0.5%. It shall be possible to change the deadband if required.

The Contractor shall provide all necessary dynamic response data for behaviour of the governor/turbine generator to be assessed under both plant and system disturbances (during engineering phase). This shall include:

- The governor frequency dead band in Hz.
- A simple block diagram representation of the governor and essential components of the turbine and generator with the appropriate transfer functions.

The governor equipment shall include a load-limiting device.

Electronic over-speed trips, two out of three, shall be provided to operate and cut off steam, by closing all turbine supply valves, when the turbine speed rises to a predetermined level which shall not exceed the normal speed by more than 10%.

The devices are to be readily accessible for adjustment purposes and each capable of being independently tested when the turbine is at any load without tripping.

The control system must have a password protected frequency step, and ramp, injection function specifically to perform Grid frequency response tests. This function should interrupt the Grid frequency feedback to the governor and replace it with the simulated frequency to achieve the required the ramp and step.

- **Steam Turbine Protection**

Hardwired STG protection shall be applied for shutdown and protection against accidental switchon. Two channel electronic over speed protection, independent from the speed control, which can be completely tested and verified during normal turbine operations.

Emergency shut-off criteria shall include (at least):

Turbine over-speed trip	2 out of 3
Lube oil pressure low trip	2 out of 3
Lube oil temperature high trip	2 out of 3
Axial displacement excessive trip	2 out of 2
Differential Expansion	1 out of 1
ACC Hotwell level high-high trip (external trip)	2 out of 3

Manual emergency trip	
Remote emergency trip	
Shaft vibration trip (Dual voting)	1 out of 1
Absolute Vibration	1 out of 1
Excessive bearing temperature Alarm	1 out of 1
Protection inputs (hard-wired) from other equipment	
Active Fire Alarm Protection	Trip of STG in case of fire alarm
Exhaust pressure	2 out of 3
Exhaust temperature	
Live steam temperature gradient	
Live steam temperature low	
Live steam pressure low	
Stress Control limitation (if applicable)	

- **Generator protection**

The protection shall meet the requirements of the ENA G59/3 (G59/3 relay in HZI scope of supply) engineering recommendation and the following requirements:

The protection shall be arranged into two (2) groups with separate DC power supplies, trip output contacts, and separate CT and VT (110 volts) cores. Each group shall include sufficient functions to provide adequate protection in the event of a failure of one group. The protection relays shall have duplicate tripping contacts and each set of contacts shall be connected to a trip/lockout relay.

The protection system shall include continuous supervision for all tripping circuits and DC supplies.

A minimum excitation limit device shall be incorporated to prevent the AVR reducing the generator excitation below a value that might endanger power system stability limits. The limit unit shall be arranged to provide an alarm and interlock in the event of extreme low excitation when operating under either automatic or manual excitation control.

The protection shall meet the requirements of the ENA G59/3 engineering recommendation and be arranged into two (2) groups with separate DC power supplies, trip output contacts, and separate CT and VT (110 volts) cores. Each group shall include sufficient functions to provide adequate protection in the event of a failure of one group. The protection relays shall have duplicate tripping contacts and each set of contacts shall be connected to a trip/lockout relay.

The generator protection system located inside the generator panels in the container, shall include but not be limited to and is more detailed reflected on the SLD:

Device No	Protection
24	Volts per Hertz
25	Synchronisation check
27	Undervoltage
32	Reverse power (two reverse power function shall be provided, one for normal shutdown and one for abnormal shutdown)
40	Loss of field
46	Negative Sequence
49	Thermal overload or temperature monitoring

50BF	Breaker failure
50/27	Inadvertend energisation (at standstill)
51V or 21	Voltage restrained overcurrent or impedance
59	Overvoltage
60FL	Voltage balance to inhibit tripping of voltage dependent relays for a loss of a VT fuse. A blown VT fuse condition shall be alarmed in the control room and transfer excitation system from automatic to manual control.
64GP	Stator ground (100% of winding)
64F	Field ground
78	Out-of-step (loss of synchronisation)
81U	Underfrequency
81O	Overfrequency
87G	Generator differential
	AVR power supply failure and failure protection
	Fault ride through dealy of 140ms

- **Power System Stabiliser**

The Contractor shall supply, install, setup and commission a PSS (power system stabiliser), possibly as part of the AVR (automatic voltage regulator) controller. This shall meet the requirements of the grid code and the connection agreement. Included in the scope of supply is a PSS study to theoretically predict the response of the Generator to the proposed parameters with representative models.

- **Generator voltage control**

The excitation system shall consist of Exciter and Automatic Voltage Regulating (AVR.)

The AVR unit shall control the terminal voltage of the generator to an accuracy of 10.5kV +/- 0.5% for lead changes of 0 - 100% when operating in isolation from the system. Quadrature droop control shall be switched off when the REC circuit breaker is open.

The AVR shall be equipment with a power factor controller which shall be automatically switched out when the DNO circuit breaker is open. The power factor controller shall control the export power factor which will normally be set at unity. The automatic voltage regulator shall be of the continuously acting type with no dead bands enabling control of the excitation over the whole generator operating characteristics. The AVR shall be of the electronic type, having backup manual control facility; failure of the AVR shall result in the AVR being tripped to manual. The manual set point shall automatically follow that of the automatic set point controller so that there is the minimum of disturbance when switching in either direction. The AVR shall include over-excitation protection which shall trip to a safe value under manual control.

Field suppression shall be achieved either by an exciter field circuit breaker and discharge resistor, or by inversion of the transistor bridge supplying the exciter field.

The voltage response characteristic shall be given for the AVR damping control at normal, maximum and minimum settings. At normal position of the stabilising control, the generator voltage response times for a –10% step change on open circuit shall not exceed a recovery time of 0.5 sec and a setting time of 2.0 sec. The value of the overshoot voltage shall not exceed 50 % of the step change or 10% of rated voltage under the most extreme condition of field forcing.

Normal operation shall be possible according to the technical data in attachment 3, while outside these limits a temporary operation shall be possible. Shutdown for minimum frequency shall be as per GOST 24278.

- **Power Factor Regulator**

The generator control system shall have power factor regulation capability at the generator terminals and at the Grid connection point. The power factor control mode shall automatically be changed to voltage control mode if the generator goes into Island mode.

The control screen in the control room shall have a reactive power capability diagram i.e. circle diagram showing the generators operating position on the diagram at any point in time.

- **Quadrature Droop Compensation**

Quadrature droop compensation shall be provided to ensure correct sharing of reactive power in accordance with generator rating.

- **Electromagnetic Compatibility**

All components of the excitation system including the AVR and power factor regulator shall be designed to operate in the electromagnetic environment of an operating power station. This shall include immunity to radio frequency interference from electrical switching, mains born interference and the use throughout the plant of VHF and UHF radio transceivers.

- **Turbine control system**

Contractor shall provide one (1) local control cabinet located close to the turbine or in container and one (1) operator station located in the central control room. Both control stations shall have full access to the turbine control system and shall be fully identical in regards of information available and functionality.

