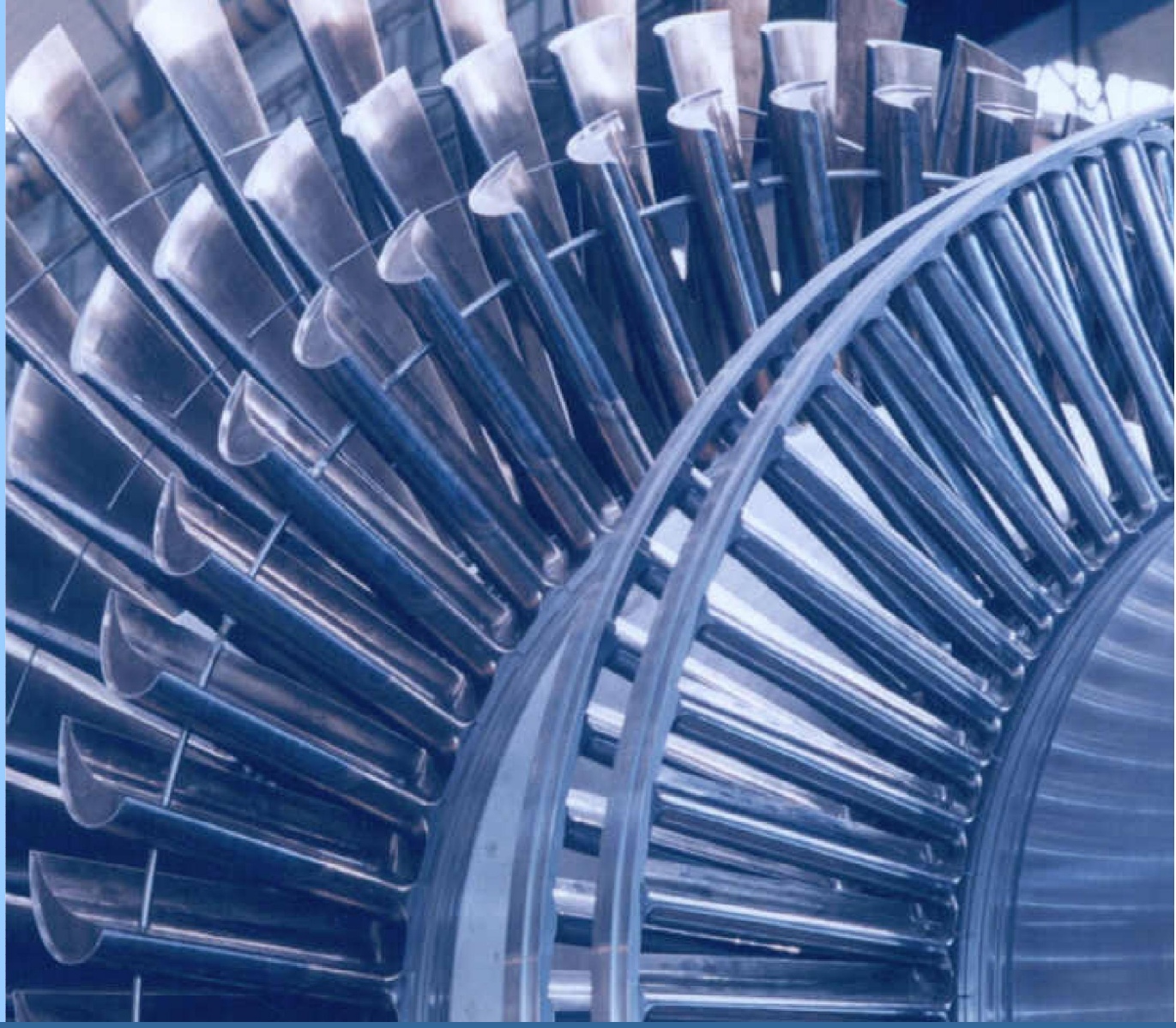


SIEMENS

AREVA – UTE Campo Grande

Consolidate Technical Proposal
3 x SST- 400 Steam Turbo-generator set
Proposal nr. : 11-003210-007-001 Rev. 15
February 02nd, 2015

Index

SIEMENS

Areva – UTE Campo Grande – 3 x SST-400

Technical Proposal

3 x 50 MW Turbogenerator set with reaction turbine, SST-400 type with axial exhaust flow for

Areva – UTE Campo Grande

Brazil

Siemens Ref: 11-003210-007-001 rev. 15

February 02nd, 2015

Revision Control

Rev	Description	Elaborated	Date	Approved	Date
0	Initial Issue	Lucas Monteiro	08.03.12	Marcelo Vasconcelos	08.03.12
1	Changed condenser bypass capacity.	Lucas Monteiro	09.13.12	Marcelo Vasconcelos	09.13.12
2	Removed generator panels and cubicles from scope.	Lucas Monteiro	10.09.12	Marcelo Vasconcelos	10.09.12
3	Power output increased to 53MW. Change in the accoustic insulation, optional items and updated spare part list.	Roberta Fonseca	17.05.13	Marcelo Vasconcelos	17.05.13
4	PLC-S7-400 included in the basic scope, instrumentation in 4-20mA+ HART.	Roberta Fonseca	21.05.13	Marcelo Vasconcelos	21.05.13
5	Optional scope added acc to customer request: WW505 Enhanced redundant, KKS tag, engineering and assembly supervision for additional scope of sealing and drainage system; assisted operation.	Roberta Fonseca	23.08.13	Marcelo Vasconcelos	23.08.13
6	Preliminary proposal changed into binding proposal.	Roberta Fonseca	29.08.13	Marcelo Vasconcelos	29.08.13
7	Comment on non return valves added. Optional scope added acc to customer request; Attachments added to the proposal (attachments 21 to 24) Main revised attachments: -Generator data sheet (load point included) -Technical Guarantee	Roberta Fonseca	28.02.14	Marcelo Vasconcelos	28.02.14
8	Base scope revised as agreed with Areva in the meeting of April11th, 2014. The following items have been removed from Siemens scope of supply: -turbogear noise insulation -condenser bypass dumping tube -turbogear packing revised into indoor storage solution.	Roberta Fonseca	22.04.14	Marcelo Vasconcelos	22.04.14
9	Base scope revised as agreed with Areva by e-mail of August 19th, 2014. The following item have been updated at Siemens scope of supply: -Condenser bypass dumping tube was included at scope of supply; -Generator with static excitation was excluded at scope of supply; -Siemens generator was excluded at scope	Everton Batagin	20.08.14	Marcelo Vasconcelos	20.08.14

	of supply; The following items have been updated at Siemens technical offer: -Steam turbine datasheet; -Part 10 terminal points; -Brazilian Generator datasheet; -Brazilian Generator inspection and test plan; -Technical guarantee document; -Heat balance diagram HBD_30.				
10	Additional optional scope according to LEME specification request, s indicated in blue and in the attachment 22 (Comments and Deviations to customer specification) Rev6	Roberta Fonseca	02.09.14	Marcelo Vasconcelos	02.09.14
11	• Scope of supply changes according to the Meeting notes from October2nd, 2014 and from October 14th,2014 between Siemens and Areva: • Additional base scope: - KKS tagging, - Box PC and router for STA-RMS, - pressure reduction valves and dessuper for sealing steam and ejector systems, - additional engineering for pressure reduction valves and dessuperheater for sealing steam and ejector systems and respective piping related to those and drainage systems - 40 days assisted operation, - bypass station logic diagram, - dehumidifier system - oil tank heating device, - protection IP54 for TCP - PLC S7-400 considered in the base scope; • Additional optional scope: - communication between turbine and bypass station (option with and without redundancy), - erection and assembly manpower (considering the existing overhead crane); - transport up to customer site including unloading; • Additional optional scope: - Package 1 (Surge and Neutral cubicles; generator excitation, protection, grouding, control), - Package 4 (Synchrnonization panels)	Roberta Fonseca	24.10.14	Marcelo Vasconcelos	24.10.14

	- Oil unit design changed into oil tank integrated to the gearbox; - Provisional Acceptance test revised from 5 days/8 hours a days for each turbogenerator set into 72h (24 hours/day) for 1st TG set, 72h (24 hours/day) for 2nd TG set and 12 days (24 hours /day) to be used for 1st, 2nd and 3rd TG set simultaneoulsy, as requested; - Dispositive for SOE; - Attachments added: Document list - Heat Balance Diagram HBD35. • Items excluded from the scope (MoM from Oct 2nd, 2014: - WW 505 enhanced redundant control system; - PLC S7-400H (redundant); - Condenser tube cleaning system; - Pneumatic drain valves; - Keyphasor; - Active magnetic pick-up; - ASME U stamp for condenser; - SS 304 piping for oil system; - Portable oil purifier; - Operating station; - MCCs; - Bently Nevada System One; - Piping interconnections: sealing steam, drainage and ejectors - First oil filling				
12	Consolidate technical offer based on negotiation between Siemens and customer.	Everton Batagin	08.12.14	Marcelo Vasconcelos	08.12.14
13	Consolidate technical offer based on negotiation between Siemens and customer.	Everton Batagin	16.12.14	Marcelo Vasconcelos	16.12.14
14	Consolidate technical offer based on negotiation between Siemens and customer.	Everton Batagin	18.12.14	Marcelo Vasconcelos	18.12.14
15	Consolidate technical offer based on negotiation between Siemens and customer.	Everton Batagin	02.02.15	André Garcia	02.02.15

SIEMENS

Proposal n°: 11-003210-007-001
Submitted to: Areva
Date: February 02nd , 2015
Revision: 15

Areva – UTE Campo Grande – 3 x SST-400

Part 1

Subject:

Scope of supply

1. Scope of Supply

General

03 (three) identical SST-400 steam turbogenerator consisting, each of them by:

Turbine and auxiliaries

- SIEMENS multistage condensing steam turbine, reaction blades, SST-400, axial exhaust type, equipped with:
  - 02 (two) Automatic steam control valves, single seat type, each one servo-motor driven by the turbine control system;
  - Automatic steam control valves with feedback position via HART;
  - 01 (one) live steam emergency trip valve, servo-motor driven,with built-in steam strainer;
  - 03 (three) bleeds and accessories according to technical description on part 2 of this technical proposal;
  - 01 Non-return valve for each bleed steam line, as follows:
    - 01 x 6" , 300#; ASTM A105 (Bleed A3);
    - 01 x 8" , 150#; ASTM A105 (Bleed A2);
    - 01 x 14", 150#; ASTM A105 (Bleed A1).

Note:

- Due to safety requirements from some Standards (such as NR12) and codes, one additional NRV (non return valve) non operated shall be included at each bleed line. Siemens informs that such valves are not included in the scope of supply and recommends the customer to install it.

- Lube Oil unit accessories:
  - Carbon steel oil tank with settling section, oil strainer and sludge and oil drain integrated with the turbine gearbox baseframe;
  - Main oil pump driven by gearbox shaft;
  - Full-duty auxiliary oil pump, driven by an AC electric motor;
  - Emergency oil pump driven by a DC electric motor;
  - Double oil cooler, for 100% duty each, with change over valve;
  - Double lube oil filter, 25µm, for 100% duty each;
  - Oil vapour extraction unit;
  - Oil level sight glass;
  - Oil tank heating device;
  - Jacking oil pump, driven by an AC electric motor;
  - Carbon steel oil piping;

- Necessary valves;
- Level switch for lube oil tank;

- Control oil unit accessories:
  - Pumps;
  - Pressurized accumulator;
  - Twin filter;
  - Oil reservoir.

- Sealing and Draining system:
  - Pressure reduction valve for sealing line;
  - Piping for drains and sealings up to turbine skid;
  - Drain collector, manifold, manual drain valves and purges for turbine drain lines.

- Further turbine accessories:
  - Thermal insulation for the high-temperature sections of turbine casing, composed of rock wool insulating mats and interconnecting wiring;
  - 1 set of special tools according to description on Part 2 (01 set for all TGs);
  - Skid for turbine;
  - Sole plate for gearbox and generator;
  - Foundation anchors, bolts and leveling screws;
  - Sheet steel cladding for turbine.
  - Dehumidifier system: Supply of 01 unit for 01 x turbogenerator set (non simultaneous hibernation and supplied loose);
  - Pressure reduction valve, desuperheater, and block valves for sealing steam and ejector systems (total of 03 sets, 01 per TG set);
  - Piping interconnections for sealing steam and ejectors (limited to 5 meters from steam turbine);
  - Project engineering, specification and assembly supervision of the following additional scope of sealing steam and drainage system:
    - Pressure reduction valve, desuperheater, and block valves for sealing steam and ejector systems;
    - Sealing steam system interconnection piping from pressure reduction valve up to turbine skid;
    - Condensate drainage interconnecting piping from turbine skid up to drain collector;
    - Ejector steam interconnection piping from pressure reduction valve up to ejectors;
  - Piping interconnections for drainage;

Control System

- Turbine local panel (acc. to technical description on part 3 of this proposal) including the following devices:
  - 1 electronic speed control governor NEMA D class, WOODWARD 505 type;
  - 1 electronic overspeed protection system 2-out-of-3 voting, WOODWARD PROTECH GII type;
  - Programmable Logic Controller, SIEMENS SIMATIC S7-400 type, programmed/configurated with STEP7 CLASSIC, for turbine auxiliaries control;
  - Human Machine Interface, SIEMENS SIMATIC ;
  - CLP analogic card with HART protocol;
  - Vibration monitoring system, Bently Nevada 3500 type including:
    - accelerometers for speed monitoring of the gearbox casing;
    - radial vibration probes for generator and turbine shafts;
    - axial displacement probes for turbine shaft.
  - 1 emergency stop button.
  - Additional for turbine control panel protection change from IP41 (standard) into IP54;
  - Redundant communication between PLC/DCS;
  - Bypass station logic diagram (supply of 01 diagram to be implemented in the DCS by the customer/ EPC);
  - Software/License for control and parameterization;
  - Siemens will provide database with monitoring points and commands, include all analogic vary available on local HMI.

- Instrumentation:
  - General instrumentation 4-20mA + HART according to the attached turbine datasheet;
  - Transmistters supplied with local indication;
  - Bently Nevada probes, proximitors and accelerometers for vibration monitoring system;
  - Junction boxes and cabling between instruments and junction boxes;
  - Solenoide valves according to IP66 class H for exhaust cooling water and command to non-return valves;
  - Direct-connected pressure gauges capable of withstanding intermittent over ranging to at least 1.5 times the maximum scale reading.
  - Cabling between junction boxes and turbine control panel, which will be installed besides steam turbine;

- Further control accessories:

- 5 speed pick-ups.

Gearbox

- Gearbox, according to technical description on part 2 of this proposal;
- Rotor turning electrical device, coupled on high-speed shaft, with automatic engage and automatic disengage;
- Coupling between turbine and gearbox;
- Coupling between gearbox and generator (flanged).

Generator (total of 03 sets)

- 3-phase Synchronous Generator, 60Hz, 1.800 rpm, 0.8PF, brushless PMG excitation and accessories according to technical description on Part 4 of this proposal.
- Generator terminal box including surge protection, star connection and neutral grounding.

Condensing system

- Axial complete condensing system (acc. to technical description on Part 5 of this proposal) including the following devices:
  - Shell-tube surface condenser with tubes in stainless steel 304 and ready for steam bypass (*) according to the Heat Balance Diagram attached to this proposal;
  - Vacuum system (ejector type);
  - 02 horizontal condensate motor-pumps (2x100%);
  - Safety relief valve on condenser, for 10% of the maximum steam flow;
  - Interconnection piping, valves, expansion joints and instrumentation for condensing plant.

(*)Bypass Designed for max boiler operation with 80t/h. Operation of bypass without TG operation => limited at max period of 4 hours.

Shop Services

- Inspection and tests according to the Inspection and Tests Plan attached to this proposal;
- Painting according to Painting Plan attached to this proposal;
- FAT between customer DCS and Siemens TCP, to be performed in Siemens factory (customer should deliver DCS software at Siemens factory) ;
- Turbogear packing prepared for land transportation and indoor storage.

Spare parts

- Spare parts recommended for start-up according to the list presented on Part 6 of this proposal.

Field Services

- Field Services according to technical description on Part 7, considering: Erection supervision, commissioning, start-up, training and performance test;
- 40 calendar days assisted operation (baby-sitting) by Siemens supervision available at the site 8 hours/days, limited in up to 03 mobilizations at customer site, according to the description of Part 7;
- 1st and 2nd turbo-generator set: test of continuous operation during 72 hours for each;
- 3rd turbogenerator set: continuous operation during 288 hours, in parallel with the 1st and 2nd turbo-generator set. In case the test of the 1st and 2nd TG sets (72 hours each) is not possible due to safety reasons, the test will be performed during 720 hours for the total time of the 3 TG sets;
- Mechanical and electrical site erection of Siemens scope (considering the existing overhead crane and including installation and supply of ducts for air distribution for dehumidificator system) according to the description attached to this offer.

- Miscelaneous and erection services for MCC cables conection up to Siemens motors terminals was included at Siemens scope;
- Siemens consider erection service based on PI&D's and layout drawings submitted and proved to customer during execution phase. If during erection execution we find an intereference on customer building Siemens will present to customer the additional price for material and service necessary to conclude the installation;
- Feeding, lodging and travel expenses for Siemens specialists responsible for the services, considering the period presented on the time schedule attached to this proposal.

Documentation

- Documentation according to the list of documents described on Part 8 of this proposal;
- 03 copies of documents certified during the project.

Unloading

- Unload equipments on customer site using customer housecrane applicable for turbine, gearbox, generator and auxuliaries. Siemens will provide a hydraulic lift device to unload the condenser on customer site. In order to execute unload activities the following pre-requisits shall be fulfilled by customer:
  - Equipment civil base must be ready to receive all equipments at time designed by Siemens;
  - Customer must certify that an area in front of condenser civil base shall be clean and available to maneuver a truck about 18 meter length;

- An additional area around condenser civil base (radius of 2meters) shall be available to install hydraulic lift device;

If Siemens does not complete the unload due to customer reasons or fault during the service period, Siemens shall present to customer the additional price.

The unit is designed for indoor installation, non electric hazardous area and non seismic zone.

Technical clarification to the specification:

- Condensate pumps are designed according to the equipment layout presented in the proposal. Pressure level is according to the Heat Balance Diagram (HBD39).
- The condenser pumps are designed according to recognized international standards and Siemens standard procedures. No change to the standard design and manufacturing for such application is being considered;
- Shell and hotwell will be designed to withstand project vacuum conditions.
- Condenser tube velocity considered by Siemens is 2,98m/s.
- The offered end switches are SPDT Contact interrupting capability: 230Vac 6A/ 125Vdc - 6A.
- Unload equipments on customer site using customer housecrane applicable for turbine, gearbox, generator and auxuliaries. Siemens will provide a hydraulic lift device to unload the condenser on customer site. In order to execute unload activities the following pre-requisits shall be fulfilled by customer:
  - Equipment civil base must be ready to receive all equipments according to time-schedule attached to contract, which can be adjusted during project execution;
  - Customer must certify that an area in front of condenser civil base shall be clean and available to maneuver a truck about 18 meter length;
  - An additional area around condenser civil base (radius of 2meters) shall be available to install hydraulic lift device;

  If Siemens does not complete the unload due to customer reasons or fault during the service period, Siemens shall present to customer the additional price.
- Siemens is considering that Steam quality for turbine operation will follow steam quality document attached to technical proposal.
- The shell and hotwell plates and welds will be provided with a corrosion allowance of 0.8mm on shell side and 1,6mm on tube side.
- Hotwell storage capacity will be 1 minutes of condensate flow rate.
- Condenser water boxes will be painted with coal tar epoxy.
- Water boxes will have 600 mm diameter manholes.
- The design of the tube sheets will be based on applying a stress analysis with stress levels not to exceed those determined using the procedures of the ASME Code Section VIII Division 1.
- The operational limits of the condenser shall be in accordance with the parameter stated in the Heat Balance Diagram and condenser data sheet attached to Siemens technical proposal.
- Ejectors included in the Siemens scope of supply. Motive steam shall be supplied at the condition stated on Page 2 of the turbine Data Sheet attached to the Proposal.

- The condensing and oil system interconnections, valves, and connections for instruments as well will be provided according to ANSI/ ASME standards. All interfaces with BOP will be according to ASME. The interconnections of turbine bearing housing and control valve servo motor connections will be acc to DIN, which have no interface with customer piping.
- Turbine inlet steam control valves are designed according to Siemens standard. The inlet control valves are single seat type, high pressure/ hydraulic operated.
- The pneumatic control valves of the sealing system does not include position transmitter, these valves are regulated according to the hotwell level and sealing steam pressure. Insulation and lagging are according to Siemens standard of supply. It will be applied in the turbine and inlet valves for indoor installation.
- The motors in Siemens scope are according to ABNT-NBR 17094-1 instead of NEMA MG-1. The motor does not include heaters due to their size.
- The WW505 can be configured to utilize an Automatic Start Sequence to start the turbine. This sequencing logic allows the 505 to perform a complete controlled system startup from zero speed to rated speed. With this function, the turbine's starting ramp rates and idle speed hold times depend on the length of time the unit was shut down. However STG is not fully automatic startup designed, once some valves are manual;
- The turbine includes a single governor. The routine for start-up does not include automatic drain valves either. Instruments used for control or monitoring are single type, those that belong to critical loops and have trip function are redundant, including the overspeed protection that is the most critical loop in the turbine and has triple redundancy (2 of 3). The PLC is not redundant. The protection relay and voltage regulator are not included in the current Siemens scope of supply.
- Siemens has foreseen an Ethernet link to communicate to the main plant operator interface, and commands like synchronization or turbine startup from the DCS shall be sent through this link.
- The available shutdown functions for Woodward 505 are the emergency shutdown and controlled shutdown.
- Siemens fulfill protection criteria according following standards: VGB R103Me-2006-Guideline for monitoring, limiting and protecting devices on steam turbine plants, EC Machinery Directive 2006/42/EC, Machinery Directive hazard and risk assessment (HRA = Hazard and Risk Analysis) acc. IEC 61508 / 61511 (SIL), Basic standards for the preparation of a hazard and risk assessment: EN ISO 12100-1, ISO 12100-2, EN ISO 14121.
- STG set will be installed in a non explosive and non classified area. For turbine control panel IP54 protection degree will be considered and for junction boxes, IP65 protection degree manufactured in aluminous.