STG control system design requirements (minimum)

- Local HMI for full control of the STG-unit including alarms and messages
- CCR operator station with 2x 24” colour TFT displays
- Engineering Station with full control and access to PLC programming
- High resolution trending facility with adjustable pen colours, scaling, time period is required.
- Clear indication of start-up and shutdown function groups and fault diagnostics
- Data Storage System capable to store information such as alarms, events, signal data for a minimum of 3 years
- Server connection for remote access for the Contractor
- A3 B/W printer
- Sufficient analogue and digital I/O capacity (channels) plus a minimum of 25% spare at PAC
- Operating within the manufacturer's recommended computer loading capacity but not greater than 60% capacity
- Interface to DCS via standardised Ethernet or Profibus data highway
- Fibre optic connections for transmission of signals over distances greater 100m; where necessary for smaller distances twisted pair cables and connections may be used
- The TCS shall be capable of receiving all necessary control functions from the DCS

In the control room there shall to be two stages of logon:

- Engineer – Full Control and access to the PLC program (modification on program)
- Operating - Access for Operation (**no** modification on program)

The turbine control system must be of the latest technology and shall be compatible with the DCS (typically ABB, Emerson or Valmet). When using two PLCs for turbine governor and turbine protection they are both to be included in a single Project and both viewable online.

All Servers/PCs to have a Norton Ghost or Acronis image created once accepted after SAT.

Requirements stated in the document TII Package Units must be complied with.

- **Automatic operation / Signals**

The STG supplier shall ensure that the TCS has all required signal exchange available, ensuring commands over all major control areas (with the ability to directly intervene at various process points), for either pressure or speed governing mode, can be received from DCS. This means that the STG-unit shall be able receiving operating commands from DCS, amongst others, for start-up, shut-down, re-start, synchronising with the grid, synchronising with the switchgear and bypass operation. It shall be possible to start, stop and synchronise the turbine in the different modes from the control station in the CCR.

Signal Exchange interfaces shall be foreseen as follows:

Hardwired:	Time-critical, protection and control signals required for a safe STG operation
Profibus;	Signals for other purposes than stated above or below
OPC:	Read only information

The signal exchange between TCS and DCS shall comprise but not be limited to the following:

- Alarm and other signals for annunciation.
- Control signals to realise the automatic operation from DCS
- Time synchronisation from GPS clock via NTP (cable in scope of STG-supplier)
- Feedback and release signals for the DCS
- Signal transmission via hardwired (approx. 60 signals will be interchanged between DCS and TCS)
- Signals with safety functions for the waste incineration plant
- Signals with safety functions for the STG-unit
- Signals from the circuit breakers of the medium voltage switchgear.
- Signals to the circuit breakers of the medium voltage switchgear.
- Analogue measuring and metering signals from the medium voltage unit
- Analogue measuring and metering signals from the STG-unit
- Analogue measuring and metering signals from the grid transformer and grid feeding.
- Signals for automatic synchronisation from the plant process control system.
- Signals for automatic synchronisation from the STG-unit

The number of signals will be determined during detailed engineering.

A detailed description of the control, monitoring and interlocking scheme with the EfW-plant shall be provided. Functional diagrams and proposals for graphic display shall be provided as input requirement to realise the operation function in the DCS.

The following signals must be measured and archived at a sampling rate of 20ms for the Grid Code Tests :

- Excitation voltage and current
- Field voltage and current
- Stator voltage, current and reactive and real power
- Turbine speed
- Injected frequency

➢ Synchronisation

It must be possible to synchronise the STG-unit across the following circuit breakers:

1.)	0BAC01	GCB in the 10.5kV switchboard
2.)	0AEA02	HV GIS CB to connect with grid

These circuit breakers are shown in the single line diagram and the synchronisation sequences are explained below:

1.)	0BAC01	Synchronisation across the 10.5kV Generator circuit breaker
2.)		The Turbine generator must synchronise to mains and then closes the generator circuit breaker
3.)	0AEA02	Synchronisation across the Main incoming 10.5kV circuit breaker
4.)		In Island mode the Turbine generator must to synchronise back across the main incoming circuit breaker.

➢ Studies

The generator supplier must provide all information and studies required by the DNO. This includes the supply of the models, the simulation and the verification of the models including, but not limited to:

- Excitation
- Frequency control
- Voltage control
- Governor control
- Power system stabiliser
- Under and over excitation limiter
- Rate of Change of Frequency
- Fault Ride Through

➢ Long-distance data transmission and remote support line

Long-distance data transmission (LDDT) and the possibility for remote support shall be considered in the design of the turbine control system and it shall be included in the contractor's offer. Please refer to TII "Package Units".

The use of data shall be described to the end customer. In particular, the following items must be explained:

- Purpose of data transmission,
- Transferred data (i.e. provision of a signal list),
- Benefits for the end customer or installation operator
- Benefits for the contractor,
- Access by personnel (internal/external),
- Form of data transmission.

The transferred data must be stored appropriately in the package unit's equipment and shall be available to the end customer operator as well.

The remote connection to the package unit will not be available permanently because it has to be manually patched through by the control room personnel. Once access has been completed the control room must be informed to terminate the link. Such interface shall be established with an Ethernet network switch installed in the package unit's control cabinet.

- **Interlocking**

All critical interlocks shall be hardwired and a duplicate, parallel signal, shall be sent to the DCS.

Failsafe, hardwired Interlocks shall be provided to prevent:

- live circuits being connected to circuits which have been earthed and vice versa;
- equipment opening or closing under loads which exceed the rating e.g. dis-connectors opening under load;
- an incorrect switching sequence;
- any situation which might endanger personnel or damage equipment
- circuit breaker closure if the operating system is not properly pressurised or charged

For electrical interlocking circuits auxiliary contacts direct from the plant item shall preferably be used. If repeat relays are required, then a monitoring scheme shall be provided. The scheme shall operate in a fail safe manner.

As a minimum the interlocks shown in the HZI interlock matrix: 50073322 must be implemented. The supplier shall assist with the engineering of all interlocks between the Turbine and Generator systems and the plant. This includes identifying the points of connections for the interface signals required

3.1.3.3 Generator

- **Mechanical and electrical design of generator and its auxiliaries**

The IEC standards for synchronous electrical machines, IEC 60034, shall apply and all recommendations for mechanical and electrical design be followed.

Stator and rotor windings of the generator and exciter shall have Class F insulation in accordance with IEC 60085, but the admissible maximum temperature rises of the windings at rated site conditions shall not exceed the limits for Class B insulation (IEC 60034-1).