- General application thermowells are made of stainless steel 316, but for high temperature and pressure application such as live steam temperature measurement the material used is F22. The Thermowell is composed of head with connections, a conical well and a union nipple to get both together.
- Thermowells for temperature sensors offered by Siemens are connected to the process using Ø 3/4" NPT thread. For critical conditions in which welded connection is required, welded connection will be used. This verification/calculation is done during project execution.
- For the oil tank, it is used a magnetic float for level measurement, and for the condenser hotwell it is used 3 differential pressure level transmitter.
- As general criteria, Siemens prefers to use transmitter than switches to control and protection loops. Where end switches are used, double pole double terminal types can be used.
- Threaded 1/4 "NPT is used for solenoid pneumatic valves only. The other solenoid valves and trip block are flanged connected.
- Limit switches used by Siemens requires only 1 normally open and 1 normally closed electronically independent contacts.
- Turbine inlet control valve is provided with position transmitter. Please, refer to the respective P&ID attached to the proposal.
- The DCS will receive the inputs related only to the alarm and trip signals from the turbine control system. Differential expansion is not applicable for this size of turbine.
- Besides of the redundant on equipments offered, the other instruments do not need to be redundant for continuous and stable operation.
- Siemens will provide the communication map to allow access to the requested measurements.
- Generator field temperature is not measured by Siemens, field current and voltage are not measured directly either, exciter position and exciter temperature are not measured by Siemens.
- FAT (Factory Acceptance Test) will be done for the turbine control panel.
- Condenser operation curves will be supplied during beginning of engineering phase.
- Moisture content in turbine exhaust is about 13% in guarantee point. Siemens guarantees efficient and safe operation under this condition.
- Lubricating oil system is not flushed in the factory. If necessary, flushing is done on field according to erection and commissioning time schedule.
- Chemical product required for oil system cleaning is included in the Assembly manwork scope.
- In the oil reservoir, there is a level transmitter, a level gauge and a temperature sensor (RTD).

- Vapor extractor at oil tank is included in the Siemens scope 1 x 100%.
- The main oil pump is assembled on gear box shaft. The DC emergency oil pump is designed to 20% of main oil flow. This pump enter in operation just in case of failure of the main pump and the auxiliary pump. So in this case the turbine is shutdown, and this emergency oil pump is sized just to keep the oil pressure during a safe shutdown, so it can not have the same capacity of the main oil pump.
- Oil coolers can be commuted during operation and are designed to be 2x100% and design fouling factor is 0.0002 m².h.C/kcal. The visual indication of oil level is at the tank. The heat exchanger can be commuted during operation, and this desing does not require a three-way transfer valve to temperature conditioning.
- Siemens considers the oil tank material in carbon steel, not stainless.
- The offered system has a redundant pressure measurement before the oil distribution to bearing, and these transmitters are responsible for switching on the pumps on different set points, and alarm or trip the turbine with 1 out of 2 voting system.
- Load control is done by the turbine control system, which is included in Siemens scope of supply. Nevertheless, the load control is also dependent on the synchronizer signs from generator control panel.
- The system offered for overspeed measurement is a SIL 3 overspeed protection device, 2 out of 3 voting system for turbine protection, a mechanical overspeed is not necessary to the protection criteria.
- Siemens specifies the oil as ISO VG 46 to be suitable for the servomotors requirements.
- For level measurement in high pressure control oil unit, it is used a guided wave radar type and a level gauge.
- Siemens scope of supply considers redundant full size pumps, being the main oil pump driven by the gearbox shaft and an AC auxiliary pump driven by an AC motor.
- It is used only one cooler because the control oil does get as hot as it would get heat from bearings. So this design is one cooling pump that keeps the oil circulating through the oil cooler, while this has to get colder.
- Siemens has considered temperature sensor (RTD) for oil temperature monitoring.
- There are 2x 100% main filters in the oil piping line.
- Reservoir heaters for oil tank immersion type included at Siemens scope of supply.
- According to customer specification, as the sealing steam pressure control valves bypass is for maintenance purposes, the bypass valves are manual operated.
- Piping are in accordance with ASTM.
- The turbine speed up is fully automatic. Drain valves, steam ejector valves and jacking oil valves are manual operated and shall be handled during turbine start-up. To start the steam turbine some requirements shall be fulfilled first, for instance

hotwell level, live steam pressure and temperature, etc. Some procedures need manual interactions. Continuous operation is automatic.

- Control system is according to Siemens standard, as described in control archteture attached to technical proposal. TG set can be operated via the HMI installed on turbine control panel.
- The current offered solution does not require the cabinets to be separated, and therefore the turbine control panel, including the distributed processing units (PLC), and input/output system (I/O cards) are installed in only one cabinet, which is our standard solution.
- Field instruments that are exposed to a more aggressive environment have redundancy when such instrument is related to a critical loop, such as speed measurement for its control and safety shutdown system for turbine protection. The for overspeed protection is triple redundant, once there are 03 MPUs for speed measurement, because this is the most critical protection of the turbine, classified as SIL 3.
- Mechanical and electrical site erection of TG is Siemens scope (considering that existing overhead crane will be full available for Siemens use). Siemens consider erection service based on PI&D's and layout drawings submitted and proved to customer during execution phase. If during erection execution we find an intereference on customer building Siemens will present, if necessary, to customer the additional price for material and service necessary to conclude the installation
- The speed governor Woodward 505 can be configured to utilize an Automatic Start Sequence to start the turbine. This sequencing logic allows the 505 to perform a complete controlled system startup from zero speed to rated speed. With this function, the turbine's starting ramp rates and idle speed hold times depend on the length of time the unit was shut down. This sequence logic is initiated by a 'RUN' command. Drain valves, steam ejector valves and jacking oil pump valve shall be manually closed according to Siemens procedures. The automatic synchronization usually is initiated by an operator command, in order to perform tests and applicable procedures during no load operation. The automatic synchronization ("RUN" mode) shall be performed by the digital synchronizer which send a speed bias to the speed governor for frequency adjustment, and voltage bias to the AVR for voltage adjustment. After synchronization, the control mode can be switched to load control that can be increased through the HMI in front of the Turbine Control Panel, or it can be sent from the DCS directly to the PLC through the Ethernet communication link available for customer.
- The two out of three voting for shutdown is applied to overspeed protection due to its importance to turbine protection. Any other shutdown action is taken by one out of two voting system.

- Due technical reason maximum allowed distance between field proximity transducers and vibration monitor is 300m. For this project we are considering that Turbine control Panel will be installed at max 10m distance from turbine;
- Vibration system offered covers monitoring function, not analysis (trends, etc.), neither generator capability, rotor stress analysis, temperature/pressure ramps, trending of both current and historical data. These functions can be performed by the systems that are out of Siemens scope.
- Instead four probes (2X and 2Y) on the hot end bearings, 2 probes (X and Y) are installed at each bearing. It is used 2 axial displacement probe at turbine thrust bearing.
- It will be provided 4-20 ma DC analog output signals from the instruments to the turbine control panel. Siemens will provide an Ethernet communication link to exchange information between the turbine control panel and central control room DCS.
  The DCS will receive the inputs related only to the alarm and trip signals from the turbine control system.
- Hand-held radio transmitters shall not be used near to the turbine generator due to interference in accelerometers signals. To avoid an undue turbine shutdown, the radio transmitters shall respect a 10 meters radius around the turbine.
- The radial rotor vibration is measured by 2 sensors placed 90 degrees from each other (X and Y) in each bearing.
- There are 2 sensors to detect turbine axial displacement.
- Casing vibration is only measured on the gear box, for turbine and generator the vibration is measured directly in the main vibration source, the rotor itself.
- The trip signal is hardwired, but alarms and different trip information are transmitted through the communication link.
- Casing and rotor expansion monitoring is not required for the size of offered turbine.
- The turbine control panel that houses the monitor rack is bottom cable entry. It is also installed in this panel the speed regulator, PLC, power supplies, etc.
- All data related to vibration can be taken by Customer from the Modbus communication link from the monitor rack.
- High oil temperature does not trip the system, bearing temperature does that instead.
- Turbine control panel protection of IP54 is considered.
- Pneumatic accessories will be mounted, tubed and suitable for indoor service.
- Solenoid valves considered in this proposal are supplied by 24 Vdc.
- Detailed information on identification will be agreed during beginning of project execution between Siemens and customer.

- Generator design corresponds to IEC 34.
- Excitation system speed of response does not attend 0.1 with offered brushless excitation with PMG. This value can only be attended with static excitation.
- The generator design may vary according to the manufacturer standard design (which may be salient pole field type). This item will be confirmed upon manufacturer selection.
- Siemens assumes that the requested automatic runback refers to a second cooling circuit (additional 100% cooler) on the generator. The generator is designed with redundant cooler.
- The offered generator cooling system refers to an air/water cooling system, being the air the cooling medium which will be in contact with rotor and stator. The water is only used to cool the air, in the air-to-water coolers installed in the generator. No water cooled stator bar is used according to the offered generator design.
- Siemens is considering excitation type brushless with PMG at scope.
- Extra fan for exciter for excitation system. Generator shall be capable of operating at ceiling excitation (with voltage of 140% of the field voltage required to operate at rated kVA) for one minute, or an agreed to period of time, without injurious heating.
- Regarding the modulus 3.6 of ONS Procedure:
  1) Item 7.3; Table 2; sub item 3 – Response time of field voltage (THIR) The system shall have a High Initial Response (HIR) with response time shorter than 0.1 sec (≤ 0,1 s). Hardly an excitation system type brushless can comply with this requirement. For this, special equipments shall be used.
  2) Item 7.3; Table 2; Sub item 2 – Positive ceiling voltage ≥ 2,5 times the field voltage at rated load.
  The brushless excitation system shall have a special project to comply with this requirement, and it might get the project unfeasible for costs and size issues.
  3) Item 7.3; Table 2; Sub item 2 – Negative ceiling voltage (80% of positive ceiling voltage). In brushless excitation system, the minimum value of ceiling voltage in the field of the main generator is 0 (zero).
- Thermal isolation for piping included at Siemens scope, applicable for temperatures above 60 degrees. Isolation will be in accordance with standard ABNT NBR 11363, Petrobras N-1618 and ASTM C 547.
- The velocity on piping included at Siemens scope of supply will be calculated by Siemens based on our standard and experience.
- Space heaters are switched on by a PLC command according to applicable interlocks. Siemens recommends use a higher voltage then 127 V for space heaters.
- The generator may also operate for extended periods of time at loads as low as 14% MCR.

- Diverged standards ANSI for generator. Generator Will be designed based on ABNT, NBR, VDE and ISO, as per manufacturer standard
- Agreed generator power factor will be 0.8.
- Diverged Negative sequence capability (I2)2T equal for generator, in accordance with ANSI C50.13. Offered Maximo I2/In (Negative Sequence Current in Nominal Current) of 10 % as table of 2, IEC 60034-1 edition 12.0 2010-2. And I^2t = 20s.
- Diverged 3-phase short circuit capability for generator: Not less than 10 seconds . Generator Will be designed to operate 1.4xIn for 10s.
- Genertor: Diverged "The wave form of the generated voltage measured from line to line on open circuit at rated voltage and speed, shall have a deviation factor of not more than 10% from a pure sine wave." Offered Harmonic distortion (phase-phase) equal 5%.
- Clarify "Generator shall have a balanced telephone influence factor (TIF) of not more than 40, and residual TIF of not more than 30 with both TIF values based on the weighing factors given in ANSI C50.13."
- Diverged "Stator bars which are water -cooled shall be pressure tested to ensure that there are no leaks in the bar or at its end connection. All stator parts shall be tes ted to ensure unrestricted passage of the coolant. All stator parts shall be tested to ensure unrestricted passage of the coolant." Offered Stator bars are air -cooled.
- Diverged "The generator rotor shall be designed and constructed so as to withstand an overspeed of 20% without mechanical injury." Offered generator able to overspeed of 1.2xn per 120s.
- Diverged "A static excitation system". Offered PMG excitation system with brushless.
- Diverged "The generator shall be capable of delivering 67% of its peak rating at the generator temperatures specified in the ANSI standards with one cooler section out of service." Offered thermal capability: heat exchanger with 4 coolers each one set with 50% of generator losses. Generator is able to operate with nominal power (100%) with two coolers (one each side).
- Diverged Nema 4 type or IP62 enclosure. Generator is IP54 enclosure, standard IEC.
- For grounding and general electrical we consider Generator supplier standard.
- Diverged NEMA 4 type or equivalent IP-66 enclosure minimum for junction boxes. Generator Juction boxes will be IP54 enclosure, standard IEC.
- Clarify "The system shall be designed to operate in a power plant environment and shall exhibit immunity to stray magnetic and electric fields."
- The generators will be tested according standard IEC60034. The tests included in this proposal are Routine Test.
- The generator was able to frequency variation +/ -2% (continuos operation).
- The generator was able to operate frequency variation 58.5 to 57.5 Hz up to 10 seconds.

- Transient characteristics: generator operation on class F. According IEC 60034 -1, item 7.3 note 2: "For conditions at the extreme boundaries of zone A, the temperature rises and temperatures typically exceed the limits specified by approximately 10K".
- Diverged cooler type 2x50%. Offered thermal capability: heat exchanger with 4 coolers each one set with 50% of generator losses. Generator is able to operate with nominal power (100%) with two coolers (one each side).
- Equipment weights and dimensions will be confirmed during project execution.
- For further detail on the Proposal consideration, please refer to the Heat Balance diagram and Standard Steam flow diagram attached to the proposal. The scope of supply as described in the Technical Proposal.
- Water balance Diagram, is not part of Siemens scope. Design of Siemens turbine will be accordingly HBD 39;
- Siemens will supply redundant communication to DCS, as per described in the control archteture;
- Water intake and discharge, water catchment, water treatment, cooling tower and other scope related to water will be provided by EPC. Siemens limit of battery is in the water inlet/outlet in each cooling water consumer
- Final steam turbine and auxiliaries design is based on HBD 39 from Siemens attached in the technical proposal.
- Condenser tubes is in Stainless steel 304, generator cooler tubes is in Cupper and lube oil cooler is in stainless steel 304. For cooling water quality, Customer shall follow Siemens recommendation as per cooling water quality document attached to technical proposal.
- Sumary of our battery limit complies integrally with flow diagrams, (Attachments 5, 6, 7 and 8 of technical proposal) and is as follows:
    - STEAM: inlet of turbine flange; outlet of turbine bleeds flange; inlet of ejector system (max 5 meters); inlet of sealing system (max 5 meters); inlet to condenser bypass;
    - VENT to ATMOSPHERE: gland steam flange (1 meter above turbine); outlet of safety valves (steam ejector and condenser pressure safety valve - 1 meter above turbine); outlet flange of startup ejector silencer; vent flange of ejector steam;
    - COOLING WATER: inlet/outlet on each consumer (oil cooler; generator cooler, condenser);
    - DEMI WATER: inlet at each dessuperheater supplied by Siemens (dessuper for ejector and sealing steam); Inlet at condenser hotwell for makeup;
    - DRAIN: will be delivered by Siemens on the floor just below drain collect point;

  - CONDENSATE: Outlet flange after export control valve (1m after ejector steam condenser);
  - OIL: outlet of oil mist; inlet at oil tank for filling; outlet oil tank for drain;
  - COMPRESSED AIR: inlet flange for condensing system consumer (max 1 meters); inlet at non return valve consumer;
  - ELECTRICAL: Generator main and auxiliaries terminal box; Motors terminal bornes; other electrical equipment terminal bornes;
  - CONTROL: connection os instruments up to turbine control panel (installed beside turbine – max 10m);
  - Some items such non return valves; instruments for customer line; dehumidifier, etc are loose supplied;
- Auxiliary loads consumption for TG set is guaranteed by Siemens as per technical guarantee attached to technical proposal.
- Equipments unloading on cutomer site is part of Siemens scope, for more information please check part 2 of technical offer.
- Siemens will be responsible to accommodate their own people.
- For condensate, Siemens limit of scope will be condensate export control valve (just after auxiliary condenser);
- Electrical equipments in the Siemens scope are: generator, motors to driven pumps supplied by Siemens, generator terminal boxes only.
- Siemens will supply instruments listed in the turbine datasheet.
- Siemens will provide accommodation/structure necessary for TG erection,
- Siemens technical guarantees is described in the file 18 of this technical proposal;
- The performance test will be done with operational instruments supplied together with the turbogenerator set. No special instrumentation neither mass flow measurement devices are included in the Siemens scope of supply.
- In a period limited to 3 months after the beginning of operation, Siemens will supply one engineer to measure the performance in the project guarantee point. The performance test will be performed according to Siemens test procedure which is based on IEC 953-2 (first edition 1990 – 12). In case the performance test is done after 4 months from the turbogenerator set startup, the degradation factor according to respective standard (IEC953-2) shall apply.
- Only operation software / license (for control system and parameterization) is included in Siemens scope of supply;
- During project execution, the documentation to be issued for customer approval is expected to follow a planned execution schedule, which was developed taking into consideration only one language (Portuguese).
  For some imported items, the documentation will follow in the original language from subsupplier (English).

Data transfer formats, file types and file versions are made in PDF (ADOBE ACROBAT). When transferring data, following media shall be used: CD – ROM or e – mail
Alternative media transfer formats to be used has to be case-by-case mutually agreed between SIEMENS and Purchaser before project starts.
During project execution, the documentation to be issued for customer approval is expected to follow a planned execution schedule, which was developed taking into consideration the documentation to be sent to customer in electronic way (email or other electronic way). In order to avoid any delay in the project execution schedule, Siemens suggests to exchange electronic files with customer during documentation approval phase, and then, after the final revision and approval is issued, the Certifcate version of each document will be sent in paper form (3 copies)."

- All manuals will be available in electronic version (CD) only. The O&M manuals (text descriptions) will be delivered in Portuguese language. The documents certified during the project, as well as other documents which compose the manuals, are handed over in Portuguese (or in English for some datasheets, drawings, etc., for some imported items) language.
- Theoretical training will be carried out by the Siemens specialist, during 2 days, 8 hours/day, to be scheduled before commissioning period. SIEMENS will provide training material, while customer will make available rooms and support equipment for the presentation, as well as distribute shifts of operation personnel to fit in the training schedule.
- Practical training will be given throughout the commissioning period, as the circumstances may require.
- Siemens will provide customer with monthly project status report.
- It was considered for condensing system and turbine exhaust design the nominal cooling water inlet temperature of 30ºC.
- It was considered that equipments is packaged for indoor storage;
- The heat rate related to the steam turbine generator can be obtained based on the data available in the Heat Balance Diagrams attached to the proposal;
- Pneumatic control valves are used in Siemens scope of supply for the following devices:
  - Front end sealing steam pressure control valve
  - Rear end sealing steam pressure control valve
  - Condensate recycling level control valve
  - Condensate export level control valve
- Siemens will provide redundant an Ethernet communication link to exchange information between the turbine control panel and central control room. The communication map will be provided to integration to supervisory system. Details of control system is showed in the control architecture attached to this technical proposal;

- Siemens recommends that the CCTV system of the entire plant shall be integrated, thus the turbine generator CCTV system should be component of it.
- To start the steam turbine some requirements shall be fulfilled first, for instance hotwell level, live steam pressure and temperature, etc.

  The Cold Start curve will be selected by the control system in case of any shutdown time bigger than 24 hours.

  The cold startup curve is calculated based on the period of time required for proper turbine startup considering that turbine casing is cold (at ambient temperature).

  The warm startup time is calculated based on the expected turbine casing temperature up to 24 hours shutdown, and Hot start up curve is calculated based on the expected turbine casing temperature up to 6 hours.

  - Coldstart shutdown time: t > 24 hr
  - Warmstard shutdown time: 6 < t < 24 hr
  - Hotstart shutdown timer: t < 6 hr

  The selection of turbine startup also depends on the junction flange temperature between upper and lower casing, for further information please refer to the start up curves document deliver during project execution.
- During the comissioning, rejection load test is done for 25%, 50%, 75% and 100% TG set load.
- Miscelaneous and erection services for MCC cables conection up to Siemens motors terminals was included at Siemens scope;
- Areva must inform Siemens in an agreed period about necessary information to allow conection between MCC and motors.
- Regarding over frequency protection, Siemens does not recommend over frequency trip, the turbine is designed to withstand an overspeed up to 110% of the rated speed. So Siemens uses a 2 out of 3 voting device (SIL 3) to trip the turbine in case of overspeed, and it does not depends on the excitation. If the setting of over frequency protection is too close and too short, there is danger to trip during load shedding. Anyhow it is against the reliability. It can be set an alarm for the frequency range 61.5 to 63 Hz (10s), but it is not usual.
- Regarding the turbogenerator set performance, the electrical power output is guaranteed according to correction factors (kW ADJ) to be established according to the correction curves to be provided by Siemens in the beginning of project execution phase. The correction formulas to be applied will be informed according to the curves. The performance test will be performed according to Siemens test procedure which is based on DIN 1943.
- The reliability testing required by the end customer may be carried out during the period of 72 hours for first unit, 72 hours for second unit and 288 hours for the 3 units altogether.

  Siemens is considering that this test will be monitored by Siemens' personnel, who will be present on site during 24 hours a day.

- For Reliability/Availability test evaluation formula, please refer to formula agreed on contract attachment.
- Siemens standard functional tests will be performed related to the items included in Siemens scope of supply.
- Please, refer to the Siemens proposal to check on codes and standards that will be applied by Siemens in the scope of supply.
- Estimated packing list can be provided in advance, however final packing list is supplied after equipment is packed.
- One single dehumidifier system will be supplied for all 03 turbines, which will be used in case of hibernation of some of those turbines
- Siemens will apply the identification based on ISA std. Identification will follow same standard already presented in the PIDs attached to technical proposal. However Siemens will include the customer tag also in the project documentation (where applicable);
- During the period of guarantee the software supplied by Siemens for PLC and HMI parameterization shall not be modified;
- Noise level considered by Siemens is 103 dbA +- 3 at 1m distance, acc to ISO 3740 / DIN 2159.
- Bleed turbine connections will be designed according to Siemens criteria for flange size design. If necessary, the piping line size shall be adjusted by the customer accordingly.
  Please, see below the size of each bleed line connection. A respective pneumatic non-return valve will be provided for each bleed, as follows:
  Bleed A3 - 1 x 6"", 40#
  Bleed A2 - 1 x 8"", 16#
  Bleed A1 - 1 x 14"", 16#
- The position of installation of the non return valve on customer bleed line will be confirmed later by Siemens.
- For valves that are in Siemens scope of supply, it is used the design criteria presented in the customer specification, except for the butterfly valve for which gate valves are used instead. Valves used as block valves for instrumentation are globe valves for steam and condensates pipes, and needle valves for oil lines.
- High pressure gate valves subject to a one side pressure shall have a by-pass valve for pressure equalization. This requirement is not applicable for lines in which gate valves are used, such as turbine drain lines, but for these lines suitable valves are used for the pressure they are exposed to.
- Turbine casing and turbine inlet valves are thermal insulated according to Siemens standard. For piping included in the Siemens scope of supply, Siemens will provide thermal insulation (when applicable) in order to reach maximum tube outside temperature of 60C.

- Painting and coals will follow Siemens Painting plan attached to the proposal.
- For details of equipments supplied by Siemens please refer to Datasheets attached to technical proposal.
- Pipe sizing within Siemens limit of battery is Siemens responsibility. Any piping sizing out of Siemens Limit of battery must be done by EPC.
- The turbine wheel chamber pressure can be used as a reference for the inlet steam flow, however it is expected a higher uncertainty (~5%) in using this measurement as a reference of flow, reason why DIN 1943 strongly recommends the installation of the proper flow measurement according to ISO 5167. The instrument itself and its installation shall be carried out by the customer with the piping routing and project.
- Pressure transmitter and temperature transmitters for live steam are supplied loose by Siemens.
- Siemens will provide the pressure control valves and dessuperheater for reducing the pressure and temperature of live steam for sealing and ejector systems. EPC be responsible to pickup steam line from main steam piping and shall bring this line at maximum distance of 5 meters from respective equipment consumer (turbine for sealing and ejectors) and upstream of the pressure reduction valves and dessuperheaters.
- The turbogenerator set offered by Siemens is suitable to receive steam from the bypass station. Details of bypass interface is included in the General overview of equipments related to Bypass attached to technical proposal.
- Each offered turbogenerator set is suitable to admit a maximum steam flow from the bypass line equivalent to 40% of each boiler capacity, as specified by the EPC.
  In case of turbine trip with boiler operation above 40% flow, the remaining steam exceeding bypass capacity shall be released to the atmosphere or lead to an auxiliary condenser.
- With the turbogenerator set out of service, the bypass system can be operated up to 4 hours sequentially. During this period, it is expected the boiler operation to be adjusted accordingly. For the operation of the bypass in parallel with turbogenerator set operation, the bypass can be operated for an unlimited period of time, since it is operated above the minimum allowed power generation for such condition. Please, refer to the Heat Balance diagram attached to the proposal for further information.
- The condenser proposed is designed to receive bypass steam at rated temperature as specified in Siemens proposal, thus this requires the water spray in operation to reduce the steam temperature in order to avoid any damage to the condenser.
- The condensate pumping system is designed according to the maximum condensate flow as stated on page 1 of the Heat Balance diagram attached to the proposal.
- The condensate passes through the ejector steam condenser, which condensates steam from the vacuum system ejectors.

- Gland steam condenser for leakage flow is not necessary due to the very reduced leakage flow expected from the condensing turbine.
- The condensate control valves regulate condensate flow based on hotwell level.
- Demineralized water shall be supplied to the hotwell to turbine startup, and the condensate discharge pumps and recycling valve are responsible for keeping the hotwell level.
- The condenser hotwell is properly designed to receive make up water, according to the Heat balance attached to the proposal.
- Condensate discharge is used for turbine exhaust hood spray, condensate pump seals and valves sealing in vacuum lines.
- Solenoids are supplied with IP-65.
- Tests and inspection are according to Siemens standard plan, attached to the technical proposal.
- Pumps are tested at the subsupplier's premisses, but not at Siemens factory. The complete hydraulic unit test is done during comissioning.
- Documents for approval are related to overall power plant, which is applied to EPC. The documents supplied from Siemens to EPC contractor are included attachment 29 of technical offer.
- Standard and codes are according to manufacturer's experience and are informed in the Technical Proposal.
- QA/QC management according to internal management control and follows recommendation from PMBOK/PMI.
- In case customer is interested to participate of any test during equipment production, this participation shall be aligned with Siemens Project Management in order to organize agenda. Customer particiaparion is for information only and Siemens shall be solely responsible to define corrective measures in case of any value is non conform during test execution. No holding point is considered for this project.
- Siemens is responsible to comply with the regulations related to its equipment design, manufacturing and erection. Any required license and/or regulation requested by Areva or end-customer applicable for customer site, equipment erection and installation and equipment operation shall be customer responsibility unless if already informed prior to contract signature.
- Heat stability test of shaft depends on geometry. If applicable, it will be applied accordingly.
- Rotor clearance check is performed during rotor assembly and this document is part of internal documentation.
- Lube oil system functional test will not be performed at factory. This test will be performed during turbogenerator commissioning at customer site.

- Standstill (non rotating) test will be applied. Generator vibration measurement is done at customer site, during turbogenerator set comissioning. Rotor high speed vaccum test will be performed at Siemens site.
- Dielectric test on stator and rotor is done on stator winding only.
- Test for flow continuity through windings (for liquid conductor cooled stators) not applicable.
- High potential tests are made by IEC.
- The electric motor drives included in Siemens scope are purchased together with the pumps, therefore, only the pump tests certificates are provided. The motors data sheet are included in the data book.
- Pneumatic leak tests are not performed for HP piping or condenser, but hydrostatic pressure tests.
- Siemens has its approved list of qualified subsupplier and guarantees their quality and performance. The subsupplier list considered is attached in the technical proposal.
- Siemens is including 40 calendar days assisted operation (baby-sitting) by Siemens supervision available at the site 8 hours/days, limited in up to 03 mobilizations customer site;
- General instrumentation and admission control valves will be 4-20mA + HART according to the attached turbine datasheet;
- Drain header and flash tube: Turbine casing and bleed piping steam drains have to be routed to a drain header and from there to a closed tank (flash tank) under vacuum and with condensate spray in order to be flashed back to liquid. Drains piping of turbine is included in the Siemens scope. Bleed piping drains is also included in the Siemens scope (limited to 5 between flash tube and drain collect point in the bleed line), however conection of such drain in the steam bleed piping is customer responsibility;
- Redundant instrumentation is not needed to perform successfully the reliability test.
- According to customer request, the Generator auxiliary panels (control, protection, excitation, synchronizing panel, surge protection cubicle, grounding cubicle) is not included in the scope. Therefore, in order to allow a proper integration into Siemens supplied equipment & system, customer shall fulfill the minimum requirements described for such panels, which will be informed during project execution.

SIEMENS

Proposal n°: 11-003210-007-001
Submitted to: Areva
Date: February 02nd , 2015
Revision: 15

Areva – UTE Campo Grande – 3 x SST-400

Part 2

Subject:

Steam Turbine General Description

2.1 Steam Turbine

Turbine design

The turbine is an axial-flow, single casing construction with reaction blading which has proven itself over the course of many years. This combines a highly robust and compact design with low steam consumption and cost-effective production.

The individual modular units have been developed on the basis of almost 100 years of experience in the field of turbine design, and have proved their worth in numerous successful applications to date. Quality assurance procedures to ISO 9001 ensure that the components fully comply with the stringent Siemens requirements.

The use of proven standard modular elements provides a guarantee for the careful execution of constructive details and, hence, for reliability in operation. The advantage of a cost-efficient production is thus combined with constructive flexibility.

General description

The turbines are designed as multistage reaction turbines and allow extraction, bleeding and induction steam (if applicable). A impulse control wheel is provided upstream of the reaction section that is always fitted with shrouded blading. The guide blades are mounted in thermo-elastic guide-blade carries which are suspended centrally in the casing.

The nozzle chest for steam admission to the control wheel are assembled separately in the lower and, when necessary, in the upper part of the casing and welded in position.

The horizontally divided turbine is of simple and fully symmetrical construction. It is symmetrically supported on the two bearing housings. Radial bolts serve to avoid a displacement of the casing center line with regard to the bearing center and thus to the rotor axis under all operating conditions.

The turbine rotor, manufactured from one single forging and stress-relieved after turning, is guided axially in the front bearing housing. The rear bearing housing is usually designed as the fixed point, so that the exhaust-side shaft end is subjected only to minimal axial movement at start-up.

The turbine incorporates guide-blade carriers that provide the following advantages:

- Rapid temperature balance between rotor and guide-blade carrier
- Large temperature gradient and insensitive to temperature and load variations
- Movement in the casing does not affect the radial blade clearances

To obtain good steam consumption at partial loads, the turbine is designed with flow control using a consecutive compound control valve system which ensure reliable steam flow control. Only one spindle passage must be sealed with a gland bush.

The control valves are housed in a cast-steel casing which is most suited for high-pressure steam. The emergency trip valve is located at one end of the valve block, the hydraulic valve actuator at the other.

The valve actuator, arranged separately from the hot valve block is operated by pressurized oil via the oil relay. In case of a sudden load drop the valve are closed very quickly. Thus the machine is prevented from reaching overspeed even in the event of a full load throw-off.

The turbine is supplied with controlled extraction (if applicable). Through this extraction steam can be taken from the turbine at a given controllable pressure and be made available to other consumers.

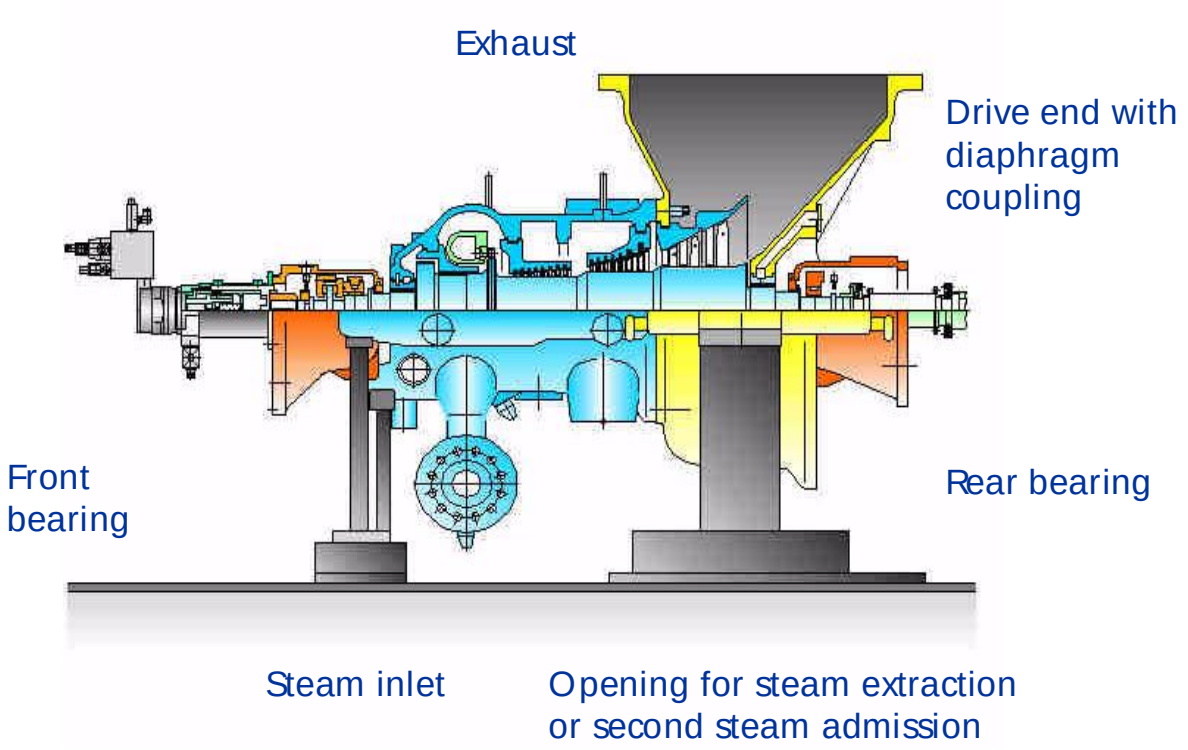
The standardized, forced-feed lubricated turbine bearings are accommodated in easily accessible bearing housings. The axial bearing, designed as a double-sided tilting-pad bearing, is flanged onto the front journal bearing.

At the shaft passages the turbine casing is sealed with non-contacting labyrinths.

Design features of the turbine

The turbine is characterized mainly by the following design features:

- Single casing design
- The front end rests on flexible supports, arranged at oblique angles to the rotor axis
- The rear end rests on flexible supports, arranged longitudinally to the rotor axis.
- Emergency-trip valve located on the right-hand side, as viewed from turbine to gear unit.
- Valve chest directly welded to the lower or upper part of the turbine casing.
- Inlet steam from above or below
- Bleeds and extractions oriented upwards or downwards (if applicable)
- The thermally stressed parts, nozzle casing and guide-blade carrier, are thermo-elastically suspended in the outer casing of the turbine.
- Actuators for live steam, extractions etc. arranged on the left-hand side, as viewed from turbine to gear unit
- Exhaust oriented upward or downward or axial (if applicable)



Steam Turbine Design Sketch (for information only)

Outer casing of the turbine

The upper and lower casing halves are almost symmetrical, except for the live-steam connection and the supports. All thermal stresses in the case of load changes or temperature variations are thus reduced to a minimum.

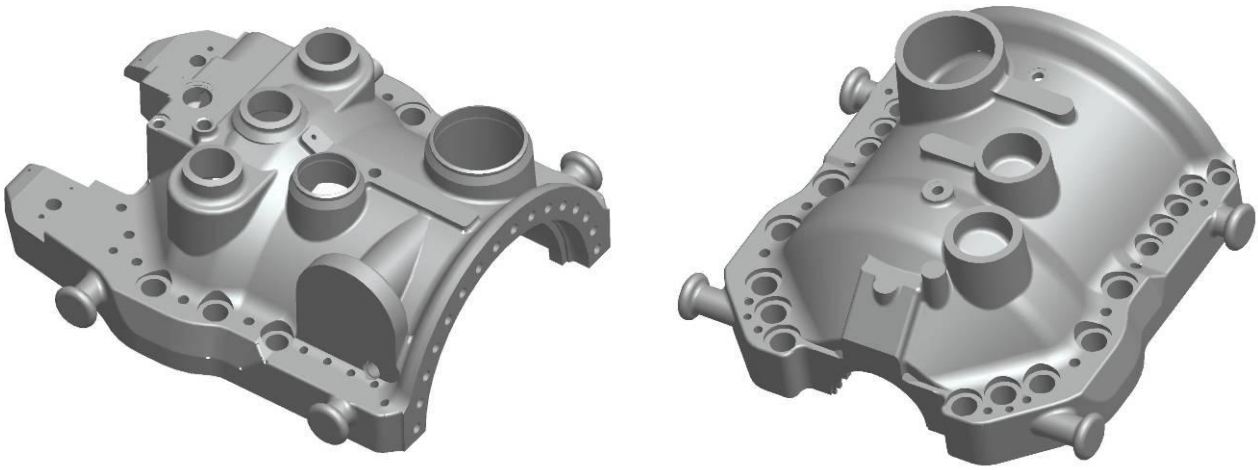
It is horizontally split and held together by pre-stressed expansion bolts.

The surfaces of the casing joints are superfinished and are steam-tight without any additional sealing material.

All connection points for bleed and extraction steam are provided on top/bottom, as standard.

The casing can be an alloyed steel casting or cast iron to meet the steam conditions and operational requirements.

Compact flange dimensions ensure short startup times.

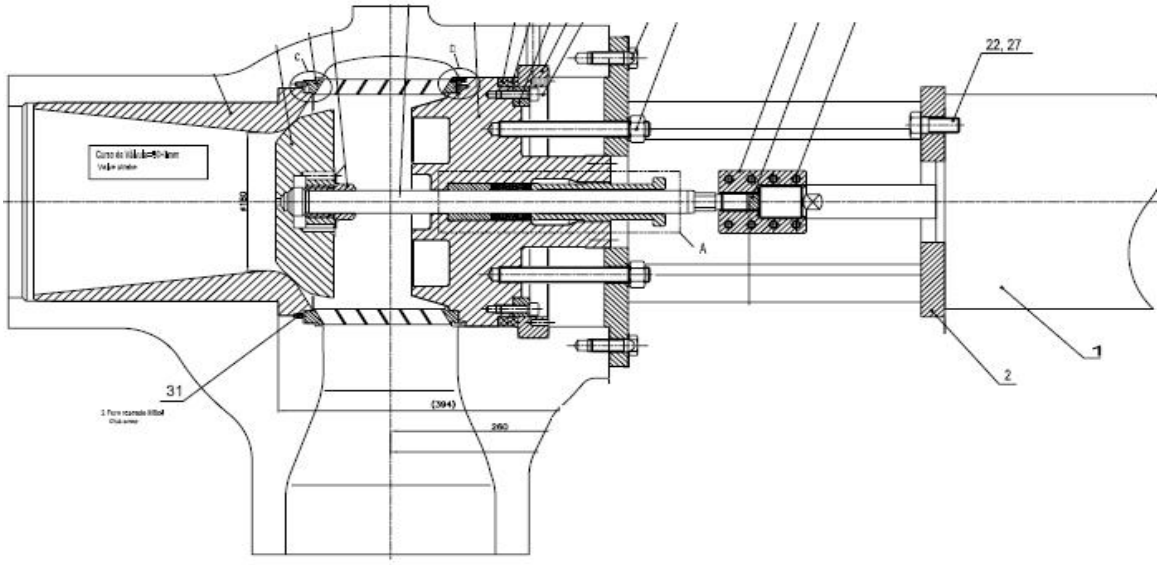


Steam Turbine Casing Ilustration – Lower and upper parts

Emergency Stop Valves (ESV)

The ESV is a poppet valve with integrate pilot valve. This equalizes the pressure before and after the main valve head, which decreases the necessary servo force. This also increases the safety of the turbine, since it is not possible to open the main poppet if the control valves are stuck in an open position and by that an uncontrolled “jet start” is not possible.

The live steam supply line is welded to the ESV. By dismantling inner parts of the ESV and using the appropriate tools (delivered), the weld between supply line and ESV is included in the steam blowing of the steam lines before the first start up.



A steam strainer of fine mesh is mounted around the ESV poppet. The strainer can withstand a very high pressure drop without collapsing. The design makes the strainer small but rugged, compared to other designs with the same or even bigger mesh. The strainer also has an important guiding effect on the steam flow and that actually decreases the pressure drop over the ESV.

Inlet part / Nozzle casing

The emergency trip valve is operated hydraulically. It closes within milliseconds in the case of a failure.

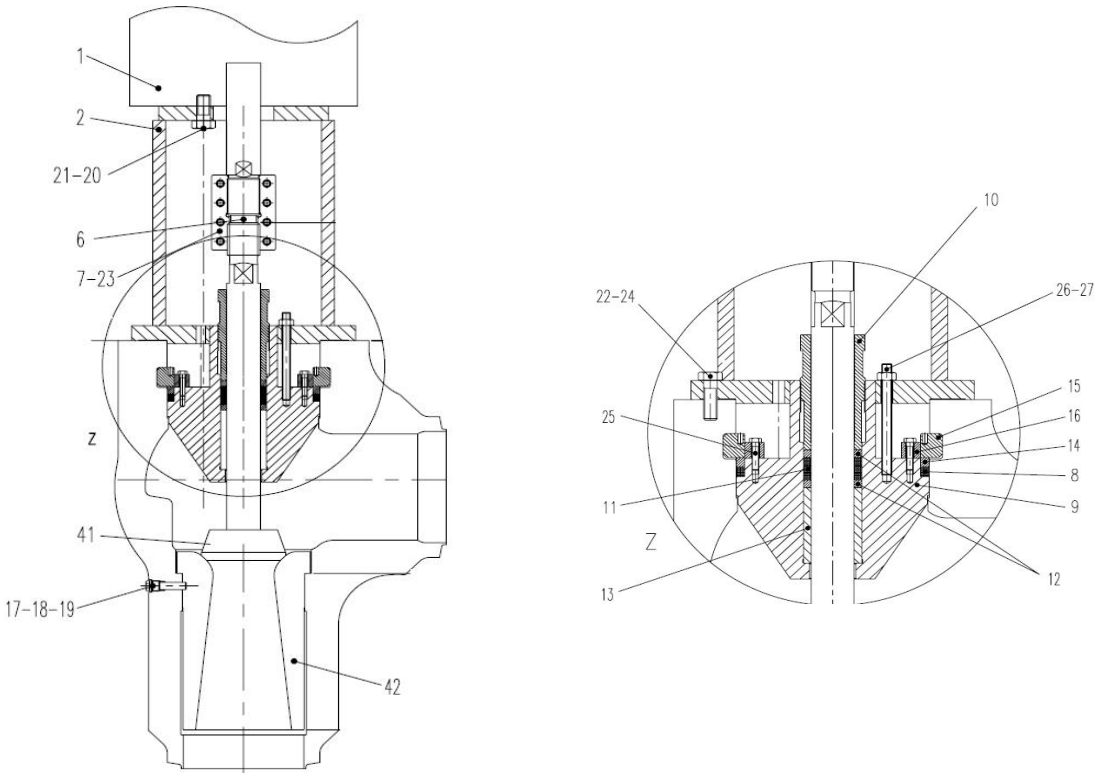
The steam is admitted through up to 4 control valves, each operated by its own hydraulic actuator. The valves are positioned adjacent to the turbine and connected with the nozzle groups.