Design requirements for the generator:

- One 2-pole 3-phase AC synchronous generator for 10.5kV +/-10%
- Enclosure classification shall be IP55
- 2x100% Water-air cooler with self-ventilation (TEWAC)
- Power factor range of 0.85 lag to 0.95 lead
- A design cos ϕ of 0.95 (capacitive)
- Minimum short circuit ratio of minimum 0.4 per unit
- Transition inductive reactance of minimum 0.35 per unit
- Minimum efficiency shall be 0.98
- Generator & AVR shall be capable of providing any load from zero to 110% MCR, duty class S1.
- Two static excitation systems (auto and manual) with the required brushes and slip rings
- Pedestal mounted sleeve bearings (lubricated from the lube oil system)
- Line side and neutral terminal box with the required current and voltage transformers
- Generator panel with automatic voltage regulation, measurement, generator protection and synchronizing equipment. Synchronizing shall be possible from the local control panel and from the plant control system in the control room
- Automatic voltage regulator AVR for 0.1 % voltage accuracy, independent of load, power factor, and temperature
- A complete set of special maintenance tools shall be included
- Neutral earth transformer (NET) inclusive switch or
- Neutral earth resistor to avoid the noise of the network
- Stator windings shall incorporate a partial discharge monitor through provision of IRIS discharge coupling capacitors, which are connected to the DCS for insulation condition assessment
- Automatic electric heaters for stator and exciter as soon as the unit is “off load”
- Base plate frame
- A prediction and online monitoring system for routine diagnostics shall be provided

- Storage for main monitoring data, information and protection information shall be included
- According to GOST 24278 the STG unit shall be capable to operate within the below stated frequencies while connected to the grid:

Grid frequency range	Allowable one-off turbine operation duration shall not exceed	Total allowable operation time for the entire turbine operation period
50.5 – 51.0 Hz	3 min.	500 min.
49.0 – 48.0 Hz	5 min.	750 min.
48.0 – 47.0 Hz	1 min.	180 min.
47.0 – 46.0 Hz	10 sec.	30 min.

Any requirements rising from the grid code are to be provided by the purchaser. Details will be discussed during project execution.

Generator cooling system

The generator cooling system shall be designed to ensure no deterioration in performance with site/machine building ambient temperatures up to 45 °C.

The cooling water shall flow in straight tubes to enable complete cleaning (border limits according to PID). The coolers design shall allow their transversal dismounting for maintenance.

The generator air-cooling system shall include all necessary ancillary equipment as appropriate and comply with the requirements of IEC 60034-3. The system classification shall be ICA1W7 to IEC60034-6.

The generator air coolers, etc., shall be sized so that 100% rated generator output can be maintained with one section of the cooler out of service for cleaning or in case of failure.

Water leakage monitor and anti-condensation heater

The openings in the cover for the cooling air shall be equipped with air filters attached to the other face cover. The filters shall be easily taken out for periodical cleaning.

Generator and auxiliaries design and construction

The generator shall be designed to operate with the steam turbine under the long term parallel with the DNO system and island operation (isolated from the DNO system, supplying the site load only).

The generator with its auxiliaries shall be capable to deliver its rated output without detrimental spot heating within the limits of the permissible temperatures. In conjunction with its excitation system, the generator shall operate satisfactorily at any load and speed as delivered by the turbine when isolated or connected to the high voltage network via the HV transformer as well as when running in parallel with other units connected to the same system.

The generator shall be capable of withstanding closure of its associated generator circuit breaker at 30° out of phase and not sustain any damage requiring repairs (minimum once in life time). Synchronising equipment will be used to avoid inadvertent mal-synchronisation. A protection by vector default will be implemented. The control and protection system for the synchronisation shall not allow a synchronisation at 120° out of phase.

Vibration monitoring

Vibration shall be measured for protection and predictive maintenance. Suitable indicators shall be supplied in the control room for each measurement point and the measurement shall be suitably alarmed where high vibration levels may cause possible damage or affect the safety of the plant.

Anti-condensation heater

Suitable anti condensation heaters shall be provided and operating in parallel with those in the main generator stator. The heaters shall be automatically energized by control signal from TCS when the machine is stopped.

➢ Rotor

Generators that utilise a cylindrical rotor body shall have it manufactured from forged steel comprising one solid forging. Following rotor machining, the forging shall be 100% inspected by ultrasonic examination. Damper windings shall be fitted as necessary to prevent cyclic irregularities and as a precaution against local overheating of the rotor surface. Inclusive but not limited to:

- Rotor ground-fault brush and shaft grounding brush,
- Rotor removal device.

The rotor shall be in electrical and mechanical balance at all speeds up to 115% of the rated speed, and at all loads up to 110% of the rated load. Balancing shall be done in accordance with ISO 10816 requirements, and overspeed test up to 120% for 2 minutes. Option for 100% X-Ray check on the rotor shall be provided.

➢ Exciter

The continuous rated current and voltage of the main exciter shall not be less than 110 % of the generator excitation current and voltage required to maintain rated output at the terminals of the generator. The cubical of the excitation control equipment must have a minimum IEC 60529 Classification of IP 43, whereas the main exciter shall have an IP54 ingress protection.

It shall be designed for automatically regulated current supply to the generator rotor winding in all operation modes (GOST 21558-2000). The excitation system shall be static, thyristor-type, based on a self-excitation principle and have a power converter redundancy for 100%. A full set of protective devices based on industrial processors shall be provided along with two stand-alone and equal converting and regulating channels, each of them covering all generator operation modes. Inside the system a protection cabinet shall be incorporated.

The availability for the excitation system shall be greater than 99.5%

➢ Generator Main Connection

The generator main connection from the line side cubicle to the 10.5kV switchgear shall be designed either for cable system connection, suitable to withstand the possible short circuit stresses.

The connection between generator and lineside respectively star point cubicle shall be made by means of copper busbars. The cubicles shall be installed directly on or beside the generator.

In order not to transfer the vibrations from the generator to the panels, a corresponding flexible connection has to be provided if required.

The access to the generator terminal points shall be possible by opening lockable or bolted covers.

The generator terminals shall be provided with appropriate earthing devices (ball-stub type).

The protection class of the panels shall be as the main machine.

Inside the generator star point panel, the following current signals shall be included for protection and measurement in each phase:

- ratio: In/1/1A;

Class X CTs for the generator differential protection scheme. The characteristics shall be co-ordinated with the differential protection CT's supplied by the 10.5kV switchgear contractor; and

- 5 P20 Protection.

In addition to the necessary current transformers (class 0.5 M5, In/1A) for measuring, voltage transformers in each phase for protection, measurement and for the voltage regulator shall be supplied by the Contractor and installed inside the main connection (lineside) cubicle.

Capacitors combined with overvoltage surge diverters for protection shall be installed inside the lineside cubicle if specified. For the generator excitation system separate current and voltage transformers are to

be provided and incorporated inside the above-mentioned panel as required. Earthing stubs (ball type) shall be provided for both cubicles.