A reliable flow control is ensured by the single valve control.

The control valves are designed as single-seat valves with diffuser.

Control Valves (CV)

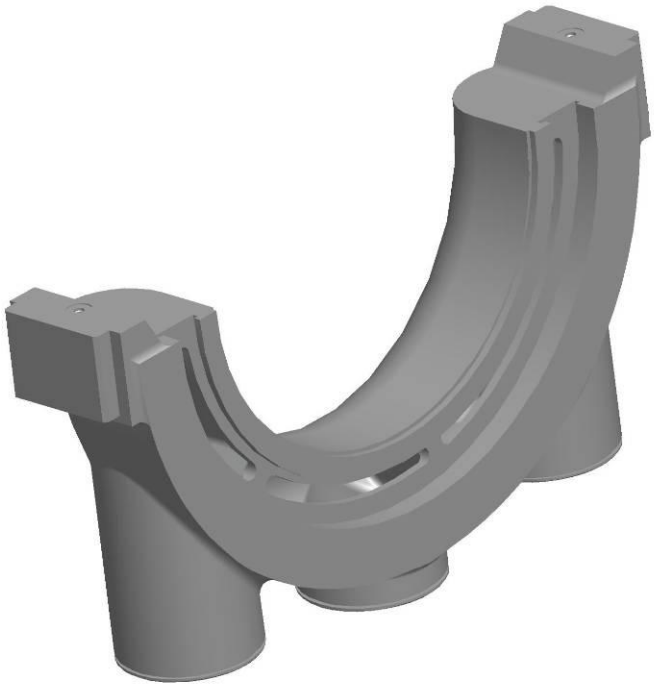
Control valves are of the poppet type, based on the well proven valve geometry with poppet and diffuser. The major benefit with this geometry is good controllability with low pressure losses and comparably small diametrical dimensions.



Nozzle segments

The nozzle segments can be adapted to the requirements over a wide range so that an uninterrupted admission arc exists for all loads.

The control stage nozzle vanes are made from drawn profile material and fitted into a double shroud ring. The cutouts in the shroud rings for mounting the vane profiles are either made by laser cutting or wire erosion.

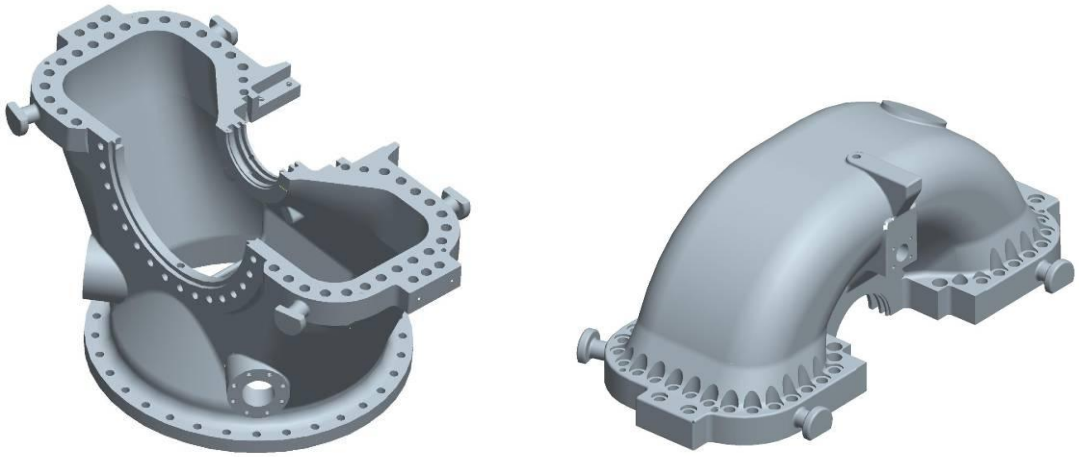


Nozzle segment illustration

Exhaust casing

The exhaust casing is selected from the modular system. It can be bolted or casted together with the inlet casing, depending on its size and the turbine type.

The two casing halves are assembled with expansion bolts at the horizontal split. Expansion bolts are also employed for bolting the exhaust casing to the HP turbine casing at the vertical flange.



Exhaust casing lower and upper parts

Guide-blade carrier

The guide-blade carriers employed are the well-proven SIEMENS design. The guide-blades are fastened in the cast guide-blade carriers.

The suspension in the outer casing is given radial with well-proved adjusting elements.

For condensing turbines in addition to the guide-blade carrier for the HP-blading a cast LP guide-blade carrier is used for the standardized condensing part. The condensing stages are carried out with reaction blading.

Depending on the application, additional drain grooves are provided in the low-pressure guide-blade carrier which drain off the centrifuged water via tangentially directed bores.

Guide Blade Carrier

Rotor

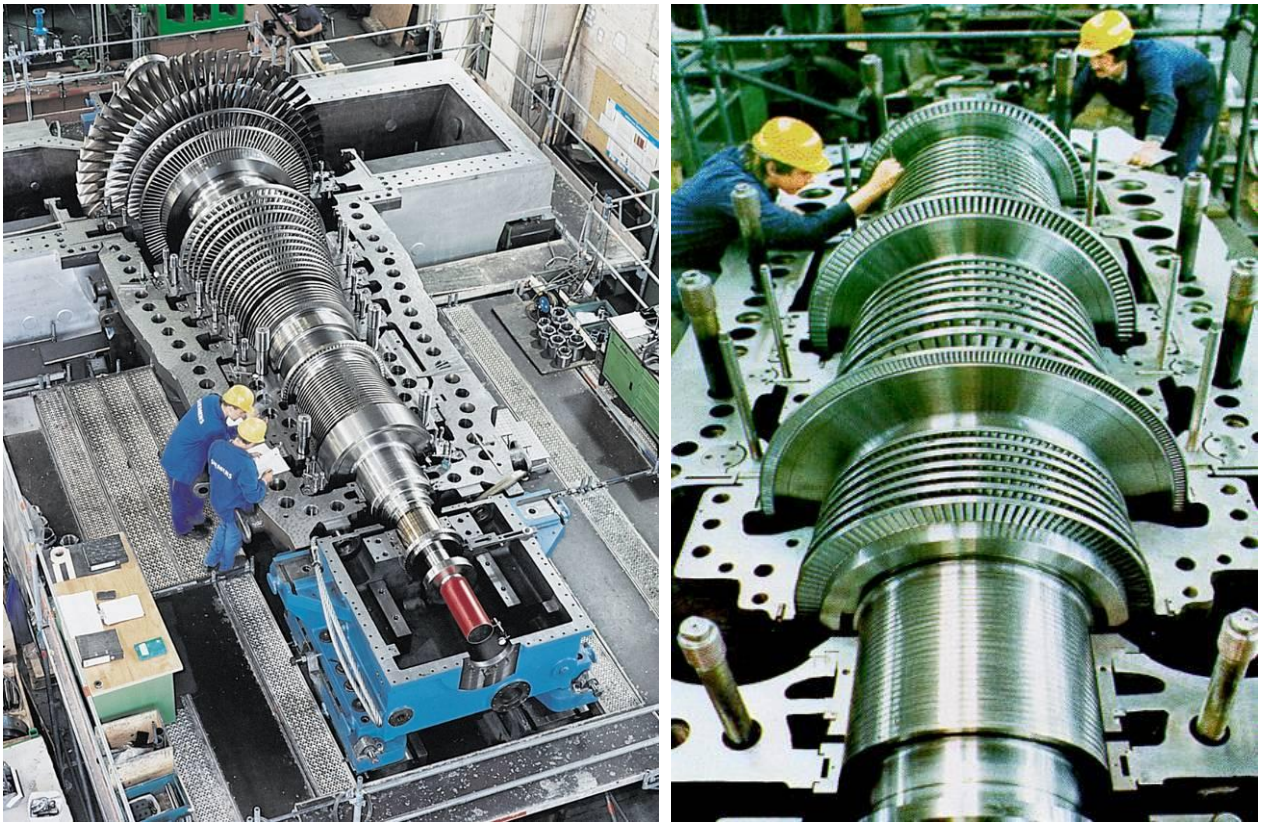
The turbine rotor is made from one single forging.

The rotor is subjected to severe tests (test bars, ultrasonic testing, crack-detection tests). Because of its compact dimensions the rotor can be thoroughly forged and tested.

The bladed rotor is high-speed balanced, in the factory.

Computerized calculation methods are employed for the torsional-critical calculation. The vibrations, in particular, are pre-calculated and minimized considering the supporting conditions and the influence of the journal bearings.

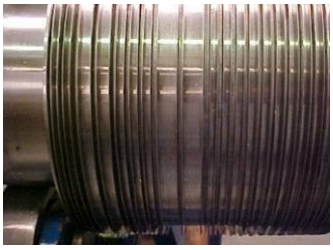
The construction permits favorable starting and loading times.



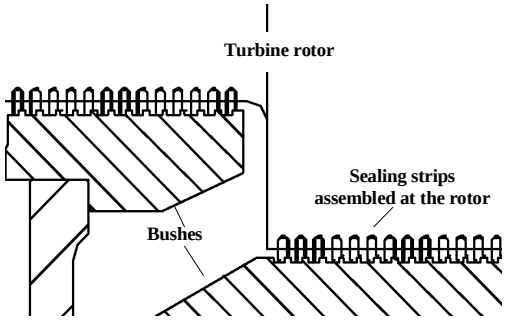
Condensing (L) and Backpressure (R) Turbine Rotors

Labyrinth seals

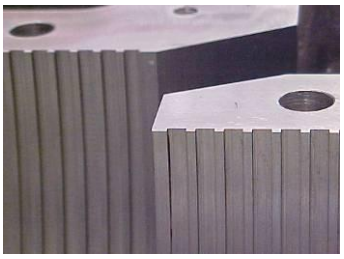
The labyrinths (see picture below) ensure contact-free sealing of the shaft, balance piston, and blading. The sealing effect is achieved by the fact that the steam passes through a great number of successive ring gaps and ring spaces whereby the pressure is converted into kinetic energy and the leak steam flow is limited by the increasing steam volume.



Labyrinth seals



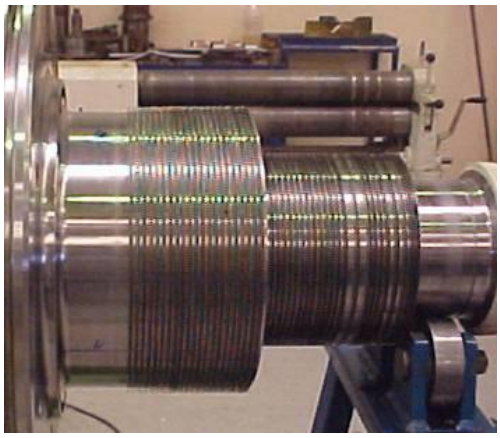
Sealing strips fixed at turbine rotor



Bushes

Balancing piston

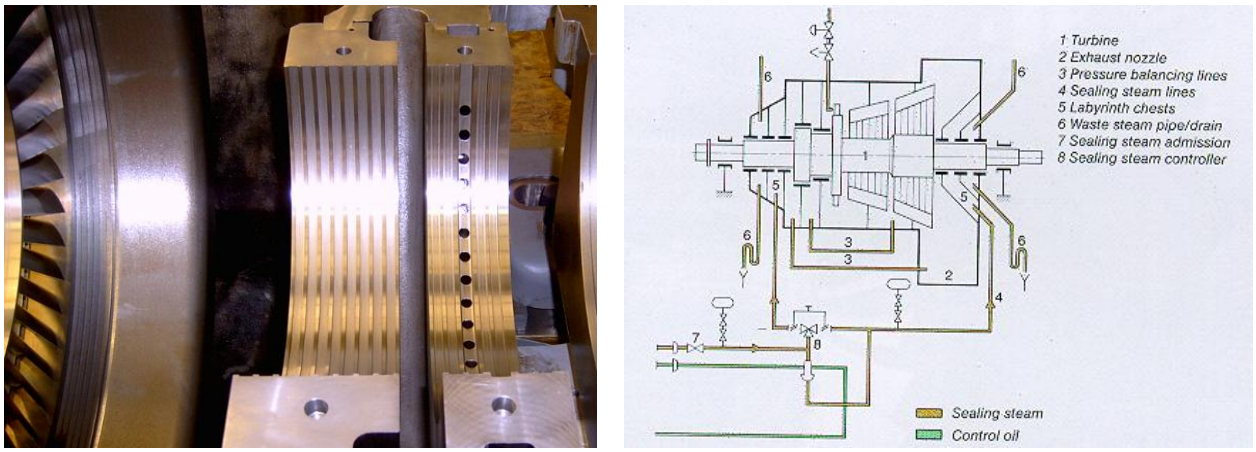
The balance pistons (see picture below) establishes the axial thrust of the turbine. This part of the rotor begins at the control stage in opposite direction of the blading. It has the mean diameter of the blading part, which axial thrust shall be balanced. The pressures before and after the pistons are the same of the corresponding blading part. The pressure before the first piston is the pressure after the first blades, the pressure before the second piston is the exhaust pressure. The sealing of the balancing piston is given by labyrinths.



Balance pistons

Sealing steam

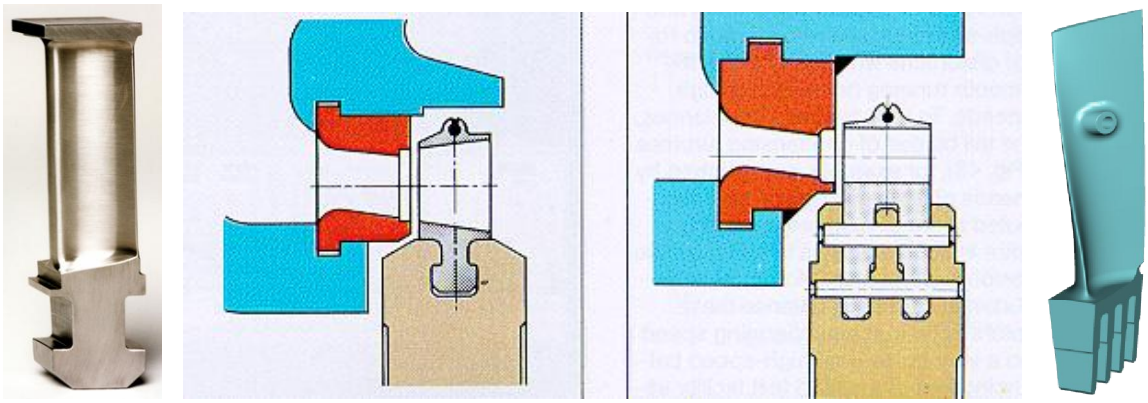
On account of the existing vacuum in the casing, condensing turbines must be sealed against air ingress by admitting sealing steam to the shaft labyrinths (Picture below – numbers 4, 5, 7 and 8). This can be accomplished either hand-controlled or automatically by means of the pneumatic control valve. The valve reduces steam from a suitable pressure level to a very slight overpressure which, on the one hand, is just sufficient to avoid an air inrush into the turbine but, on the other hand, produces only very little waste steam leaking to atmosphere.



Sealing bush, Sealing steam system and balance pistons

Bladings

The control wheel (when applicable) is arranged downstream of the nozzle groups. The rotor blades with integral roots and shroud members are milled from the solid. They are fastened with finger-type roots, steel strip-loaded in circumferential direction, and held in place with axial pins.

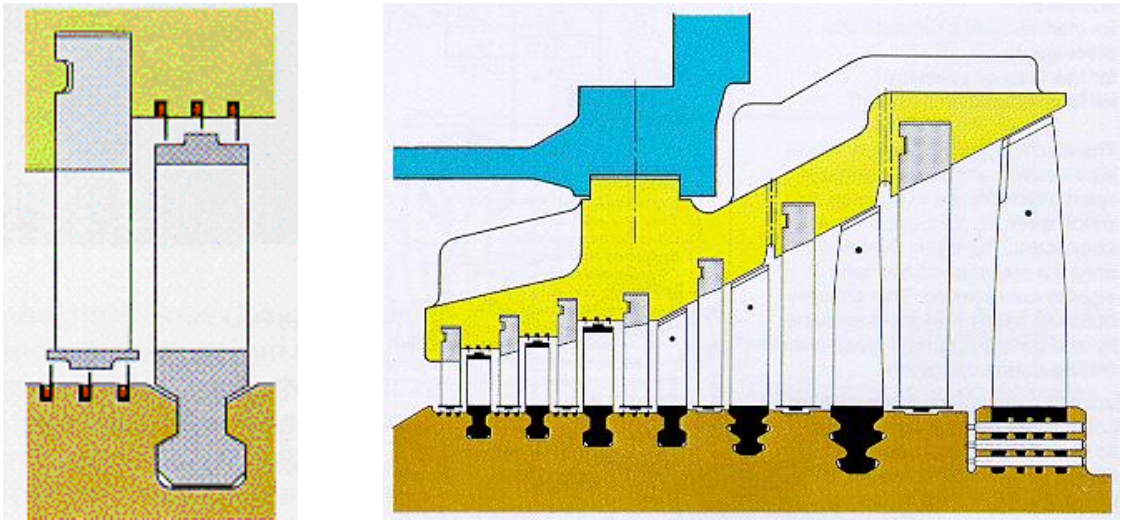


Inverted-T root / Finger type root (for reference only)

The rotor blades of the succeeding reaction stages are milled from the solid with integral shrounding.

The condensing blades which are exposed to high centrifugal forces, have no integral shrouding, so may be fitted with damping wires or not (depending on selected design). The damping wires are loosely inserted into bores and develop their damping effect in operation.

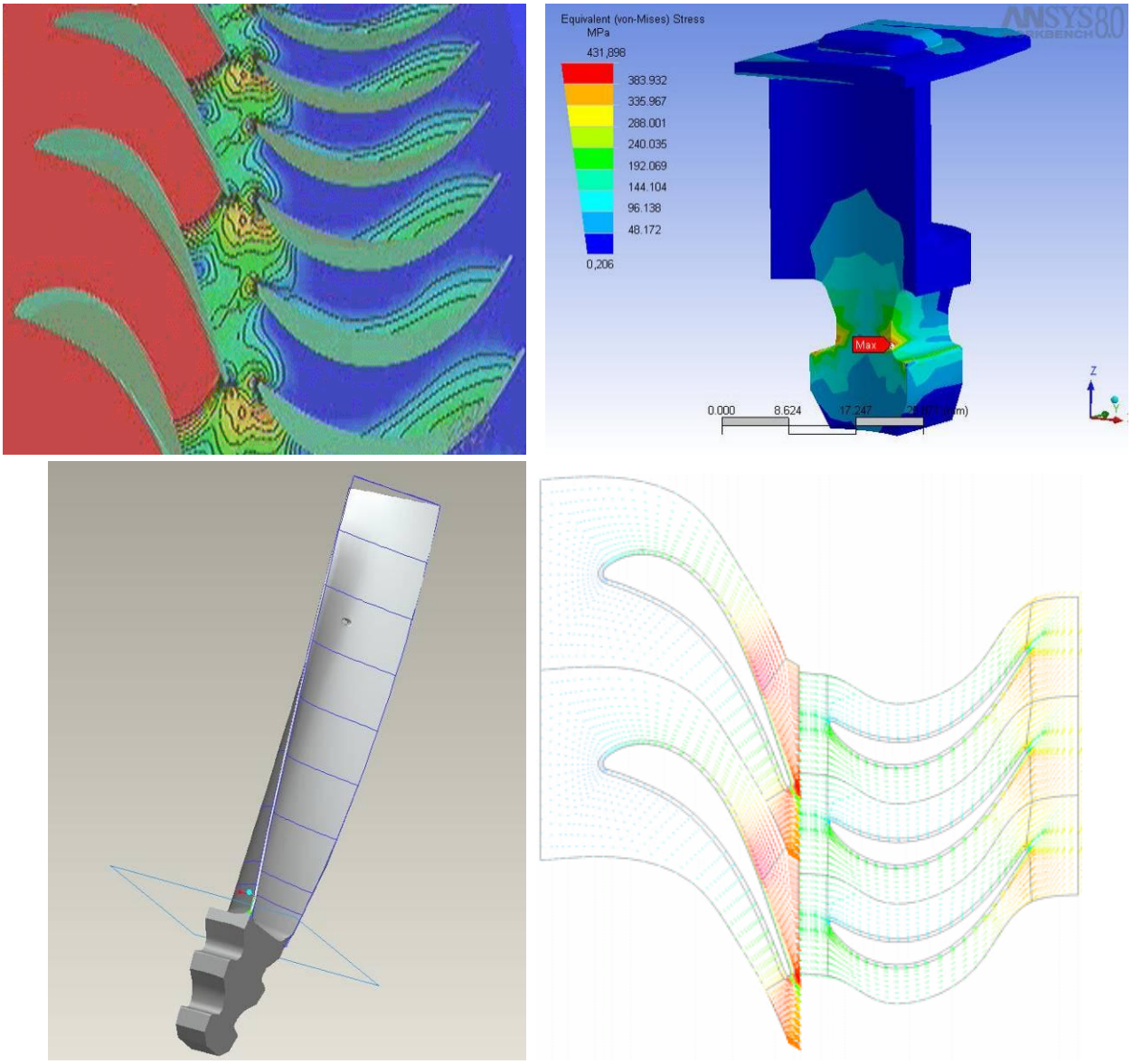
In the wet-steam zone, the inlet edges will be flame hardened in the upper area, if necessary.



1) Shrouding and labyrinth sealing for guide and rotor blade;
2) Standardized blades of a condensing turbine with different roots depending on the stress level.

The guide blades are made from drawn profile material and are fastened in the fixing groove of the carrier by means of spacers. Each guide-blade row is fitted with riveted shrouding (see picture above). Sealing against the shaft is done with double labyrinth sealing tips. All rotor and guide blades are made from 13% chromium steel.