- **Generator Workshop Tests**

The following generator workshop tests shall be performed and witnessed by HZI's Project Manager or his representative. The tests shall include but not be limited to:

(1) measurements of the insulation resistance;
(2) loss factor measurements;
(3) measurements of winding resistances, cold;
(4) dielectric tests;
(5) open-circuit characteristic test and determination of no-load losses;
(6) short-circuit characteristic test and determination of short-circuit losses;
(7) heat test run to determine the temperature rise of windings (alternatively separate heat test runs are permitted (IEEE 115) with graphic superposition of their results as follows (*):
    a) at 1.1 x stator rated voltage and no-load (*);
    b) at 1,05 x stator rated current and terminal point short circuit (*);
    c) at zero excitation and no-load (*);
    d) overspeed test at 1.2 x rated r.p.m.;
    e) measurement of vibration; and
    f) preparation of a summarising report of the above-mentioned tests with evaluation of the results and comparison with the permitted values according to the standard or this Contract.

In addition the following tests may be added if the Contractor considers them advisable:

(1) As Option: sudden short-circuit tests at approx. 0.2; 0.4 and 0.5 Un rated voltage with determination of transient and subtransient reactances and time-constant extrapolated to 1.0 x rated voltage
(2) determination of voltage wave form and THF-factor; and
(3) noise measurement according to IEC 60034-9 and ISO 1680 (*).

The factory tests are to be completed according to IEC 60034.

The tests marked by (*) can also be substantiated by means of a test report (to be certified by an independent institute) for a generator of the identical type. Reduced prices for the tests not completed according to the above are to be stated in the tender.

3.1.3.4 Uninterruptible power supply

An UPS system (220V DC) which is sized to drive the turbine into a safe condition in case of a total black-out of the normal auxiliary power supply, and a failure of the EPS system shall be provided by the Contractor and be integrated into the E-house. The capacity of the UPS system shall be 2 hours at 100% or 4 hours at 50%, and shall include all essential loads required for a safe shutdown of the STG-unit towards a defined state. All equipment which cannot accept a disconnection of power supply and required for continuous operation, such as the proprietary turbine control systems, shall be fed by the STG UPS-system. Specifically the following equipment shall be connected, while components are to be added as deemed required by the Contractor ensuring the fulfilment of a safe and controlled operation:

- Turning Gear device
- Emergency oil pump
- Jacking oil pump

Main power 400 V/230 V to the turbine package shall be fed from the switchboard which, under normal conditions, is fed by the import/export transformer and the additional 10.5kV power supply.

The design data of the turbine unit UPS shall be shared with the Purchaser in order to engineer the plant UPS. The STG UPS shall be capable to work independent from any other power supply in case of main power failure and/or Purchaser UPS failure and contain redundant (two) infeed connections.

Also refer to the “TII UPS Uninterruptible Power Supply”, document number 500xxxx.

3.1.4 Painting, corrosion protection

Full undercoat and top coat plus corrosion protection measures have to be applied. The colours applied have to be in line with BS1710 or RAL.

Corrosivity category C3 is applicable for the Turbine Hall and has to be carried out according to EN ISO 12944-5:2008 Protection period “High (H)” (Coating system: Primer EP / additional coats PUR).

Following requirements need to be considered:

Table 10: Initial Protection

Note that given values are to be fulfilled for category C3 according to EN 12944-2				
Supplier	Initial Protection	Touch up and repair on site	Type	NDFT [um]
Sika	X		PC: SikaCor EG Phosphat Rapid	120
	X		TC: SikaCor EG	80
International	X		PC: Intercure 200 HS	140
	X		TC: Interthane 990 sg	60
Geholit + Wiemer	X		PC: GEHOPON- E90R	120
	X		TC: WIEREGEN-M87	80
Jotun	X		PC: Penguard Express ZP	120
	X		TC: Hardtop XP	80

Table 11: Initial Protection

Note that given values are to be fulfilled for category C3 according to EN 12944-2				
Supplier	Initial Protection	Touch up and repair on site	Type	NDFT [um]
Sika		X	PC: SikaPoxicolorPrimer HE alu	60
		X	IC : Sika Poxicolor Primer HE	80
		X	TC: SikaCor EG 5	60
International		X	PC: Interplus 356	70
		X	IC: Interplus 356 pink aluminium	70
		X	TC: Interthane 990 sg	60
Geholit + Wiemer		X	PC : GEHOPON-E60-Korrogrund-AL	60
		X	IC : GEHOPON-E60-Korrogrund-ZP	80
		X	TC : WIEREGEN-M87	60
Jotun		X	PC: Jotamastic 80, aluminium red	75
		X	IC: Jotamastic 80, aluminium	75
		x	TC: Hardtop XP	50

3.1.5 Thermal and noise protection insulation

The contractor is responsible for insulating components and equipment within his scope of supply, while the following main requirements are to be followed:

- for energy efficiency purposes and in areas of personnel access thermal insulation shall be based on a cold face temperature of 45°C with stagnant air at 25°C
- where personnel are to come into close proximity with hot surfaces they shall be suitably protected to prevent injury. Process components not requiring heat conservation measures may be guarded instead of insulated for personnel protection
- for equipment that needs to be dismantled frequently, thermal insulation shall be of a removable type with suitable robust quick release fixings.

The TII “Thermal and Sound Insulation“ doc nr: 50060352 (see Attachment 1a) must be complied with.

Insulation of the turbine casing must be discussed and agreed. The main consideration is in regards of the installed firefighting (absorbing oil & water). Heat radiation which might cause damage to the foundation shall be avoided. Housing flanges shall be provided with reusable insulating sections.

Oil piping of the turbine does not need to be insulated if not contradicting to above requirements. Hot sections which cannot be insulated, such as observation openings, shall be provided with corresponding contact protection. (Exceptions can be agreed with the purchaser).

3.1.6 Temporary Labelling

The labelling will be implemented uniformly in the whole plant. Therefore, HZI will appoint a single labelling-supplier for the permanent marking of the whole plant. This means that each supplier is “only” responsible for the temporary labelling of his lot. It will be con-trolled at the end of the erection of each lot.

The temporary labels have to be carried out in a weather/waterproof way. E.g. no card-board-labels and wire for the fixation is allowed. Instead, plastic cords, cable binders or similar shall be used. The labels shall also be attached on all partial packaging. They might be hand written (with waterproof pen), but in a readable manner in block letters, size at least 10mm in height. The temporary labelling contains the KKS-number and description, for example "0QFA11 AN001 Compr Air Sply"

Nozzles also must be labelled, with the according KKS of the pipe connecting to it (see PID)

The temporary labels must be easy to remove (E.g. no gluing, no adhesive etiquette).

Each contractor is responsible for the mounting of the safety-marking (mandatory-signs, prohibition signs, warning signs etc) of his lot, in agreement with HZI.

To ensure the correct labelling of the whole plant, every single component /device has to appear on the P&ID. It is the responsibility of the contractor to ensure the “as built” state of the P&ID (within scope of supply). Handwritten corrections might be handed over to HZI. The correctness of the P&ID will be checked at the final inspection on site.

As for the electrical part in the scope of supply, the permanent marking/ labelling has to be done for the entire scope according to the EIC labelling concept (TII Identification and Marking EIC Components).

The part of the building components will be handled separately.

By delivery, all items shall be marked with project designation, contractor, KKS-Number of the main component and the description of the delivered part.