The optimum shape of the steam path and the selection of the best suited cascade are calculated with the help of calibrated computer programs which are particularly adjusted to the individual task.



Steam path through guide blades and rotor blades

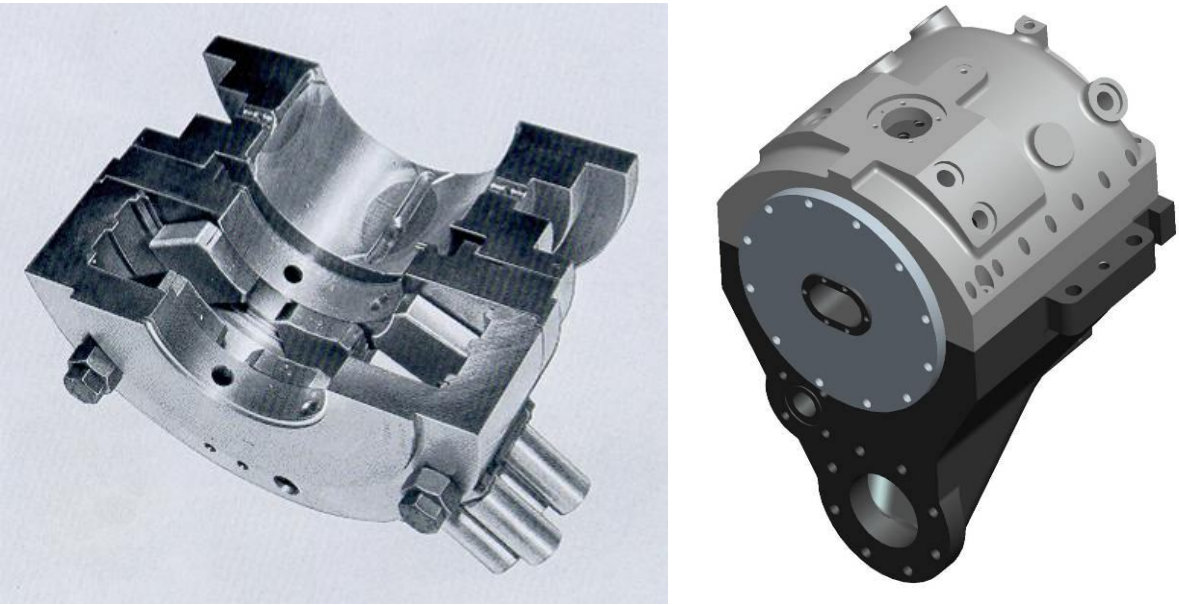
Supports / Bearings (*)

The turbine rests on supports on the inlet and exhaust ends, preventing the casing from being displaced even in the case of high pipe forces on the casing nozzles.

The fixed point of the casing is situated at the exhaust side in axial direction. By arranging the axial bearing and, hence, the fixed point of the rotor at the inlet steam side, the clearances of the HP shaft seal and that part of the blading which reacts most sensitively to geometric changes due to its very small dimensions, remain almost constant.

The slide bearings are high quality machine elements with state of the art design and production. The casing is provided with the recurred passages for oil supply and oil return. The casing halves are screwed together by machine screws and pinned in addition by tapered pins.

The turbine rear end bearing is a combined lemon-type plain bearing and tilting pad thrust bearing with oil-nozzles. The combined plain and thrust bearing consist of the housing, impregnated with a white metal plain bearing and two tilting pads thrust bearings. The front-end lemon-type bearing consists of the bearing housing and impregnated with a white metal.



Left: rear end combined thrust-journal bearing. Right: front bearing house

(*) Depending on the rotor dynamical calculation it is possible that the standard tilting pads bearings should not be applied and shall be substituted to double wedge bearings in order to reach better critical speeds of the turbine.

Site conditions

The site conditions shall be considerd for preparation of this proposal, mainly the following items:

- Installation data
- Cooling water
- Desuperheating water (when applicable)
- Steam for auxiliary services (when applicable)
- Compressed air (when applicable)
- Electric voltage levels

For a complete assessment of the considered data, please refer to item 2 of turbine data-sheet annex to this proposal.

Steam purity requirements

For steam purity requirements, see document attached on this proposal.

Cooling water requirements

In condensers and oil coolers, the selection of their construction materials depends directly on the type (aggressiveness) of cooling water. It becomes evident then that the aggressiveness of the cooling water must not increase as compared to the originally specified value, since the average working life of the equipment may be reduced significantly.

Besides, the deposition of debris on the pipes markedly reduces heat exchange efficiency and increases internal corrosion.

In order to guarantee safe operation, some basic requirements/values must be maintained, as presented on the document “Cooling water recommendations for protecting indtustrial steam turbines” attached to this offer.

Our offer is based in the material presented in the attached datasheets and the assumption that the customer water quality meets the requirements of the document attached to this offer.

The material might need to be changed depending on water contents, which might impact presented price, therefore the customer shall inform in case its water characteristics is incompatible to the offered material, so that Siemens can perform a revision of this offer.

Performance

The steam consumption is guaranteed at fully open control valves, deposit-free blading, and a clean surface on the cooling equipment, in accordance with the rules given in "The Thermal Acceptance Tests on Steam Turbines (VDI – Steam Turbine Regulations) DIN 1943" Edition February 1975.

The guaranteed values do not include the power and steam requirements of the auxiliary equipment.

For the performace data of the equipment, as well the guarantee points with their respective tolerance values, please refer to item 3 of the data-sheet attached to this proposal.

Constructive Features

The constructive features of the turbine include but are not limited to:

- Manufacture standards
- Design parameters
- Sound pressure levels
- Vibration levels
- Critical Speeds
- Connection flanges
- Materials

For a complete assessment of the informed data, please refer to item 4 of turbine data-sheet annex to this proposal.

Special tools

One set of special tools for all TGs, composed of:

- tool for inlet steam control valves assemble and disasemble,
- tool for emergency stop valve assemble and disasemble,
- tool for turbine casing assemble and disasemble,
- rotor lifting device,
- blow-out device for the live steam emergency trip valve,
- filter inserts for oil flushing,
- rotor locking system,
- device to assemble/disasemble of the bearing housing cover and bearing,
- device for mounting of the sealing retainers of nozzle box,
- accessories for turbine alignment in skid.

2.2. Gearbox, turning gear and coupling

The gearbox has as purpose to transmit the power of the turbine shaft in reduced speed, so that the driven machine receives the torque in appropriate conditions for its application.

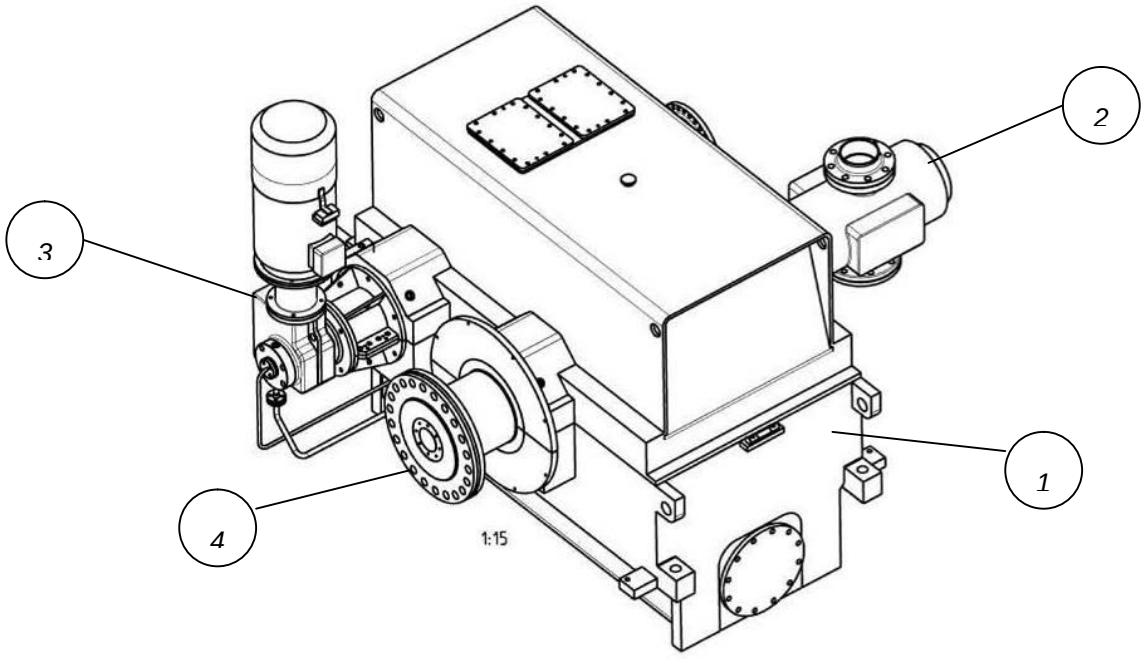
The gearbox design is based on double-helical gearing and cemented teeth, thus ensuring balanced and more silent operation.

Casing is made of welded steel or cast iron, and gears are manufactured of cemented steel. The sleeve bearings are covered with babbited-white metal.

Lubrication is supplied by the steam turbine oil system, feeding the bearings and gears in pressurized and closed circuit.

Depending on the type and size of the turbine, it might be necessary a turning gear device. In order to reduce the effects of casing thermal expansion, the turning gear forces a turbine operation in low speed during the start-up and shut-down periods.

All the coupling have protection sheets in carbon steel for a safe operation, avoiding risks of operational accidents.



Gearbox set.

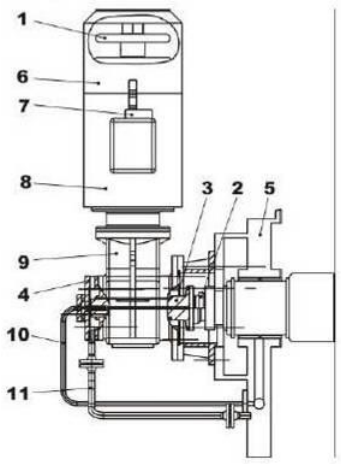
(1) gearbox; (2) main oil pump; (3) turning gear; (4) Low-speed coupling.

The rotor turning drive is required to turn turbine plants during the heating up or cooling down phase. It is usually attached on the free side of the high-speed gearbox shaft. Alternatively, it may also be attached on the free side of the turbine shaft.

The design speed of the turning drive takes into account the minimum speeds at turbine, generator and gearbox, and corresponds to the turning speed of the turbine. The rotor turning drive can be engaged while the turbine is at rest or while it is operating above the turning speed of the turbine plant.

A hand wheel (1) with a square is situated at the motor (8) of the turning gear, protected by a hood (6). This hand wheel allows to turn the shaft line of the plant, provided that all the coupled machines are free to rotate. The hand wheel permits to position the gearbox gear set for mounting purposes of the generator and turbine. A limit switch (7) protects the equipment when the hood is removed.

A clutch allows the turning gear to automatically disengage after the turboset has reached its barring speed. The engage type is also automatic.



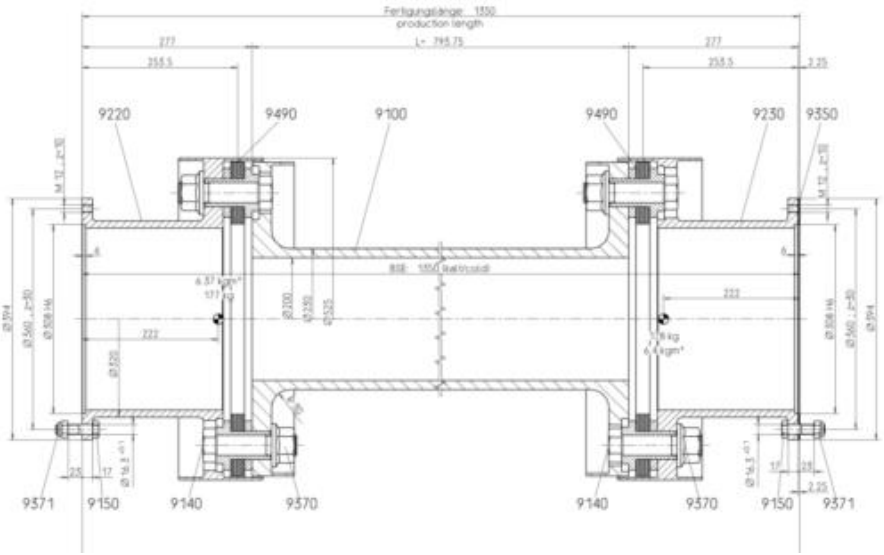
Turning gear device

(1) Hand wheel with square/hexagon head
(2) overrunning clutch
(3) Flange shaft
(4) Oil supply cover
(5) Gearbox-turbine casing
(6) Protective hood
(7) Limit switch
(8) Motor
(9) Bevel wheel gearbox
(10) Pressure oil piping
(11) Leakage oil piping

Coupling

The turbine is coupled to the gear pinion by means of a diaphragme coupling.

Depending on the dynamic behavior analysis the type of coupling can change to ensure a smooth operation and low vibration.



Flexible coupling (just for reference).

Design Data

Refer to the item 7 of turbine data-sheet annex to this proposal.

2.3. Lube Oil System

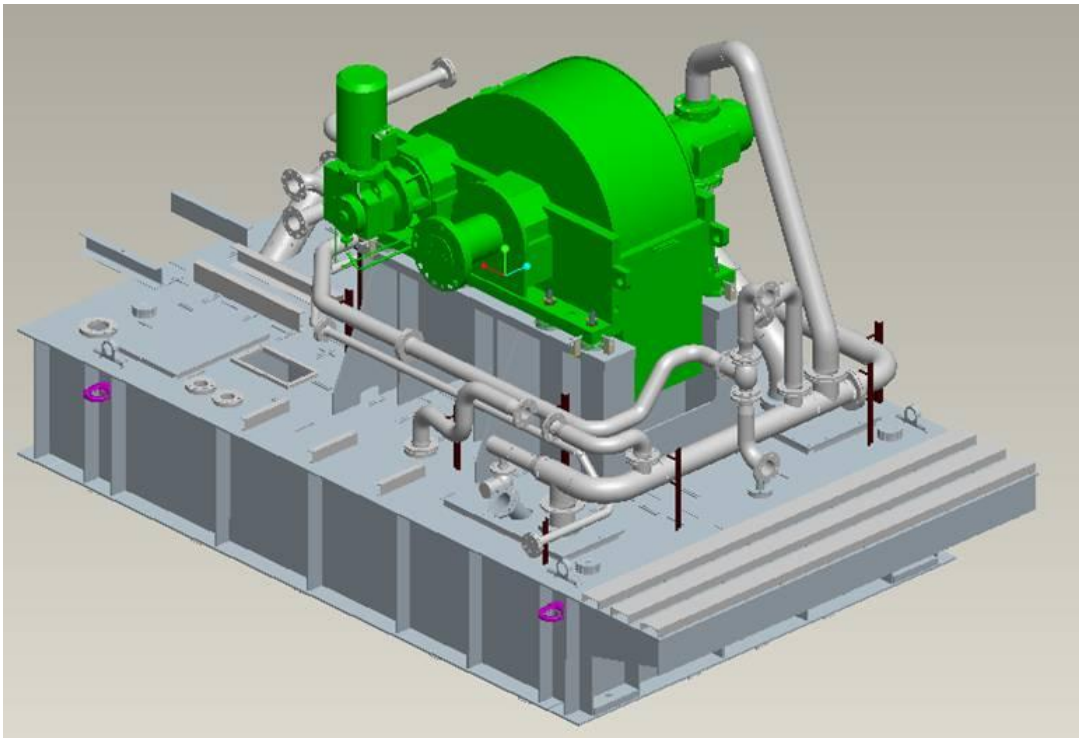
The process description shall be followed with the preliminary lube oil flow diagram attached to this proposal.

The oil system supplies the turboset, consisting of turbine, gearbox and generator with lubricating oil and the control and emergency trip system with control oil. It is divided into two pressure ranges. The oil is pumped out of the tank at a pressure of about 8 bar and return oil is allowed to drain to the tank. The control and emergency trip system is supplied at this pressure. Before the pressure is reduced to 2 bar by means of oil pressure control valve, the oil is cooled down in the oil cooler and filtered by double oil filter (25 µm mesh). After the filtering and before the pressure reduction part of the oil is taken for control purposes (servo-motors and ESVs), filtered again (10 µm mesh) and then conditioned for the servo-motors operation.

The oil unit consists mainly of the oil tank, out of which the main oil pump or auxiliary oil pump sucks the oil, the lube oil cooler to cool the heated oil, and the lube oil filter to extract dirt particles and other deposits carried along with the oil stream. A heater preheats the oil to a min. temperature required to initiate the operation (if applicable).

The DC motor driven emergency oil pump is so sized, that during run down period of turbine lubrication can be provided to the bearing and heat be dissipated at standstill.

When applicable a jacking oil pump provides high-pressure impulse oil to both turbine and generator bearings, allowing a minimum oil film to the initial turning without hydrodinamic effects. Thus, it can ensure that the rotors will not damage their bearings during start-up.



Oil unit (for reference)

To monitor the important operating parameters such as lube oil pressure and temperature suitable devices are used. The oil unit not only serves to provide pressurized lubrication and supply the controlled emergency trip system, but it also dissipates heat caused by bearing friction and thermal conduction.

The bearings are supplied with lube oil from the low pressure header over throttling orifices in the individual supply lines. The oil system also contains devices to trip the turbine and provide the corresponding alarm signal when upsets occur. These devices prevents turbine start-up if there is a shortage of oil.

The considered piping materials can be assessed on part 4 of turbine datasheet.

Main components:

- Oil tank

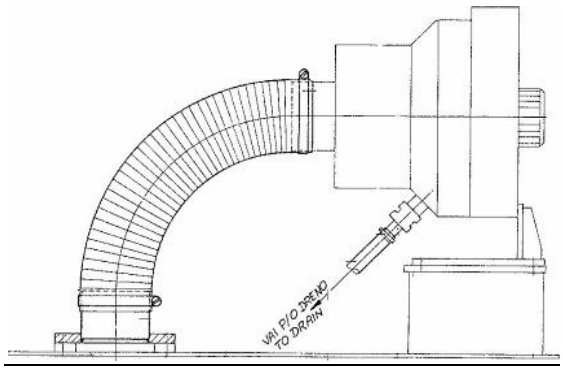
The oil tank is integrated to the turbine gearbox baseframe. The oil tank characteristics are according to the turbine data-sheet attached to this proposal. The oil should be able to settle in the oil tank. All foreign particles, which flow with the oil should be separated. The design of tank takes these requirements into consideration. The oil return line goes vertically into the oil tank and foaming is thereby prevented. Air and gases escape over a suitably dimensioned hole. The separation of foreign particles is improved by leading the oil through a chicane before being sucked again into the system. Sludge and fine particles are deposited in the oil tank. Enough dwelling time for the oil in the tank is therefore necessary. Sludge and condense is drained from the lowest point in the tank by a bottom valve. Pressure control valves at oil tank controls internal pressure properly.

A certain oil temperature must be reached before the turbine is started. For this reason when applicable the tank can be furnished with an oil heater, that certifies the minimum allowed oil temperature is reached before starting the oil-pumps. Oil that is too cold has reduced lubricating properties and exerts inadmissible high pressure on the filter elements due to its high viscosity.

➢ Oil vapour extraction

Oil mist forms in the tank and is removed into the atmosphere by and extraction unit built directly on the tank. The air flow is designed to set the whole oil return system as well as the bearing housings under a slight vacuum. The vacuum produced in the tank positively affects the air separating properties. In addition the oil mist formed in the individual oil users (bearing) is sucked off over the partially filled oil return line above oil level in the tank. By this means, not only the gaseous, oxidization and aging products of the circulating oil removed, but also, a reduction of the water contends in the oil is achieved.

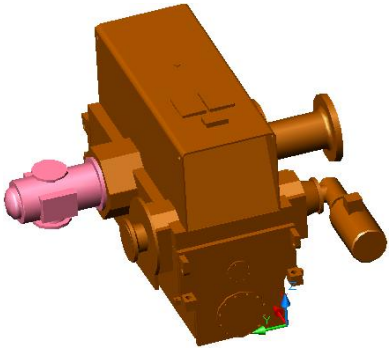
The unit consists of a filtering vacuum fan driven by an AC electric motor.



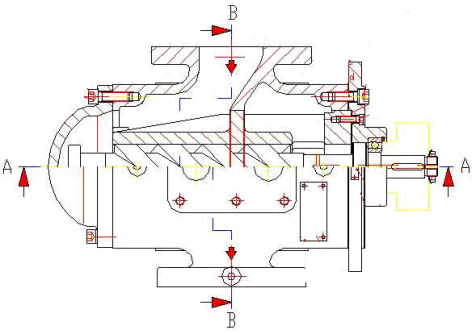
Oil vapour extractor

➢ Main and auxiliary oil pumps

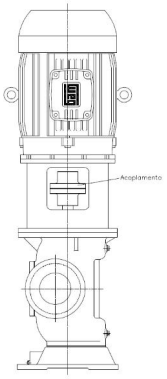
The main oil pump is mechanically driven by the gearbox low-speed shaft. This pump is of positive displacement type, therefore is always ensured that oil line will be filled when in operation. The oil is sucked from the oil tank and sent to distribution flow lines to the oil cooler. A check valve guarantees that backflow through the pump will not occur.



Main oli pump



Assembled on gearbox



Auxilliar pump

During start-up or in case of malfunction of main oil pump by low system pressure, the auxiliary oil pump takes place. The auxiliary oil pump has the same capacity of the main pump, however is driven by a AC electric motor to be independent from the mechanical

drive, i.e., it can be run without the turboset running. A check valve guarantees that backflow through the pump will not occur.

The pumped oil flows to the oil cooler as follows.

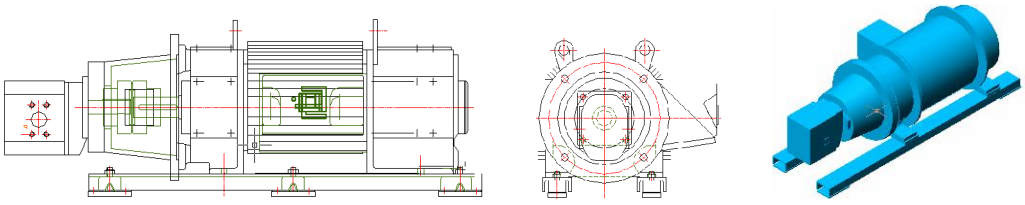
➢ Emergency oil pump and DC motor

In most cases when both main and auxiliary oil pumps are not working according to minimum pressure requirements, an interlock signal is sent to start-up the emergency oil pump. The purpose of this pump is to allow a safe trip of the turboset by sending lubricating oil only for cooling purposes to avoid overheating damages at bearings durting shutdown.

The pump set is composed by a 25% system capacity gear type pump, and a DC current electric motor. A 100% reliable DC source come from the battery bank to feed the motor, becoming therefore independent from any public grid or power sources which could likely be lost during operation.

The emergency oil circuit bypasses the main system path, including the oil coolers and the main oil filter. The emergency oil line has its own oil filter, and the discharge line is sent after the pressure reducing valve.

THE EMERGENCY OIL PUMP IS NOT INTERLOCKED WITH THE TURNING GEAR. Since this pump is only for emergency shut down cooling purposes, it does not provide enough lubricating pressure to switch turning gear motor, and consequently the turning gear must be turned manually.

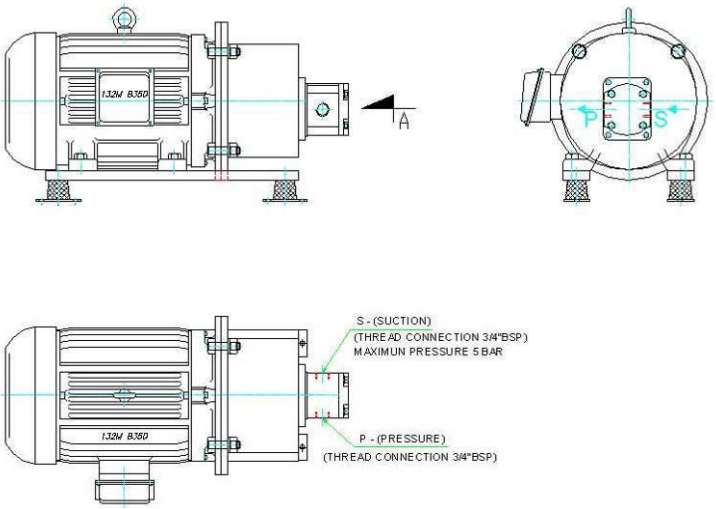


Emergency oil pump.

➢ Jacking oil pump

The jacking oil pump is used to lift turbine and generator rotors, when weights are too big to be first turned without an hydraulic lifting system. During start-up or shut downs, only with oil system pressure it is not possible to ensure the necessary oil film to provide hydrodynamic effect. Moreover, the turning gear will not have enough strength to provide barring speed to both rotors.

The suction oil is extracted after the pressure reducing valve and is sent at 180 bar directly to turbine and generator bearings. A control valve regulates the excessive pressure by relieving overpressure flow to the oil tank. Before reaching the bearings, 4 pressure regulating valves controls individually the proper pressure to each bearing. A check valve prevents oil backflow to the pump.



Jacking oil pump

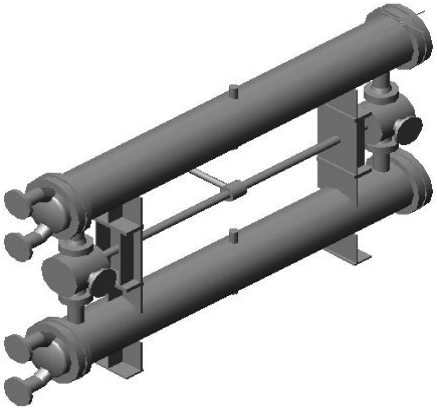
➢ Oil cooler

The oil cooler is meant to exchange heat from the lube-oil to the cooling water. It consists of a casing in which tube bundle is assembled. By means of two gland seals between casing and water chamber and a tube plate, the heat exchanger provides excellent properties such as:

- Ability of the tube bundle to expand during operation of the turbine;
- Tight chambers totally enclosed;
- Strict division between flow media;

The tube bundle consists of round tubes which are expanded at both ends in the tube plates. The casing consists of a steel tube. Flanges are welded at both ends of the steel tube. Standard is double coolers type with change-over valve and tube bundle non removable.

Cooling water is forced through the tubes in two passes. It enters through the flanged inlet in the front chamber, distributes itself evenly before the tube plate, flows through all tubes, is turned in the rear-chamber an leaves in the front chamber. During its flow through the tubes it absorbs the heat from the oil and leads it away to the cooling water. The oil to be cooled, flows on the casing side through baffles plates, in several passes around the cooling tubes. Counter-flow of the oil to cooling water is absolutely necessary.



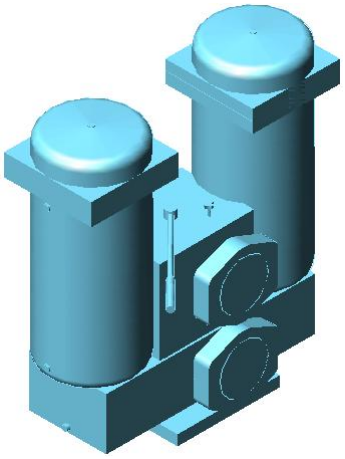
Double oil cooler with change-over valve

From the oil cooler, the system oil flows to the lube oil filter described as bellow.

- Lube oil filter

The filter is of the twin type. Only one of these two filters is in operating. It consists of two filter-casings which can be switched in by a switch-over unit. A built-on differential pressure indicator shows the filter saturation grade and when it should be replaced.

The oil to be filtered flows into a filter chamber, where several filters inserts are placed one inside the other. The oil is pressed through the vertically standing filter surface where dirt particles are retained, and the cleaned oil flows upward between the filters inserts. The cleaned oil leaves the filter through the outlet on the upper side to the oil system.



Lube oil filter, twin type.

- Pressure reducing valve

After the outlet of the double lube oil filter, the circuit branches out to the regulating, safety and lubrication system. At this point, the line pressure is about 8 bar. A reduction valve provides a drop from 8 to 4 bar in the line feeding the bearings under normal operating conditions.

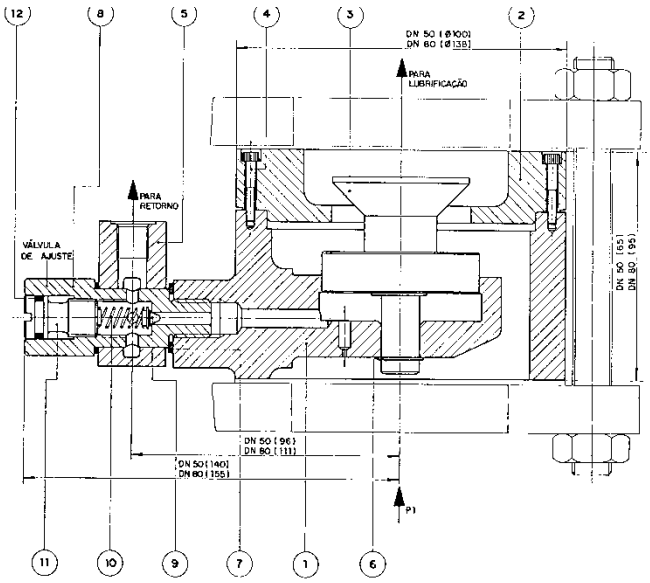
These valves are devices designed to keep a specified lubrication pressure constant, regardless of pressure P1 of the hydraulic circuit.

As all the mobile parts are immersed in oil, there is practically no wear during operation, so the valves are to all effects needless of maintenance. The disassembly is simple, allowing easy checking of the parts.

In order to verify proper working, it is only necessary to turn the screw and watch the pressures. For each turn of the screw there should be one operating pressure. After testing, return to the original position.

After this pressure reduction, several monitoring devices are installed at oil line, to provide proper interlock setpoints and protection alarm and trip signals to the control system.

Before reaching turbine, gearbox and generator bearings, calibrated orifice plates are installed at oil lines to once more reduce oil pressure to individual custom values for each bearing.



Pressure reducing valve.

➢ Pressure Safety Valve

The safety valve at oil tank is installed to protect the lubrication and control systems. With an increase in pressure, the oil is unloaded into the tank and protects the pumps against an overload.

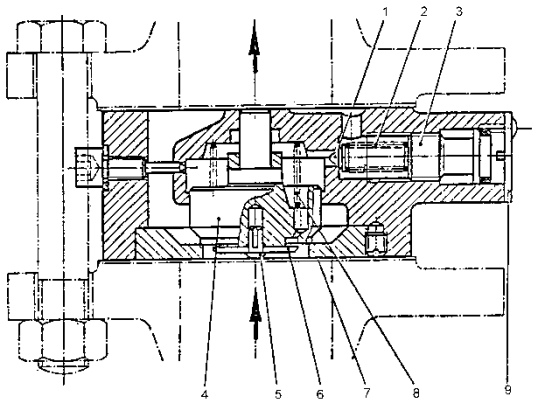
Since it is installed between flanges, only a small space is required for its assembly on the piping. The flanges are built according to DIN standard.

The safety valve keeps the pressure inside the system constant, regardless of the oil flow.

The intermediate working pressure on the upper part of the piston produces a strong damping effect. This condition, together with the different spring constant, prevents fluctuations in the system.

Since all moving parts are immersed in oil, there is no wear during operation, the valves needing virtually no maintenance.

Their disassembly is simple, allowing for easy checking of the parts.



Pressure safety valve.

General information

To obtain more details, please refer to the item 6 of turbine data-sheet annex to this proposal.

2.4. Control Oil System

General description

The hydraulic system operates the Emergency Stop Valve (ESV) and the Control Valve(s) (CV). The hydraulic supply unit is installed on a separate skid ready for installation. All pipe connections and the instrumentation are located on panels. All instrumentation wires are connected to junction boxes. The hydraulic pipes are lined up to the servos. Type of hydraulic oil: Turbine oil, ISO VG46:

Functional description

Oil supply unit

- Pressurised oil is delivered to the entire system by one of the two axial variable displacement piston type of pumps
- Thus driving power is maintained at a minimum value and oil coolers are not required
- Necessary cooling by natural heat convection from the system in ambient temperature conditions up to about 40 °C
- During rapid valve movements the pressurised accumulator covers the brief high flow rate demands.

Control oil circuit and CV servo motors

- Normal operation:

Servo motor stroke controlled by a servo valve connected to and steered by the turbine governor

- Load rejection:

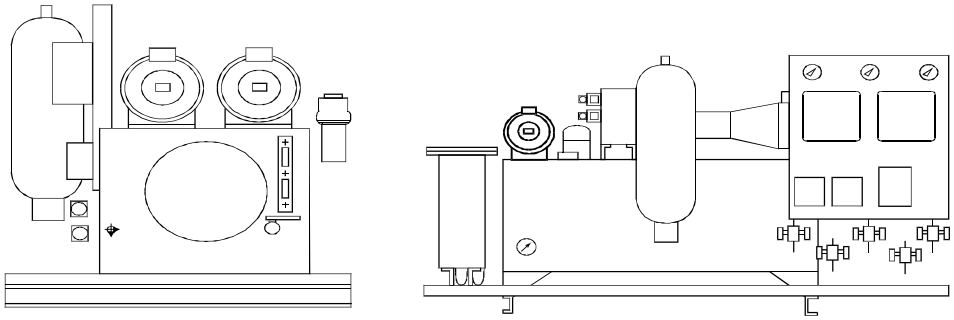
Drain and trip valves of the circuit allow for the CV to close
Closing initiated by a pulse from the turbine governor

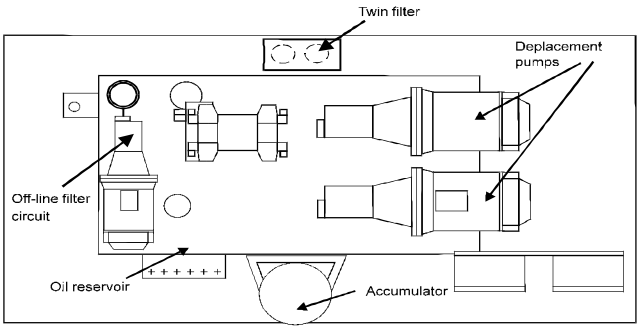
✓ The turbine governor also determines when the drain valve will return to not actuated position

- Emergency stop:

The circuit is drained via a trip valve with relay function
Tripping oil pressure collapsing, the valve shifts to drain position

The picture below is a typical one and intended only to support this description.





Tripping oil circuit and ESV servo motors

- Tripping oil circuit supplied from the supply unit via an orifice plate
- Three independent solenoid valves drain the system if more than one of the solenoids is de-energised by the turbine protection system

This makes testing of the solenoids possible during operation, one at a time

- A manual trip valve also drains the system and allows the ESV and consequently the CV(s) to close

Instrumentation and monitoring

- Supervision of :
  - oil pressures
  - oil level in the reservoir
  - differential pressure across filters
  - valve positions
- Alarms are given for :
  - low oil pressure
  - low level in the reservoir
  - high pressure drop across the filter
  - de-energising of any of the trip solenoids

2.5. Auxiliary Systems

The process description shall be followed with the preliminary steam and cooling water flow diagrams attached to this proposal.

Drain system (*)

The live-steam pipe and the turbine are furnished with a number of drains to remove the condensate during the condensing phase of the start-up. The condensate from the drains flows to the drain collector. When the turbine is in normal operation, the drains of the live-steam line and the HP-part of the turbine must be closed.

The drain lines are arranged at decrescent pressure order in the drain collector, in order to avoid backflow and turbulent flashing stream.

The drains are all collected to a header and then sent to the drain collector. Before every drain there are restriction orifices to calibrate the outgoing pressure accordingly.

Also, the drain collector collect the vents from turbine command devices of emergency trip valves.

Flashed steam shall be sent through a line to the atmosphere outside the TG building.

(*) Please see the correct Limit of Supply for drain on Part 10 of this prosposal.

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Revision: 15

Areva – UTE Campo Grande – 3 x SST-400

Part 3

Subject:

Turbine Control Panel and Generator Terminal Box

3. Turbine Control Panel

3.1 Turbine Control Panel – TCP (Local) (01 for each turbo-generator):

The panel contains the following:

- Turbine governor to speed control and extraction pressure control, type Woodward 505, with the following features: cascade control, auxiliary control and frequency control. Cascade and auxiliary controls can be used for limiting or control of the following process variables: generator load or inlet steam pressure.
- Human Machine Interface for turbine startup, with the following functions: alarm annunciation, turbine commands and measurements of steam pressure, steam temperature, oil pressure, oil temperature, bearing temperature and shaft vibration.
- Vibration protection system to monitoring:

  Axial displacement of the turbine rotor;

  Shaft vibration of the following points: turbine non drive end, turbine drive end, generator non drive end and generator drive end;

  Case vibration (radial and axial) of the following points: gearbox high speed shaft.
- Electronic overspeed protection (2 out of 3 logical trip).
- PLC with the following functions:

  Measurement & monitoring:

  temperature of the turbine, gearbox and generator bearings

  temperature of generator stator coils

  temperature and pressure of the oil system

  temperature and pressure of the steam system

  Interlocking and commands for following auxiliaries: oil vapour exhauster, auxiliary oil pump, emergency oil pump, jacking oil pump, turning gear and generator space heater, condensate pumps.

  TRIP management

  ALARM management

  Sealing steam pressure control

  Condenser level control

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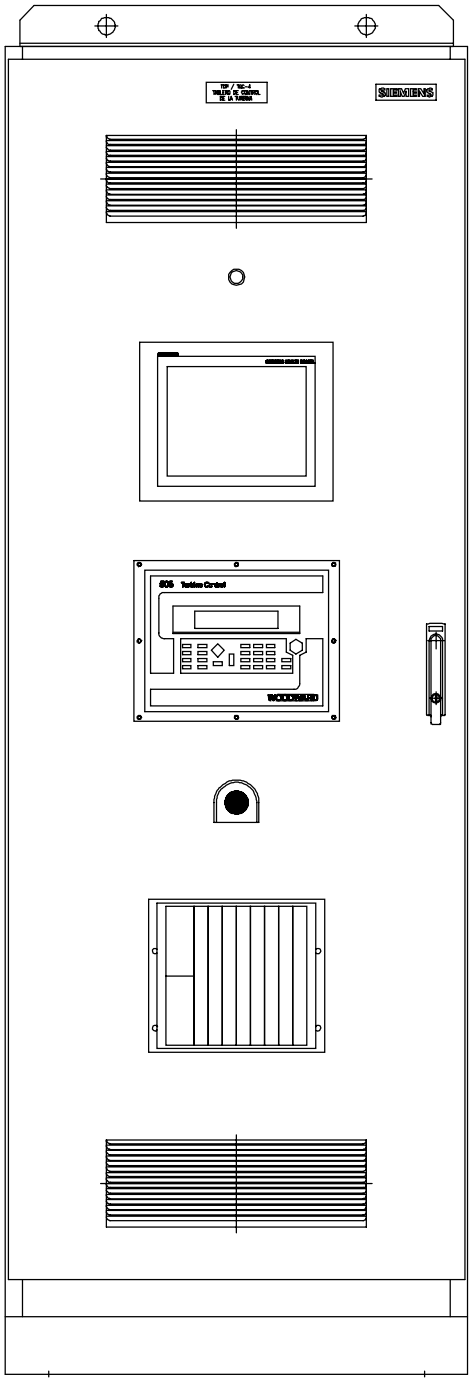
Installation	indoor
Protection degree (IEC)	IP-54
Voltage class	0.6kV
Prelim. Dimensions	1200x2300x800mm(LxAxP)



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Containing:

3.1.1. Turbine Governor:

01 Digital controller type WOODWARD 505

3.1.2. Human Machine Interface:

01 HMI Siemens– color graphical touch screen 12”

3.1.3. Vibration Protection:

01 Rack type BENTLY NEVADA 3500 with the following electronic cards and sensors:

01 Power supply	- 3500/15
01 Interface module	- 3500/22
01 Absolute vibration monitor module	- 3500/40
02 Radial vibration monitors modules	- 3500/42
01 Output relay module	- 3500/32
01 Communication interface	- 3500/92
10 Sensors type Proxipack	
02 Accelerometers	

3.1.4. Overspeed Protection:

01 Electronic overspeed device type WOODWARD PROTECH GII

3.1.5. Control:

01 PLC type SIEMENS SIMATIC S7-400 with the following components

01 CPU type 414-3 PN/DP (to custumer DCS)
40 Analog inputs type 4..20mA
08 Analog fast inputs type 0..20mA

16 Analog inputs type RTD (Pt100)
16 Analog outputs type 4..20mA
96 Digital inputs type 24Vdc
64 Digital outputs type 24Vdc – 0.5A
01 MODBUS to PROFIBUS-DP interface module (for internal use only)
01 PROFIBUS-DP interface module for customer use

3.1.6. Power supply

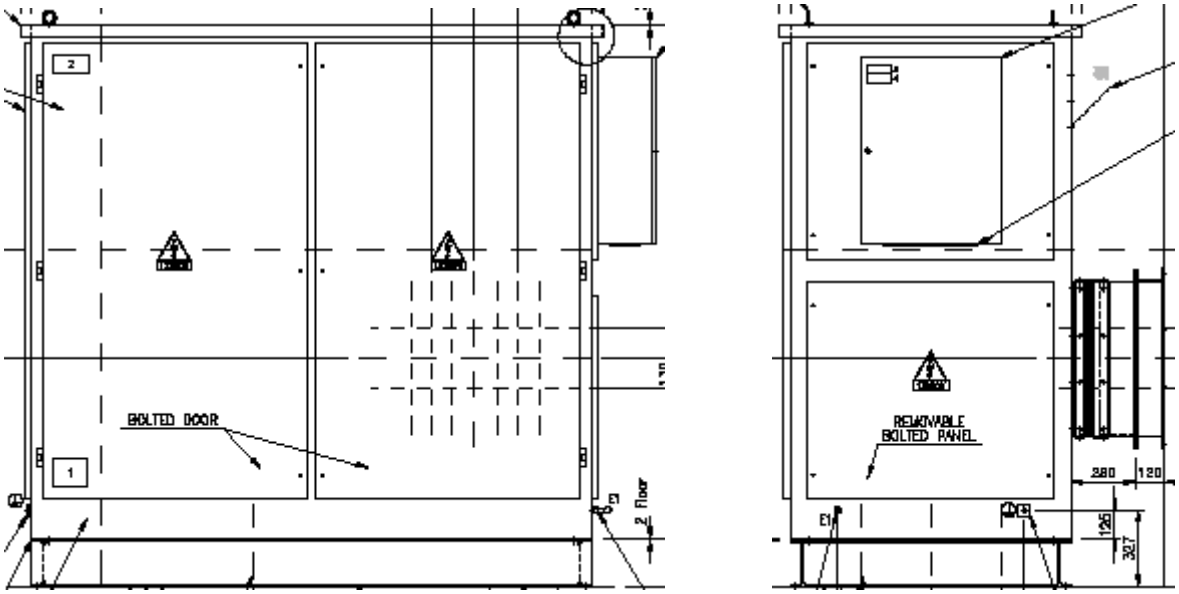
02 Independent units type PHOENIX QUINT, input 125Vdc, output 24Vdc / 20A.