3.1.7 Wear parts, spare parts, tear parts and consumables

Check chapter XVI "Spare and Wear Parts" in the purchase conditions for detailed information. Notice that the quotation has to be binding for one year.

All spare and wear parts for three years operation are included in the scope of supply. These and their expected lifetime have to be listed by the Supplier in a HZI template (see Attachment - 1a). The list has to be ready in due time (see Attachment - 2).

The Contractor shall provide all necessary spare parts as required for the installation, start-up, commissioning, testing and putting into operation of steam turbine and associated equipment, detailed in the scope of supply and which are required in addition to the already prepared list. The supply shall include all sealants, gaskets, caulking, packing's and associated materials.

The Contractor shall provide all necessary flushing oils as required for the complete cleaning of the turbine and generator oil systems. If flushing oil is used, it shall be completely compatible with the operating oil to be used. The first-fill and top-up of all oils and greases shall be provided by the Contractor. The operating oil shall be compatible with the steam turbine and generator systems under all operating conditions.

The Contractor shall provide a replacement set of all oil filters as required for putting the plant into operation on completion of flushing and commissioning.

The Contractor shall include sufficient quantities of spare instrument and gauge glasses, indicator lamps and fittings as required for the installation.

All consumables shall be delivered suitably packaged and protected as required for storage at site. Any special handling or storage requirements shall be clearly specified by the Contractor.

3.1.8 Naming of Delivery Units and Lifting Units

The supplier must follow naming of Delivery Units and Lifting Units provided by HZI. This must be reflected on the drawings and on delivered material.

3.2 Scope of performance

For basic conditions and further details see document „TII General Technical Conditions of Purchase“ as well.

All information (e.g. drawings, e-mails, etc) from the supplier will need to be exchanged with HZI PIRS Web Portal. This will request an introduction of the system of approximately 1 day via go to meeting or in ZH. See also PIRS Portal Guide (document TVENG036 in attachment in 1a).

3.2.1 Engineering

This includes all the engineering and the documents that are to be provided in accordance with the documentation schedule, Attachment 2 to this TSD ”Documents from contractor”.

All documentation provided shall be sufficient for the Purchase to execute, design, install, commission and as well to operate and maintain the provided equipment.

The documents listed, to which must necessarily be added any documents required on the part of the authorities, must be supplied according to the instructions and templates of HZI. The language in which the documents are to be written, together with their number and format, can be found in the project specific “Terms and Conditions of Purchase”.

The engineering especially includes also:

- All necessary procedures for the guaranteed quality of the delivered items, as tests, examinations and acceptances at the manufacturer’s works and at HZI’s site as well as all relevant statements, certificates and reports (incl. material cost), according “Terms and Conditions of Purchase”.
- Examination, correction and addition of HZI-supplied drawings, PI&D’s and other documents containing the Supplier’s scope of supply
- Filled in technical data into the submitted lists according to the P&IDs (e.g. manufacturer, part number, size, etc.)
- All documents for the scope of supply, directly or indirectly necessary for the operating approval of the authority
- The Contractor shall prepare material purchase specifications for all major forgings and castings and submit these for review on request
- Attendance during monthly progress & engineering meetings at HZI office in Zurich
- Participation on the HAZOP studies of HZI at HZI offices in Zurich (appr. 4 days)

3.2.1.1 Monthly Progress Meetings

During project execution monthly progress meetings will be held, covering engineering, progress and other items. Each of these meetings will be a face-to-face meeting at HZI premises in Zurich, requiring the attendance of the supplier as the meeting will purely be related to the STG-lot, and last one to two full business days.

3.2.1.2 HAZOP

In general, the turbine and its auxiliary equipment shall comply with the safety requirements as per GOST 24278 “Fixed steam turbine plants for power plant electrical generator drive. General technical requirements”. Safety-related ancillary equipment of the turbine shall comply with FZ No.116 “On industrial safety at Hazardous Production Facilities”.

The HAZOP for the turbine system will be part of the overall plant HAZOP which will be carried out at HZI premises during project execution. The HAZOP analysis will be carried out, following HZI standards included in attachment 1b. The project specific HAZOP report will form the further basis of the plant design. Sub-suppliers of package units have to ensure, that their system complies with the requirements identified and agreed during this HAZOP meetings, whereby each subunit has to ensure that it is unit is impartial protected, independent from up- / HAZOP downstream conditions.

Potential extra costs resulting from poor or incomplete scope of supply have to be taken by the sub-supplier, e.g. additional safety valves, SIL protection loops, stop valves, etc.

3.2.1.3 Interface engineering

The CONTRACTOR of the steam turbine unit shall cooperate with the PURCHASER with designated partners and SUB-CONTRACTORS in order to achieve a safe, economical plant layout and arrangement.

This includes also 2 face-to-face coordination meetings with the grid owner, each approximately 2.5 business days. If actions or implementations resulting out of this meetings which are outside of these contractual requirements, then these implementations must be evaluated.

3.2.1.4 Civil Engineering

Engineering for turbine table incl. embedded parts. The foundation for the STG shall be either a table top type or a steel frame. If applicable, the turbine table shall be constructed in reinforced concrete and designed according to mentioned standards.

To prevent excessive vibrations, the Steam Turbine Plant shall be equipped with all necessary absorbers, compensators etc. The assessment will be made according to VDI 2057 or ISO 2631. In case of a turbine foundation or block foundation the design shall be made in such a way to prevent excessive vibrations.

Concrete ground bearing floors shall be designed in accordance with the Cement and Concrete Association's Technical Report No 34.

At the commencement of design the Contractor designer shall prepare a document titled 'Outline Basis of Design'. The Outline Basis of Design shall be a comprehensive document and shall list all relevant codes, standards and major design criteria on which the design will be based. In this respect, the main design of the structural and civil elements shall not proceed until the Outline Basis of Design has been approved by HZI and the Civil engineering partner.

The structures shall be designed to the Standards as appropriate and applicable in the Russian Federation to the part being considered, its use and materials of construction. The Turbine supplier can propose replacements with equivalent European or International standards (Outline Basis for Design).

3.2.1.5 List of Documents to be provided as a minimum

Drawings (except for drawings of the ancillary equipment supplied by other suppliers which are issued by this equipment manufacturer)

- turbine section drawing;
- cylinder;
- turbine rotor;
- stop and regulating valve unit;
- stop valve autolock;
- crossover pipes from valves to the turbine;
- pillow block and thrust bearing;
- generator front pillow block (if ordered);
- glands;
- shaft rotating device;

- regulating valve servomotors;
- oil filter;
- oil tank;
- oil lines of lubrication and regulation system;
- pipelines of the turbine proper;
- installation of foundation frames;
- turbine cladding (outer protection case);
- ejectors: main, starting, cool-down (if supplied);
- gland ejector,
- water filters;
- check valves KOS;
- turbine lifting devices;
- installation of sensors;
- control and protection unit;
- electrical installation of control and protection unit;
- protection slide valve unit;
- control slide valve unit;
- additional protection unit;
- servomotor position sensor unit.