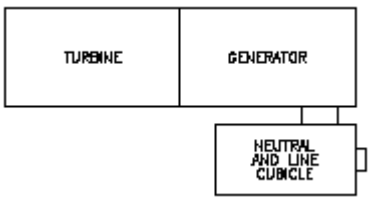
3.2. SURGE CUBICLE – C2

The cubicle contains the following:

- Potential transformers (PT) to protection, measurement, synchronism and excitation feedback
- Surge protection devices to absorb operating and atmospheric surges

Installation	indoor
Protection degree (IEC)	IP-54
Voltage class	15.0 kV





Containing:

3.2.1 PT:

03 M.V. potential transformers, 2-core type, class: 0.5P50 and 0.5P50

3.2.2 Surge Protection:

03 M.V. lighting arresters, rupture voltage = 17,5kV, continuous voltage = 14kV, discharge current = 10kA, class 2

03 M.V. surge capacitors, 0,25μF, 15kV

3.3. GROUNDING CUBICLE – C3

The cubicle contains the following:

- Ground resistor
- Current transformer (CT) for earth fault protection (51N)
- Current transformers (CT) for protection and excitation

Installation	indoor
Protection degree (IEC)	IP-54
Voltage class	15kV
Rated current	100 A

Containing:

3.3.1 CT:

01 M.V. current transformer, 1-core type, ratio: 100 A : 1A, class: 5VA 10P10

- 03 current transformers for protection and measurement, 2-core type, insulation class: 15kV, accuracy class: 25 VA 10P20 – 25 VA 0.5FS7

3.3.2 Ground Resistor:

01 Resistor, voltage class = 15 kV, rated current = 100 A @ 10 seconds.

Remark: for this configuration it was considered that the generator will be directly connected to the busbar without other generators operating in parallel, or this generator will be connected to the busbar through a step-up transformer (out of Siemens scope).

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Areva – UTE Campo Grande – 3 x SST-400

Part 4

Subject:

Generator

4. Generator

Please see the complete generator technical description, datasheet and other technical data attached on Part 13 of this proposal.

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Areva – UTE Campo Grande – 3 x SST-400

Part 5

Subject:

Condensing system

5. Condensing system

5.1. Condenser General Description

In power plants, the surface condenser is used for condensing the steam flow from the last turbine stage (turbine exhaust).

The offered condenser is dimensioned to recover the whole steam coming from the turbine exhaust or according to specific design conditions.

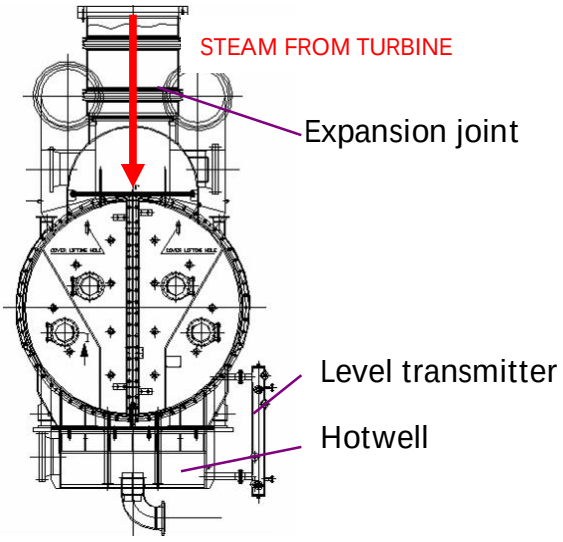
To condensate this steam it is used cooling water coming from a cooling tower, not included at Siemens scope.

5.2. Process Description

The condensation occurs on external wall of the cooling tubes, which has high resistance at erosion-corrosion as well as the non-condensable gases dragged the steam through its corrosive characteristics.

The condensate is collected in the hotwell mounted on lower part of condenser shell, with sufficient volume to allow safe and correct operation of the condensate pumps. The level control on surface condenser as well as the interlocks for the condensate pumps operation are made through instruments connected to the hotwell, assembled on a stand-pipe.

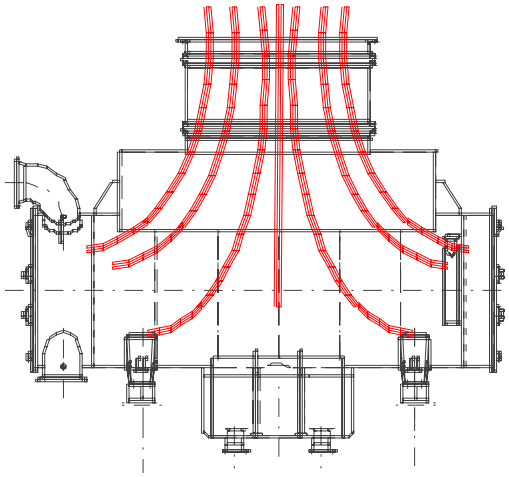
For the extraction of condensate, there are 02 (two) pumps driven by electric AC motors which operation is commanded by level switches assembled on the hotwell. The purpose is to extract the condensate from hotwell and deliver it to condensate process.



Ilustrative Surface Condenser (for reference only)

5.3. Construction and Mode of Operation

The surface condenser is a surface heat exchanger multi-bundle design with straight cooling tubes, through which cooling water flows. The steam flowing from the turbine condenses on its outer surface.



Steam path through the condenser (for reference only).

The tube bundle is enclosed horizontal in a shell with a circular cross section. This shell is closed at either ends by the tubesheets in which the cooling tubes are leak-tight expanded. Welded to the tubesheets are the waterboxes through which the cooling water is supplied or removed.

The inlet / outlet and return waterboxes are welded to the shell. In addition, inspection openings with bolted covers are provided for quick inspection inside the waterboxes. Connected to the waterboxes are flanged inlet / outlet connections, where Siemens recommends assembled with expansion joints (out of Siemens scope) with rubber, in order to prevent piping forces.

To guarantee the perfect tubes drainage, the tube bundle is mounted with a few inclination in direction of inlet / outlet waterboxes.

To ensure that the vacuum being created in the condenser remains constant and optimal, the non-condensable gases are continuously drawn-off.

The perfect condensation is guaranteed through deaerating pipes, in such a way that all the non-condensable gases and air are extracted in a way to keep the thermal exchange coefficient constant on all tube bundle surface.

To protect the turbine and the surface condenser in case of overpressure, an atmospheric relief valve for 10% of the maximum steam flow is installed in the pipeline connected on surface condenser neck.

5.4. Condensate Pumps

The condensate pumps have the purpose of extracting the condensate from the hotwell of the surface condenser and send to condensate process crossing through service steam ejectors inter/after-condenser.

For the condensate extraction, two (2 x 100%) horizontal pumps driven by electric AC motor are foreseen. They operate commanded by level switches and transmitter installed on hotwell.

5.5. Condensate System

The process description shall be followed with the steam and condensate system flow diagram attached to this proposal.

The system extends from the hotwell of the surface condenser to the condensate process. The system deliveries the condensate from the hotwell of the condenser with the main condensate pumps (one is stand-by) via ejector steam condensers to condensate process.

From two nozzles connected to the hotwell bottom plate, mounted with two rubber expansion joints, the condensate flows to main pipelines from which is suctioned off by the condensate pumps through individual pipelines connected to each pump suction nozzle.

The pump suction lines are also provided with gate valves, that allow the total isolation of condensate pumps. During plant start-up, temporary filters, are assembled in the suction lines to avoid any damage of the pumps caused by strange objects like peaces of welding electrodes, etc.

Each discharge line is equipped with a check valves and can be isolated by means of the gate valves.

The main condensate line, feeds the cooling water of service steam ejector inter/after condenser (purpose of this equipment is found on vacuum system description). The pipeline derived from the main condensate line isolated by needle valve feeds the sealing system for vacuum valves.

Other pipeline derived also from the main condensate line isolated by needle valve feeds the spray water for drain collector and turbine exhaust casing.

5.6. Hotwell level control system

After the condenser of ejectors, the condensate is either sent to the process or recirculated to the hotwell by the level control valve.

The recirculating line returns to the condenser hotwell, whenever the hotwell control valve is partially or completely closed, assuring the proper cooling water supply to the service steam ejector inter/after condenser in all operating conditions.

The main condensate control system comprises the hotwell level transmitter, level controller and the recirculating control valve. The control valves are actuated by the hotwell level transmitter, fitted directly to the stand-pipe, connected to the hotwell and condenser shell.

In normal operation, the level control valve in the main condensate line keeps the level constant in the condenser hotwell. In case of low level in the hotwell, the main control

valve closes and the recirculating valve opens, in order to recover the normal condensate level.

In case of abnormal operation, any large deviation of the normal level in the hotwell is indicated by an alarm in the control room and interlocking system. Besides the alarm in the control room the level monitor automatically performs the following tasks:

- High-high level: alarm on the high-high level and turbine trip;
- High level: Alarm on the high level and the stand-by condensate pump is switched on into circuit automatically.
- Low level: Alarm on the low level.
- Low-low level: Alarm on, switches off the condensate pumps and trips the turbine.

Start-up / shut-down:

In these cases (start-up and shut-down) the condensate extraction pumps delivers condensate through the recirculating line and recirculating valve, thus assuring the minimum flow to the condensate pump and the service steam ejector inter/after condenser.

The pump is started automatically (provided the system is filled), or manually by the operator from the control panel in the control room, considering a sequence of manually closing valves.

Abnormal operation:

a) Outages of a pump: The stand-by pump is switched-on automatically if the pump in operation is switched off and an alarm is given.

High level in the hotwell, the stand-by pump is switched-on automatically and an alarm is given. The stand-by pump is switched off manually when the level on hotwell to return at the normal.

b) Cavitation protection for the pumps: When the minimum level signal in the condenser hotwell is actuated, the pump in operation is switched-off. Alarm is given and the turbine trips.

c) Protection against shut-off operation: If the hotwell control valve and the recirculating valve are closed, due to some trouble, both pumps are switched-off. Alarm is given. In case of instrument air supply failure, the main valve is closed and the recirculating valve remains open.

5.7. Vacuum System

The objective of vacuum system is to use motive steam to suck out the non-condensable gases from the condenser to atmosphere, and thus produce the necessary vacuum to star-up and operate the steam turbine at the required performance.

It is composed by a start-up ejector, two service ejectors (1st and 2nd stage) two spare service ejectors, condenser of service ejectors, piping, safety valves, block valves and local instruments.

5.7.1 Start-up Ejector

The start-up ejector ensures the quickly removal of air + non-condensable gases existents in surface condenser and turbine exhaust before start-up.

When the pressure is reduced to the value of pre-estabilished vacuum the start-up ejector is put out of operation and during the normal operation of plant, the vacuum is kept constant by the service steam ejectors.

It is composed by one ejector nozzle and by one diffuser forming one stage. Operated by the basic principle of a Venturi nozzle, the motive steam is forced to flow in direction to decrease of transversal section of pipe inducing one high loss load achieved the maximal depression in place of mounted nozzle. In this exact point is connected the by-pass of air and non-condensable gases piping, which shall be suctioned out of surface condenser and ejected to atmosphere through line.

The outlet of pipe of mixture air + non-condensable gases is furnished with one silencer to reduce the noise level on the plant.

5.7.2. Service Ejectors and Condenser of Ejectors

The service steam ejectors ensures the constant vacuum of surface condenser by continuous removal of air and non-condensable gases of cooled steam on air coolers of condenser inserted into the condenser shell.

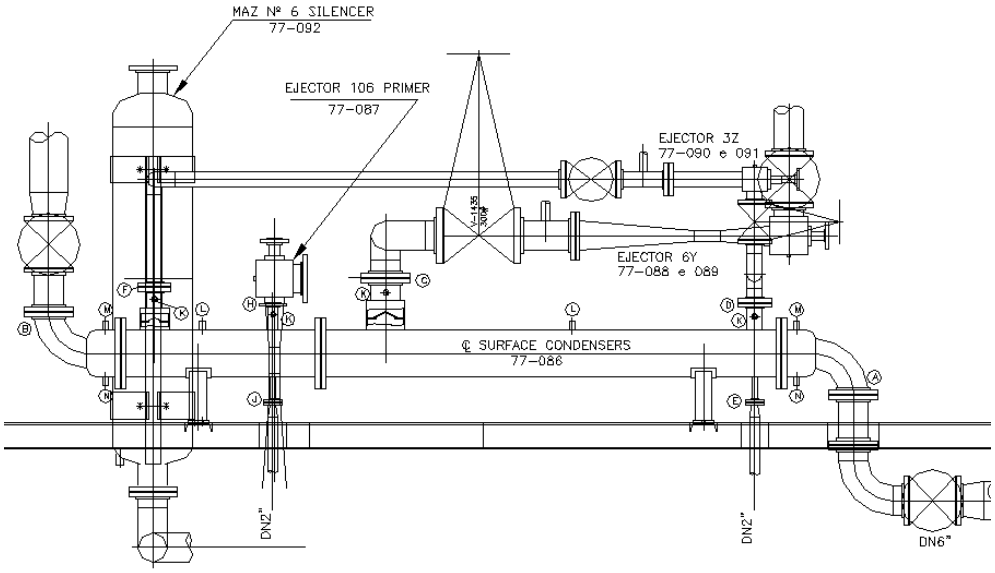
It is composed by two air ejectors of two stages (both stages have a redundant ejector for the other operating ejector), each one fed by steam at constant pressure from branch lines. They operate under the same principle of start-up ejector.

The first stage nozzle produce a high vacuum, inducing the air desiring of surface condenser air. In the diffuser of second stage the mixture pressure from is increased until one value is slightly higher than the external pressure.

Between two nozzles of two stages find out one service steam ejector inter/after condenser purposed to condense the feed steam of first stage, with aim of not overloading the second stage nozzle with this extraction and recovery on circuit. The steam of second stage is condensed on service steam ejector inter/after condenser of second stage.

The condensate of first and second stages shall be transferred to main surface condenser. The air and non-condensable gases shall be eliminated to the atmosphere.

The outlet lines of all the service are provided with safety valves. In case of an overpressure of the system, these valves are set to relief the mixture to the atmosphere.



Vacuum system layout.

5.8. Drain collect system and flash

The drain collect system and flash are composed of a drain collector connected to flash tube. The flash tube is part of the auxiliary system to connect the turbine drains and the drains from the bleed/extraction (if applicable) with the steam condenser.

The process description shall be followed with the steam and condensate system flow diagram attached to this proposal.

The turbine are furnished with a number of drains to remove the condensate during the condensing phase of the start-up. The condensate from the drains flows to the drain collector.

From the drain collector, the steam/condensate is sent to the flash tube and afterwards to the to the condensing on the top of the condenser and part of that directly to the hotwell.

When the turbine is in normal operation, the drains of the steam line and the turbine drains must be closed.

The following drain lines are comprised and are arranged at decrescent pressure order in the drain collector:

- Drain at live steam control valve
- Drain at wheel chamber
- Drain at 1st blading carrier
- Drain at 2nd blading carrier
- Etc.

Before every drain there are restriction orifices to calibrate the outgoing pressure accordingly. Thise orifices are out of Siemens scope.

5.9. Pipes

The pipes will be designed considering the operation of the plant. The tubes will be directed in support structures, funnels or supported by metallic structures whenever the previous solutions are not applicable.

The materials of the tubes to be used will be specified in accordance with the technical standards and taking in consideration the operational conditions.

Pipes to be supplied:

- Pipes and accessories between turbine exhaust and condenser neck (interconnection piping and expansion joint);
- Tubulações e acessórios para linha de vapor entre escape da turbina e entrada do condensador;
- Condensing pipes between condenser hotwell and condensate pumps;
- Condensate pipes for vacuum system until 1 meter after the by-pass valve of the level control valve of the system.

5.10. Water quality

The cooling water shall fulfill the minimum requirements requested by Siemens, once the material of the tubes were defined.

For details, plese refer to the table on Part 2 of this offer.

5.11. Condenser technical data (preliminary)

Please see part 8 of turbine datasheet attached to this proposal.

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Areva – UTE Campo Grande – 3 x SST-400

Part 6

Subject:

Spare Parts

6. Spare Parts (Start-up)

The list presented below is recommended for start-up for turbine and generator.

Spare parts for start-up (01 set for each turbo-generator):

DESCRIPTION	QTY	UNIT
Instrumentation		
RTD, turbine bearings	02	pcs
RTD, oil system	01	pcs
RTD, gearbox bearings	01	pcs

	QTY	UNIT
Generator		
Rotating diodes and varistors	01	Set

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Areva – UTE Campo Grande – 3 x SST-400

Part 7

Subject:

Field Services

7. Field Services

Erection Supervision and Orientation

Based on the technical specification of each equipment, a team of specialists from Siemens will supervise and orient how should be realized the erection working on client´s site, in order to assure the objective the technical quality and the operation of each equipment supplied by Siemens. The following activities compose the basic scope of activities involved in this period:

MECHANICAL ERECTION SUPERVISION AND ORIENTATION

TURBINE

- Topography (base inspection)
- Base preparation (Supports and regulators)
- Installation at base
- Pre alignment
- Levelling
- Grouting
- Final alignment

GENERATOR

- Base inspection
- Installation at base
- Pre alignment
- Levelling
- Grouting
- Final alignment

OIL PIPELINE

- Manufacture and adjustments
- Pre assembly
- Scouring
- Final assembly

COOLING WATER AND CONDENSATE PIPELINE

- Manufacture and adjustments
- Pre assembly and supports
- Final assembly

STEAM PIPELINE (Customer Responsibility)

- Manufacturing
- Pre assembly
- Cleaning preparation
- Live steam blowing
- Final assembly – paralelism check

FINAL ASSEMBLY

- Thermal insulation assembly
- Oil flushing

ELECTRICAL AND INSTRUMENTATION ASSEMBLY SUPERVISION AND ORIENTATION

TURBINE PANEL & INSTRUMENTATION ASSEMBLY

- Fixation of the panel at base
- Local instruments assembly
- Hydraulic tubing interconnection
- Cable positioning
- Bently Nevada 3500 probes and proximitors
- Interconnection until junction boxes

Commissioning and Start-up

After completion of erection of all equipment, a group of specialists by SIEMENS will command the commissioning activities until the start-up of turbine. Below is a brief description of commissioning activities:

MECHANICAL COMMISSIONING

- Lube oil system check-out
- Control oil system check-out
- Gland steam and condensate system check-out
- Cooling water system check-out

INSTRUMENTATION COMMISSIONING

- Cable continuity tests
- Instrument calibration check-out
- Adjustments Bently Nevada proximitors
- Hot tests

ELECTRICAL COMMISSIONING

- Verify generator insulation
- Check panels for energization
- Check-out measurement system
- Check-out synchronization system
- Excitation system tests
- Control panels command tests
- Protection systems settings and tests

CONTROL SYSTEM COMMISSIONING (*)

- Calibration PLC cards
- Commissioning Bently Nevada monitors
- Loop tests with auxiliary systems

(*) The control panel is tested and pre-commissioned in factory.

START-UP

- Coldstart test (manual / semi-automatic)
- Overspeed test
- Generator no-load tests
- Synchronization

- Loading tests
- Load rejection tests

Estimated Available Personnel Required from Customer

The required personnel from customer for the site erection and comissioning shall be dimensioned by the Erection company (not included in Siemens scope) in order to attend the period as presented on attached time schedule for erection supervision, commissioning and start-up.

Field Service Training

Theoretical training will be carried out by the Siemens specialist, during 2 days, 8 hours/day, to be scheduled during commissioning period. SIEMENS will provide training material, while customer will make available rooms and support equipment for the presentation, as well as distribute shifts of operation personnel to fit in the training schedule.

Practical training will be given throughout the commissioning period, as the circumstances may require.

The following programme will be presented during the training period.

TURBINE

- Turbine operating conditions
- Turbine sectional drawing
- General maintenance and periodicity

OIL SYSTEM AND HIDRAULIC UNIT (if applicable)

- Oil tank
- Main oil pump, auxiliary oil motor pump and emergency oil motor pump
- Double oil cooling and double oil filter
- Safety and pressure reducing valves
- P&I diagram overview (protection and control)

STEAM SYSTEM

- Emergency stop valve and valve actuator
- Control valves
- Steam consumption graph
- P&I diagram overview

CONTROL SYSTEM

- Measurement of speed and axial position

- Control Modes
- Turbine Overspeed Protection
- Operation by Turbine Control Panel (HMI)

START-UP

- Quality of cooling water, steam and oil
- Cold and warm start diagram

Operational Acceptance Test

After successful start-up and load tests, the equipment is put into continuous operation,during the below stated periods, under a load condition to be stipulated in the contract, according to the conditions available at the plant. The operation is carried out by customer trained operators, under supervision of SIEMENS available at site during 24 hrs/day, covered by 03 different specialists, being each one available at customer site during normal working time (8 hour shift):

- 1st and 2nd turbo-generator set: continuous operation during 72 hours for each;

- 3rd turbogenerator set: continuous operation during 288 hours, in parallel with the 1st and 2nd turbo-generator set.

In case the test of the 1st and 2nd TG sets (72 hours each) is not possible due to safety reasons, the test will be performed during 720 hours for the total time of the 3 TG sets.After the period above mentioned for each equipment, such equipment is passed on the customer and the Term of Acceptance is issued and signed between the parties.

The Term of Acceptance shall be issued for each equipment individually right after the equipment is passed on the Operational Acceptance Test.

Assisted Operation (40 calendar days)

Immediately following the Provisional Acceptance terms for the supplied turbogenerator sets, a Reliability test may be carried out according to the total period described above.

The Customer determines the mode of operation and load of each turbogenerator set in agreement with the specifications of the equipment suppliers' operating instructions. The operation of the plant during this period is performed by the Customer's/ Owner's staff.

The operation will be monitored by 01 Siemens' specilist, who will be present on site during 08 hours a day.

The total of 40 calendar days of assisted operation can be scheduled according to customer convenience, since it does not exceed the total of 03 mobilizations (any break between the total schedule of 40 days will be assumed as a different mobilization) and the total of 40 calendar days shall be executed within a period of 3 months after the 3rd turbogenerator set provisional acceptance. The successfully performed Reliability Test is to be confirmed in writing by representatives of the Customer and Siemens.

Performace Test Support

In a period limited to 3 months after the beginning of operation, Siemens will supply one engineer to measure the performance in the project guarantee point. The performance test will be performed according to Siemens test procedure which is based on DIN 1943 of February –1975, and the use of standard instrumentation to be supplied together with the Turbogenerator.