Diagrams:

- lubrication oil supply system, hydraulic flow chart;
- intraturbine pipelines, combined flow chart;
- regulation and protection systems, electrical and hydraulic flow chart;
- regulation and protection systems, combined electrical and hydraulic flow chart;
- functional group monitoring and control;
- sensor installation.

Documentation:

- turbine service log containing data on the turbine stand assembly and manufacture certificates, certificates on plant stand tests and turbine acceptance;
- turbine plant operation manual (turbine technical description);
- turbine plant operation manual;
- regulation and electrical and automation system test program and procedure;
- automatic regulation and protection system operation manual;
- technical descriptions and operation manuals on the equipment supplied with the turbine;
- shaft rotating device operation manual;
- mode diagram with offset curves;
- manuals on depreservation and restoration of the turbine paint during installation;
- manuals on the storage procedure of steam turbine equipment supplied by the Supplier;
- the catalogue of parts and assembly units (spare parts);
- turbine and equipment installation manual;

- data sheets on lifting devices;
- ejector data sheets (within the scope of supply);
- check valve data sheets;
- a list of spare parts for warranty operation period;
- a list of spare parts for the 1st capital repair;
- a list of operation documents for the steam turbine plant within the scope of supply;

The supplier shall submit to the Employer (the Employer's General Designer) terms of reference for development of detailed design for instrumentation and automation.

- monitoring and control diagrams for functional groups (PI-diagrams) (for systems within the scope of supply of equipment with KKS marking);
- process protection diagrams;
- a list of the turbine plant controlled parameters;
- limit process parameter setups;
- a list of electrified equipment;
- control algorithms for electrified fittings and equipment (including explanatory note);
- electrical installation diagrams (bearings, servomotors and autolock);
- general electrical diagrams for the equipment supplied complete with the turbine;
- design of interface of devices for control of the turbine mechanical values, including vibration.

3.2.2 Installation

The Contractor scope of performance is the complete erection and installation of all material, which includes the following:

- The erection will be executed by the Contractor.
- Unloading of material and equipment including incoming goods inspection.
- Incoming goods inspection for all material and equipment. Procedure defined in "TII Process for Material Handling on Site" (Attachment 1a).
- All Transport of all material and equipment on the Construction Site.
- Erection and Installation of equipment in the final position by means of gantry crane (see also picture at the end of this section).
- Installation and dismantling of all temporary structures.
- Contractor has to check survey protocols of the handed over civil structures (plinths, embedded parts etc.). The check should consist of comparison with erection documentation, as well as physical re-measurement. This should be done during the hand-over or if not possible as soon as possible after the hand-over. In case of latter, appropriate note has to be written in the hand-over protocol.
- All major interface connections have to be measured after erection. The results have to be recorded and approved by HZI. If measurement do not meet HZI requirements appropriate actions are to be taken after clarification with HZI Management. Check if applicable. In this scope Contractor mostly connecting to all interfaces.
- Before lifting of pre-assembled lifting units Contractor shall measure the main dimensions of the lifting units to ensure the fitting accuracy and avoid long lifting times or necessary interruption of the lifting activity.
- Contractor is obligated to submit to HZI a temporary works register with all necessary temporary works during the construction phase 4 weeks prior the works commencement.
- Contractor shall nominate Temporary Works Supervisor(s), who will be responsible for Temporary Works,

- Contractor is obliged to participate in scope clarification meetings organized by HZI in time between Contract award and Kick-off Meeting
- Adaptations of any gratings, chequered plates and railings within scope of services of the Contractor are within scope of services of the Contractor.
- Drilling of holes to complete equipment fixation anchors.
- Contractor is responsible for daily cleaning of workplace and final cleaning after completed erection.
- Installation of earthing lugs and equipotential bonding (if required)
- Safeguarding of the erection location,
- Lighting (task lighting) and heating of the workplace,
- Organization and costs of all required NDT tests (if required)
- Protection of works and material,
- Contractor shall provide the supervision personnel, admin staff, setting foremen, skilled workers and manual workers as well as security officers required for the performance of his works,
- Temporary floor covering for platforms at all required locations,
- The drawings, quality test schedules, calculations, erection quality documentation and erection plans on which the construction work is based shall be kept ready by the Contractor at all times on the Site,
- Adaptation works to any interfaces with other components,
- Relocation of Contractor's containers (tools, workshop etc.), equipment and materials free of charge whenever demanded by HZI
- Erection and dismantling of any provisional equipment and auxiliary structures, such as lifting lugs
- Intermediate storage and preservation of material. Please refer to "TII Process for Material Handling on Site" (Attachment 1a)
- Participation in coordination of site activities. Contractor is in general obliged to co-ordinate all interfaces of the scope of services with other Contractors involved in the overall project in co-ordination with the HZI Site Management. Once per week Contractor has to participate in Weekly Coordination Meeting organized by HZI supervisor. Moreover, Contractor has to participate in all other meetings organized by HZI. Contractor has to also participate in process described in "TII Lean Construction Management Tool" (Attachment 1a).
- Contractor is obliged to check available documentation minimum 4 weeks before start of erection. He has to check if all necessary information for erection is available. Please also refer to "TII Lean Construction Management Tool" (Attachment 1a).
- Repair of corrosion protection occurred between arrival of material to site until final hand over to HZI. The following regulations apply: TII "Corrosion Protection" (Attachment 1a), TII "Colour Concept Process Technology" (Attachments 1a).
- Security of Contractor's containers, warehouses, tools, equipment and all material for which Contractor is responsible,
- Contractor should make complete engineering of all temporary works prepared by him. The calculations should be included in the Temporary Works procedure.
- Before accessing any steel structure, which is not included in scope of services of the Contractor, Contractor has to obtain from HZI release in form of mutually signed document "Shared Work Area Access Pass" (Attachment 1b). After the access is no longer needed, Contractor has to obtain from HZI mutually signed document "Shared Work Exit Certificate" (Attachment 1b)
- Services in scope of Contractor defined in Site Conditions and Regulations (Attachment 1a)
- Contractor has to stay in line with HZI EHS requirements. Please refer to Attachment 1a.
- Contractor has to stay in line with HZI Quality requirements. Please refer to Attachment 1a.
- The roll in of the turbine-generator-set is planned to be done through the access gate of the turbine hall (appr. 5 x 5 m) and is part of the contractors scope.
- All necessary information and documents, stated in the purchase condition and attachment 2, needed for safe and proper erection will be given to the Purchaser in time.
- The assembly & erection shall include the erection, the adjustment and the assembly of the components at the designated location. Specifically, this means that CONTRACTOR shall

supply the necessary personal with the required professional competence, tools, complete construction facilities, and qualified supervision to complete this work.

The following works are content at the assembling of either the CONTRACTOR or the PURCHASER: “Final Documents to HZI” are to be delivered by the CONTRACTOR.

Table 3: Erection plan

	Erection	**Requirement / Condition**	**Final Documents to HZI**
1.1	**Preparatory activities**		
	Confirmation of assembly concept planning phase		Confirmation erection concept
	Approval of foundation before pouring of concrete	Acceptance of preparation and measurements of foundation and embedded parts	Acceptance report
	Measuring foundations		Acceptance reports for all foundations
1.2	**Placing Turbo Generator Set**		
	Transportation, storage at site		
	Placing / set up of components on foundations		Report, lift in is OK
1.3	**Mechanical Erection**		
	Alignment of Turbine Set (Turbine, Gear, Generator) Fine-Alignment		Alignment report
	Installation of transition piece turbine - condenser / steam exhaust pipe		
	installation of connecting oil piping, internal drain lines, Safety valves and Non-return valves, other pipes		
	Weld examination		
	Repair painting		
	Installation noise hood		
1.4	**Electrical Erection**		
	Installation of electrical equipments and cable ducts		
	Installation of cabling (Turbine - Generator with Electrical and proc-ess control cabinets, Bus plug connections)		
	Generator bus duct and generator connection cells		
1.5	**Connection works**		
	Connections of bleeds and extractions	Confirmation protocol, that the calculated piping (pipe stress) forces and moments are in conformance with the supplier requiring	Approval for connection

	Connection of steam exhaust	Confirmation protocol, that the calculated piping (pipe stress) forces and moments are in conformance with the supplier requiring	Approval for connection
	Connections of cooling water, condensate, steam, water and instrument air and flushing of cooling water and condensate lines		
	Grouting of base frames / machines / plants		
	Connections external cabling for electrical and process control cabinets	Connection readiness for supply and control cables	Protocol, that connection is made
1.6	**Further operations**		
	Oil flushing and filling of oil system		Report, Oil flushing and filling of oil system
	Installation turbine dryer		
	Insulation works (Turbine and Turbine internal pipe work)		
1.7	**Final erection**		
	Erection final inspection (mechanical and electrical) between HZI and supplier on site	Points 1.1 to 1.6 finished	Erection final inspection Protocol signed by HZI
		Presentation of cur-rent PID	
	Erection final inspection (mechanical and electrical) between HZI and customer on site	Erection final inspection between HZI and supplier on site	Erection final inspection Protocol signed by customer

3.2.2.1 Scaffolding

See document “Scaffolding Procedure for Installation Contractors” according to Attachment 1a.

3.2.3 Commissioning and trial operation

Commissioning, test operation and training are a part of the scope of performance. For detailed information see “Terms and Conditions of Purchase”.

The commissioning phase involves the complete cold and hot commissioning of the turbine assembly. The following table lists the most important setup steps. The main points must be confirmed documentary. The contents of the tables does not claim to be exhaustive.

Table 4: Cold Commissioning

	Cold Commissioning	**Requirement / Condition**	**Final Documents to HZI**
2.1	**Prerequisites**		
	AC/DC is available	Acceptance document from HZI	
	Extern cabling work has been completed	Acceptance document from HZI	

	Extern piping work has been completed	Acceptance document from HZI	
	Control Air ready	Acceptance document from HZI	
	Oil modules have been filled with oil up to the specified level, Oil flushing (purging) of oil modules completed and the required level of oil purity attained	Acceptance document from HZI	
2.2	**General checks**		
	All pipes and elements have been provided and connected according to P&ID		
	P&ID and lists have been updated to the status as built		PID as built
	All treaded couplings of piping and holders have been checked		
	E-consumers have been checked as per test sheet		
2.3	**Control cabinet**		
	Supply voltages, secondary voltages at the transformers and power supply units checked		
	Control cabinet with all cables is fully installed		Demonstration to HZI that all e-consumers have been connected and tested
	Check function of units		
	Signal exchange from control cabinet to control room checked	Protocol signal tests	Demonstration to HZI that all signal tests are conducted and completed success-fully
2.4	**Turbine-Generator-Set and Steam system**		
	Check complete path of the sensors via all terminal distributors to the switch cabinet		
	Emergency stop switching tested of (1 out of 2) and (2 out of 3) measuring points and solenoid valves		
	Monitoring instruments (pressure, temperature) have been checked for functioning and plausibility		
	All functions of the control and regulation system have been checked as per the functional description and/or functional plan. (switching points, alarms and functional group)		Check protocol by supplier
	Generator heating checked		
	Motor of rotor turning device checked as per control test sheet		
	Function of safety switch checked		
2.5	**Control Oil and Lubrication Oil system**		
	Emergency stop switch tested		
	All Motors of control, circulation and emergency oil pumps, oil mist blower and fine filter checked		
	Protection relay, overflow valves, dry run protection, main cooling water valve and all solenoid valves check of function		

	Pressure reservoir system (accumulator) has been checked for its functioning		
	Check complete path of sensors via all terminal distributors to the switch cabinet and all functions of the control and regulation system have been checked as per the functional description and/or functional plan. (switching points, alarms and functional group)		Check protocol by supplier
	Hydraulic system run on system pressure and the entire system checked for leakages and pressure test conducted		Check protocol by supplier
	Oil heating checked		Check protocol by supplier
	110 VC/DC battery system capacity checked as per control test sheet.		Check protocol by supplier
2.6	**Blowing out of steam lines**	**Confirmation that the blowing of the boiler and pipes according to specifications has been made.**	**Confirmed blow down protocol - Statement: "Turbine Unit ready for Steam”**
	Steam Blow as per VGB-Guideline with target plates provided by purchaser according VGB. Acceptance criteria shall be as per VGB.	Confirmation that the blowing of the steam header has been made.	Confirmed blow down protocol - Statement: "Turbine Unit ready for Steam”
2.7	**Connecting steam pipe**	**Approval to connect the steam pipe issued**	**Attested supply protocol**
2.8	**Beginning first steam admission**	**Turbine unit ready for steam**	

Table 12: Hot Commissioning

	Hot Commissioning	**Requirement / Condition**	**Final Documents to HZI**
3.1	**Prerequisites**		
	Final assembly inspection carried out; open points that obstruct the operation have been processed		
	Cold commissioning has been completed		
	Cooling water circuit is ready for warm commissioning		
	Steam cleaning of boiler and live steam piping has been conducted		
	Required cleanliness of steam blasting has been certified by Turbine contractor		
	External pipe work has been completed for warm commissioning		
	Configuration of turbine controller has been completed		
	Control valve Limiting is activated		
	Generator excitation is disconnected		
			Statement: "Turbine Unit ready for Steam"
3.2	**General Checks**		
	The local temperature, level and pressure displays have been checked for plausibility und compared with the readings on the visualisation at the control panel		
	System checked for leakages. Leakages, if any, have been rectified		
	All operational data is recorded in accordance with the step chain during commencement operation		
	Function of turbine governor and turbine trip has been checked		
3.3	**Turbine-Generator-Set**		
	Plausibility of rotation speed sensors have been checked		
	Over speed test has been conducted. Function of trip actuation has been tested		
	Function of drain system during start up and shut down of turbine has been checked		
	Alignment of generator checked		
	Electrical connection of generator checked		
	Generator protection system checked by secondary injection		Protocol
	Function of generator excitation checked		
	Generator Open circuit test		Protocol
	Generator Short Circuit Test		Protocol
	Complete signal path of synchronisation unit checked		
	Control parameter and function of Turbine-Generator-Set checked during start up of turbine		
	All signals of generator checked for plausibility		

	Turbine trip function checked		
	Start up and shut down turbine-generator-set (several times)		Protocols of tests
	Transition to island operation checks		
	Load dumping (disconnection) tested and checked		Protocol
	Tests for connecting with the public grid (grid code compliance)		Protocol
	Grid Code Compliance Testing as per Grid Compliance Concept		Protocols
4	**14 day hand-over run**		**Protocol**
5	**Turbine performance test (During hand-over run)**		**Protocol**
6	**Turbine performance tests report according to IEC953-2 or DIN 1943 and Noise Level per DIN 45635**		**Report acceptance test**
7	**Customer Training (See 3.2.4 Training)**		
	Basic introduce of operating during commissioning		
	Class room training at site		
8	**STG Functional Tests**		
	The STG trial operation shall only start once the operation concept has been finished. With the end of Trial Operation no changes of applied setting and control concept are allowed.		
	Confirmation of start-up and shutdown times as per design		Protocol/ Trends
	Full load rejection with operation in island mode for at least 12 hours with 100% MCR		Protocol/ Trends
	Demonstrate satisfactory operations of the Works from shutdown through island mode, on to import supply and then on to full load exporting to the DNO distribution system, along with other required DNO testing requirements;		Protocol/ Trends
	safe (normal and emergency) shut down of the Works using the standby generator and demonstrate extended operation of the generator at maximum continuous rating while starting up one line;		Protocol/ Trends
	Check of tightness of control valves and proper operation of main throttle valve		Protocol/ Trends
	Check out electrical and other protection systems in conjunction with DNO personnel (if required) to verify protection and tripping equipment, e.g. over-speed trip, synchronise, G59 and G75 trips.		Protocol/ Trends
9	**STG Trial Operating Period (TOP)**		
	The TOP of the plant will last for 1500 hours where it will be operated at 100% MCR. During this time 24 cumulative hours without electricity production are allowed		
10	**Reliability Test incl. Performance Tests**		
	Test run from the complete plant (30 days).		
	During Test Operation supplier shall be present the first 14 days 8 hours shift and on-call system over night and 16 days site support within 24 hours.		
11	**Plant guarantee performance test**		
	Assistance during plant guarantee performance test (2 days) taking place any time within the first 6 months after plant takeover.		Protocol

The results of the cold and hot commissioning will be incorporated into the final documentation of the STG-OEM.

3.2.4 Training

A theoretical and practical training of the operating personnel is part of the scope of performance and will be carried out each on separate dates in the phases during the commissioning and trial run. For detailed information see “Terms and Conditions of Purchase”.

- The training documents shall be in Russian and English.
- The training shall be given in Russian and English, at least for period of 6 days.
- A special training program will be submitted to the contractor at an agreed time
- HZI provides a training powerpoint template - if requested

The contractor shall propose a rough scheme (content and duration of the training) 6 months before commissioning (allowing HZI preparing the training with the client).

The CONTRACTOR has to provide a one day classroom training for HZI personnel at the purchasers office concerning turbine and generator set. The date and content of training has to be agreed on.

3.3 Supply limits

If not specifically stated, the limit of supply for each interface point shall be as defined in general at the interface or connection of the following:

The Battery Limits for the steel structure and foundation of the turbine-generator are according to the Layout Arrangement Planning.

3.3.1 Mechanical

Table 6: Main Mechanical supply limits (P+ID is binding document)

No.	Interface description	P&ID	Layout/ Drawing
	Steam and condensate		
	Pipe stub at the live steam emergency stop valve		
	Pipe stub of sealing steam regulation valve		
	LP steam bleed connection studs on the turbine casing (bleed fittings as loose de-livered components, all with butt welding end)		
	Entry flange for injection water on the exhaust casing		
	Entry and exit flanges on the gland steam condenser (cool water)		
	Exit flange of drain on gland steam condenser		
	Exhaust flange turbine casing (exhaust adapter as option)		
	Flange of water injection to flash box		
	Steam pipe after flash box as shown in P&ID.		
	Cooling water		
	Entry and exit flanges on the lube oil cooler		
	Entry and exit flanges on the generator cooler		
	Lube and control oil		
	Complete and all within the scope of supply.		

	Process air / Instrument air		
	Exit flange on the gland steam condenser exhauster fan leading to outside the turbine building		
	Blind flange for connecting of external turbine drying device		
	Inlet flange to STG-instrument air header for limit switches, solenoid valves & positioners ending at junction boxes		
	Terminals of panels & local cabinets.		
	Drains		
	Drainage pipes are included in the scope and shall be guided into the flash box. Battery limit is after siphon of flash box.		

3.3.2 Electrical

Table 7: Electrical supply limits (50060230 EMCR Limits of supply)

No.	Interface description	P&ID	Layout/ Drawing
	Limit switches, solenoid valves & positioners ending at junction boxes		
	Terminals of panels & local cabinets.		
	See interface drawing		

3.3.3 Distributed Control System, DCS

Please refer to “EIC Single-line Diagram” and “EIC Limits of supply” (Attachment 1b) as well.

Table 13: DCS supply limits

No.	Description of interface	Delivery/ assembly	Connection	Engineering/ documentation

3.3.4 Structural (Civil)

Table 8: Structural (civil) supply limits

No.	Interface description	P&ID	Layout/ Drawing
	Depending on the provided solution this will be either, whilst the design still remains with the OEM • Below the turbine slab in case of a non-spring-application • Below the spring elements in case of a spring-application With the package unit offered the interface to the civil (structural) is below the spring elements. Where applicable: fixing and anchoring on concrete or steel structure including bolts, nuts, washers, chemical anchors		

4 Technical documents – basic principles

In the TSD, these documents shall apply in the following order:

1. This TSD
2. Enclosure Attachment 3: Technical Data
3. Enclosure Attachment 4: Turbine part customer specification
4. Enclosure List of General Attachments – 1a: “Technical regulations, instructions and templates for technical documents”
5. Enclosure List of Specific Attachments – 1b: “Diagrams, plans, drawings and piece lists”
6. Enclosure Attachment 5: Time Shedule
7. Enclosure Attachment 6: More information from customer to turbine part

4.1 PIRS Portal => Exchange of Documents

PIRS is the software system HZI uses for document management. The supplier shall use the exchange platform “PIRS Portal”. This will make the document handling and communication much easier, ensuring that all parties will always know which are the most up-to-date documents. For further details, see document “PIRS Portal Guide” (TV ENG 036).

4.2 PIRS Portal => Correspondence

PIRS is the software system HZI uses for correspondence management. The supplier shall use the exchange platform “PIRS Portal”. This will make the communication much easier, ensuring that all parties will always know which information has been exchanged and also to link correspondence to documents.