Flow meters and any special necessary instrumentation (higher accuracy) are not included in the scope of supply.

The activities that would be realized are:

- The issue of the performance test procedure
- The verification of the calibration certificates necessary for the instrumentation
- The verification of the instalation of instruments and primary elements according to the standards described in the procedure
- Supervision of the equipment operation, done by clients operators
- Collection and analysis of data that were obtained from the performance measurement
- Issue of a report according to the test method

The responsibilities of the customer are:

- To arrange and to assure that the piping project and instrumentation are in accordance with the tests standard requirements
- Provide the necessary instrumentation for the test (complementary with the Siemens scope)
- Provide plant availability to simulate stable process conditions equivalent to guarantee points
- Carry out laboratorial analysis for steam quality
- Provide the project documentation (diagrams and Isometrics) of the steam lines and instrumentation datasheets in the necessary time before the test for analisys
- Operate equipment during execution of tests

Estimated time for the execution of the proposed services

The time for the execution of the proposed services is estimated according to the "Assembly supervision, commissioning and start-up time schedule" attached to Part 13. The time estimate is considered after availability of the equipment and the respective erection / services site at the Client installations.

For the execution of the above scope of services it was considered:

- Working time in erection supervision and commissioning: Monday /Saturday – 9 hrs/day
- Working time in start-up: Monday / Saturday – 12 hrs/day

However, the above execution time may be changed after if the Inspection Report on the equipment and local, requires additional services.

Technicians team for the proposed scope of services

- 01 Mechanical Supervisor (Installation & Commissioning)
- 01 Electrical Supervisor (Installation)
- 01 I&C Supervisor (Commissioning)
- 01 Electrical Supervisor (Commissioning)

Please find attached on Part 13 also the “Field Services Prerequisites”.

Remark:

- Siemens inform that any part and service not mentioned in the supply scope above, will be considered as additional scope and submitted at analysis and approval of the Siemens and increase of the price and delivery time can occur.
- The price table is presented on the Commercial Proposal and shall be applied in case of additional work hours on the above proposed period, not related to Siemens fault.

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Part 8

Subject:

Documentation

8. Documentation

Scope of Documentation

Please refer to the complete document list attached to the proposal.

Deliverables by Customer				
	Description	Documents required	Time required before first issue (weeks)	First issue (weeks)
Y1	Electrical diagram and internal layout of the following panels and cubicles: TCP	C.3 approved C.4 approved D.1 approved D.2 approved D.3 approved General singleline diagram of the plant (client document)	12	34
Y2	Cable list and interconnection diagram	C.2 approved C.5 approved C.7 approved E.4 approved	6	44
Y3	I/O list for customer DCS or supervising system interface	C.5 approved E.2 approved	8	44
General		Plant General Lay-out	hold	-
Foundation anchors definition		Information about the turbine installation base	hold	-

Documentation handed over by the Customer

SIEMENS demands this documentation for project design. The above delivery time of SIEMENS's documentation starts and depends on the date that customer hands over below required documentation.

Documentation to be supplied by the customer (when applicable depending on the scope of supply, and additional documentation can be required by Siemens's) is presented below:

Basic design information

- Basic system design
- Operation philosophy

- Standard & directives
- Designation system of drawings
- Designation system of equipment

Turbine power house layout (place of turbine installation)

Main Component Drawings: This drawing shall show the dimensions of the components in close proximity to the turbine.

General Arrangement Drawing: This drawing shall show the main dimensions of the building and the equipment in proximity of SIEMENS's scope of supply. Reference dimensions between the building and equipment shall be given from the centre of driven machine.

Technical parameters of equipment:

Technical Data: Data needed by SIEMENS for equipment design to be supplied. Confirmation of data given in the technical specification and other important data for the project.

Process Diagram: The diagram shows how the turbine is interconnected in the total process of the project.

Single Line Diagram: Diagram showing the electrical distribution, electrical instrumentation and relay protection for existing grid and how the generator will be connected to this grid.

Documentation status

Exchange of documents and clarification of information needed for documentation preparation during the stage of project work is directed in compliance with the Manufacturing Time Schedule.

All the documents submitted to the Customer will be designated by one of the status mentioned below.

FOR INFORMATION

Documents which are not subject to comments by the customer, but are sent to complement knowledge of supply and project design.

FOR APPROVAL /APPROVED

Time period for elaboration of comments to this documentation is 15 days, counted from the electronic issue time. If SIEMENS does not receive any comments within this time period, the documentation is considered as approved. Subsequent changes and comments may allow SIEMENS to review commercial conditions (price and delivery time).

CERTIFIED

Based of the Customer's comments, the final documentation is elaborated and submitted. Any additional changes or comments in this documentation will have impact to the delivery

conditions, and may result in additional engineering and/or material costs which SIEMENS reserves the right to pass on to the Customer. In this case the delivery terms are subject to postponement proportional to the overall delay which was resulting from the re-certification of documents.

AS-BUILT

Documents which are changed during (1) factory tests and/or (2) commissioning periods. In the first case, these are submitted with O&M manuals. In the second case, a copy with the remarks is kept with the customer, while the originals are sent back to SIEMENS for update in due time.

Data transfer formats

Data transfer formats, file types and file versions are made in PDF (ADOBE ACROBAT). When transferring data, following media shall be used:

- ✓ CD – ROM
- ✓ e – mail

Alternative media transfer formats to be used has to be case-by-case mutually agreed between SIEMENS and Purchaser before project starts.

If the documentation is handed over in paper form, the Customer is provided with the quantity of copies mentioned in document list. As standard, all manuals will be available in electronic version (CD) only. Additional copies shall be subject to additional costs, upon Siemens criteria.

Documentation standard

The documentation from documents list will be submitted in accordance with SIEMENS standard.

The documentation from auxiliary equipments (pumps, oil coolers,...) will be in accordance with supplier's standards.

Documentation language

Official language throughout project communication, include written reports, shall be developed in Portuguese.

All documents submitted during delivery period are made preferably in Portuguese or in English (for some imported items).

The O&M manuals (text descriptions) will be delivered in Portuguese language. The documents certified during the project, as well as other documents which compose the manuals, are handed over in Portuguese (or in English for some datasheets, drawings, etc., for some imported items) language.

Documentation in another language shall be object of negotiation between the parties.

Documentation time schedule

The dates for submission of drawings and documents shall be defined upon document schedule agreement between SIEMENS and customer after order award, being directly connected with all information and technical drawings receipt by SIEMENS from customer.

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Part 9

Subject:

Standards and Codes

9. Standards and Codes

Siemens Industrial Steam Turbines and its auxiliaries are designed and manufactured in accordance with DIN, ASTM, AISI, ANSI, VDI, NEMA, AGMA, IEC and ISO.

Materials

Materials are purchased in compliance with ASTM standard. The quality of material shall be equal or better than required in tender documents. Equivalent materials or basic features can be shown for reference. For some materials supplied out of Europe, DIN standards are applicable.

Manufacturing

Manufacturing will be made in accordance with the procedures and standards of the workshop where the manufacturing takes place. The procedures and standards can be reviewed if required.

Turbine design

The steam turbine is designed in accordance with Siemens standards, which are based on the major international standards. The steam pressure containing components of the turbine conform with the IEC 45 Recommendation and DIN 4312. These standards are similar identical to the requirements of NEMA SM 24 – 1983.

Oil system components

The oil system is designed and built in accordance with Siemens standard, based upon selected parts of DIN. Terminal points are in accordance with Client requirements. Oil coolers and oil filters are in accordance with TEMA C and ASTM standards.

Piping

Factory assembled piping within turbine package are in accordance with ASTM. For external connections (terminal points) our delivery is limited to the flanges and we make them in accordance with Client requirements.

Electrical and control equipment

The basic design of the Siemens steam turbine electrical and control equipment is made in accordance with the standards of IEC. The cabling, when included in scope of supply, will be erected after International Standard.

Quality assurance

Quality assurance is in accordance with ISO 9001 and internal standards.

Environmental Standards

Siemens operatiorn are in accordance with ISO 14.000 standards.

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Part 10

Subject:

Terminal Points

10. Terminal Points

Remark: The attached P&IDs are for reference, since some changes were done during the negotiation, therefore in case of discrepancies, please refer to below description for details about the terminal points below.

Steam

- Inlet flange of the turbine live-steam emergency trip valve;
- Outlet flanges of turbine bleeds;
- Inlet and outlet flanges of bleeds non-return valves;
- Inlet flange of the start-up/service steam ejectors (limited to 5 meters from steam turbine);
- Flange of sealing steam line (limited to 5 meters from steam turbine);
- Flanges of turbine gland steam piping up to turbine skid;
- Outlet for steam at safety valves at steam jet air ejectors units;
- Inlet flange at the condenser for the steam coming from the bypass station.

Cooling and service water

- Inlet and outlet flanges of oil coolers;
- Inlet and outlet flanges of generator air coolers;
- Inlet and outlet flanges of surface condenser;
- Inlet flanges of the demi-water for the desuperheater of the ejector systems.
- Inlet flange for condenser make-up water.

Condensate

- Outlet flange of the condensate level control valve, limited to 1m after the by-pass valve for this control valve.

Oil

- Outlet of oil mist eliminator;
- Outlet oil tank valves for drain and filling oil.

Compressed Air

- Inlet connection for valves: condensate level and pressure control (limited to 1m from steam turbine);
- Inlet connection for non-return valves;
- Outlet flange of the start-up ejector silencer to atmosphere;
- Vent flange of ejectors steam condenser to atmosphere;
- Outlet flange of the condenser pressure safety valve to atmosphere.

Air

- Inlet and outlet connections of desumidifier.
- Connection from desumidifier at the turbine.

Drains

- Flanges of drain at steam ejectors collector.

Electrical power and instruments

- Generator Main Terminals (power output);
- Generator auxiliaries terminal boxes;
- Motor and Electrical Equipment Terminals;
- Instrument interconnections material after 10 meters length between junction boxes and panels.

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Part 11

Subject:

Exclusions From Scope of Supply

11. Exclusions from Scope of Supply

Piping

- Steam (live and bleed) piping and respective accessories (valves, supports, joints, isolation, screws,etc.);
- By–pass system (pressure and temperature reduction stations);
- Oil supply;
- Complete piping system, special appurtenances, piping supports and hangers, piping thermal insulation, lagging, and other required specialties for the gland seal system;
- Ducting;
- All the necessary bypass equipment (valves, spray, piping, bypass control etc) to allow steam at the requested condition at condenser inlet;
- Flexibility studies;
- Auxiliary condenser for bypass operation;
- Atmosphere relief system for bypass operation;
- Steam piping between the steam generator and turbine.
- Pipe support for items out of Siemens scope of supply;
- Painting for piping and supports not supplied by Siemens;
- Compressed air piping beyond 5 meters from TG;
- Steam headers and pipe-racks;
- One additional NRV (non return valve) non operated for each bleed line;
- Steam Generator;
- Spooling of piping at factory or site;
- Nitrogen storage and supply system;
- Heating, Ventilation, and Air Conditioning (HVAC) systems;
- Station and monitoring for effluents, emissions and air pollution;
- Pipe hangers and supports for piping out of Siemens scope;
- Raw Water System;
- Demineralized Water System;
- Automated startup and shutdown sequences for the steam turbines;
- Cycle Chemical Feed System;
- Cooling Tower Chemical Feed System;
- Automatic safety control including: (Automatic function), automatic safe shutdown (ramp down), selected shutdown (ramp down);
- Automatic Drainage Systems;
- Sanitary Wastewater System;
- Sampling System;
- Service Water System;

- Diesel Oil Supply System;
- Air Emissions Control System;
- Fly Ash Handling System;
- Bottom Ash Removal System;
- Chips Handling System;
- Emmergency Button for Hardwire Turbine Emergency Trip in the control room;
- Automatic temperature control (DCS/ST/HRSG interface);
- Steam Generator feedwater flow control;
- Steam Generator steam attemperator spray valve;
- Steam Bypass Valves;
- Fire Protection and Detection;
- Mechanical overspeed trip protection;

Civil

- Foundations, earthworks, soil preparation;
- Masonry;
- Civil works and building civil design;
- Grouting;
- Machine house crane;
- Heating and lighting of the machine house;
- Steel structures and platforms;
- Lightning protection;
- Emergency lighting system;
- Other items for machine house not specificated in this proposal;
- Construction environmental plan;
- Transport until site;
- Power house, structural, civil works, architectural design criteria and any soil investigation;
- Civil base and preparation of foundation surface.

Accessories

- First oil filling and oil for flushing;
- Compressed air, water, nitrogen and power supply on site;
- Sump pump;
- Inlet and discharge oil pump strainers;
- Strainers for oil return to tank(*);
- Bearings differential pressure measurement(*);

- Fuller's earth and polishing filters;
- Electrical vacuum trip with provisions for remote reset;
- Reheat pressure feedback;
- Manufacturing drawings;
- Ladders and lifting platforms;
- Strainers at pump suctions;
- Fire protection and figthing system;
- Oil accumulator;
- Bypass lines for manual operated gate valves (Except the bypass lines represented in the steam flow diagram within Siemens battery limits);
- Oil conditioner unit;
- Automatic starting devices including motor starter;
- Chemical feed system;
- Sampling system;
- Feedwater Pumps;
- Make up water devices;
- Blowdown system;
- Portable water system;
- CCTV system;
- Chlorination system;
- Flow meansurement;
- Low pressure steam system for the deaerator, soot blowers and other uses;
- Line valves (outside Siemens scope);
- Silencer (except the ones represented in the flow diagrams within Siemens battery limits);
- Cabinet with top cable entry;
- Keyphasors;
- Pressure reducing valve for process (By pass);
- Bypass station for steam to the condenser (pressure reduction valve, desuperheater, control system and control logic);
- Accoustic hood/ noise insulation;
- Gland steam condenser;
- Condenser cleaning system;
- Cooling water control valves;
- Emergency pump driven by steam turbine;
- Portable oil purifier;
- Redundant communication station between turbine and bypass;
- Valve body with stamping, stainless plate or any combination marked in accordance with ANSI B16.34;

- Heating, Ventilating and Air Conditioning.

Electrical part

- High Voltage, Medium Voltage and Low Voltage cables, switches, contactors and fuses, cable trays and its supports;
- Step up transformer;
- Copper conductor for grouding;
- PLC and speed governor redundant;
- Dispositive for SOE;
- Vacuum metering for remote indication;
- Revenue Metering (equipment to be furnished as per ONS Procedure);
- Steam turbine-generator designed based on PLC and Governor fault tolerant (redundant)(*);
- Manual valves available in the operator screen;
- Auxiliary transformers;
- Operator workstation;
- Automatic start-up connection cables and buttons;
- Grounding;
- Communication through Modbus communication link;
- High voltage switch gear;
- Thermocouple for oil monitoring;
- Hand-held radio transmitters;
- Encapsulated conductors;
- Three-phase AC and DC distribution systems;
- Local pushbuttons for motors;
- Cabling and cable trays between motors and MCC;
- Load shedding, sharing system;
- MCCs ;
- Secondary air fan with motor;
- FD fan with motor
- Spreader air fan with motor;
- Battery charger and rectifier for DC supply;
- Generator Control, protection and synchronization panels;
- Interconection between Generator instruments Junction boxes, generator control/protection/synchronization panels and turbine control panel;
- Electromechanical rack relays;
- Generator with static excitation and the static excitation panel;

- Generator redundant protection relay;
- Generator protection relay;
- Generator designed and constructed in accordance with ANSI standards, C50.10 and C50.13;
- Multi digital indicator on generator control panel;
- Generator control panel;
- Digital synchronizer;
- Eccentricity measurement;
- Supervisory systems and hystorical server;
- Circuit breaker cubicle;
- KKS tag;
- RMS - remote monitoring system;
- Study of electrical system;
- Emergency diesel generator;
- Substation;
- Protection IP-66;
- Alarms and shutdown indication;
  - High shaft eccentricity
  - High shaft Differential Expansion
  - DC Seal Oil Pump Running
  - Rotor resistance
  - Generator Ground Detection
  - High Enclosure Temperature
  - Low Enclosure pressure
  - DEHC System UPS Trouble
  - DEHC Fluid Pump(s) Overload
  - DEHC Fluid Pumps Not in AUTO
- Voltage Regulator;
- Pressure test on hydrogen-cooled stator frame for gas-tightness;
- Grounding and Lightning Protection System beyond Siemens scope;
- High potential test for generator;
- Generator grounding system and cables connecting it to the customer grounding system, as well as panels, instruments and vessels grounding;

Instrumentation and control

- I&C cabling between turbine control panel and MCC;
- I&C cabling between turbine control panel and DCS;
- Sensors and tap points for operation of equipment controlled by DCS;
- Steam and condensate flow measuring devices;

- Cooling water flow control and temperature measurement to the condenser;
- Impulse lines from process to allow pressure and temperature metering and adjustment (PT and TT) according to attachment 29 of technical proposal;
- Central control room with instrumentation control and alarm annunciation equipment;
- DCS systems and communication inteface with bypass;
- Mechanical overspeed trip;
- 220 Vac Uninterrupted Power Supply (UPS);
- Workstation for PLC configuration/opperation;
- Explosion proof provision (Ex);
- Supervisory system (CPU, software, hardware, cables, monitor, printer, etc.);
- Turboset vibration analysis and diagnostic ;
- Connection between turbine control system and supervisory system from customer;
- Sealing and ejector control valves with feedback position;
- Sequence of events;
- Laboratory equipment;
- Interconnecting valves operated by the control room with position microswitches;
- Zero-Speed sensors;
- Eccentricity sensors;
- Redundant speed governor;
- Energy dispersion devices (baffles, orifice distribution headers, multistage pressure reducing devices);
- Differential expansion measurement;
- Thermometers for local mounting;
- Redundant instrumentation;
- Operator interface monitor with keyboard and printer;
- Reheat pressure feedback;
- Local turning gear control panel;
- Functional control system;
- Approval witnessed test at Siemens factory for test approval;
- Holding point for any equipment test;
- Generator PLC;
- Chemical solution plant.

Others

- In case of Environment Authorities or Public Authorities required to Areva any specific documentation that involves TG set, Siemens will support Areva in this preparation and in common agreement will define how to proceed with such requirement;

- Site Facilities and Temporary Services: electricity, water, sanitary facilities, fire prevention equipment, noise attenuation, dust attenuation, erosion controls, refectory, compressed air, ambulance/medical structure, structure for end customer and restore of faciliting areas for final plant condition, except extinguishers bottles;
- Fixed plataforms, walkways, stairs, fixed ladders and other access requirements;
- Sheltered area for enclosed storage;
- Infra-structure required by owner;
- Biomass buffer silo and fuel feeds;
- Spare parts for 2 years operation;
- Steam piping blow out;
- Satellite/radio link for telephone/data transfer;
- Waste disposal;
- Site cleaning and other services not related to STG erection activities;
- Packing for outdoor storage;
- Portable water system;
- Chlorination system;
- River water intake and pipe line (raw water and treated discharge effluents);
- Fuel receiving, handling and storage system;
- Disposal of construction debris and site cleaning rejects;
- Station and monitoring for effluents, emissions and air pollution;
- Transport and insurance after place of delivery (FCA factory);
- Site location and site preparation;
- Power house auxiliaries system;
- Water intake and discharge;
- Water treatment;
- Telephone and communication systems for power plant;
- Mechanical running test for rotating equipments;
- Cooling water system (cooling tower, pumps, interconnection piping, etc.);
- Costs for people out of Siemens to follow the witnessed tests – if any (lodging, feeding travel expenses, etc.);
- Special material/instrumentation for the performance test besides the standard turbogenerator instrumentation presented in the attached datasheet, such as steam flow meters;
- WW 505 enhanced redundant control system;
- PLC S7-400H (redundant);
- Condenser tube cleaning system;
- Keyphasor;
- Active magnetic pick-up;
- Vacuum breaker;

- ASME U stamp for condenser;
- Operating station;
- Bently Nevada System One;
- Make up water devices;
- Permanent plant Systems security;
- Feed water heating equipment such as boiler feed pumps, water storage tank, preheater;
- Overhead cranes and Hoists;
- Licenses, permits and authorizations;
- Condensate pre-heaters;
- Cooling water control valves;
- Pneumatic drain valves;
- License for configuration changes (except for HMI and PLC parameterization);
- Sequence of events recording;
- Synchronism with a GPS;
- Closed circuit cooling water system;
- Supervisory system;
- Historical Server;
- Analogic devices (outside Siemens scope);
- Tanks (except lube oil);
- Fieldbus protocol for field instrumentation;

(*)In case Areva request a technical support, Siemens will delivery all support to Areva in front of customer during technical clarifications and divergencies.

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Part 12

Subject:

Comments and deviations on specification

12. Comments and Deviations on Specification

The following documents have been considered in the preparation of this proposal:

Documents received for proposal preparation	Reference code
1-11-0485-000-115-02 - CASA DE FORÇA - 3x50 MW - UTE CAMPO GRANDE.pdf	1-11-0485-000-115-02
1-11-0485-000-119-01 - LAYOUT DA CAPTAÇ╠O DE ╡GUA - RIO GUAR╡ .pdf	1-11-0485-000-119-01
1-11-0485-000-167-05 - LAYOUT GERAL - ESTUDO - 3X50 MW - ALTERNATIVA 02 - CT MAIN.pdf	1-11-0485-000-167-05
1-11-0485-000-200-00 - OWNERS TEMPORARY SITE OFFICE.pdf	1-11-0485-000-200-00
1-11-0485-100-001-02 - FLUXOGRAMA DE ╡GUA E VAPOR - CTMAIN	1-11-0485-100-001-02
1-11-0485-100-002-00 - FLUXOGRAMA DO SISTEMA DE RESFRIAMENTO - CTMAIN.pdf	1-11-0485-100-002-00
1-11-0485-100-003 A -00 - Water balance Diagram.pdf	1-11-0485-100-003 A -00
1-11-0485-100-059A-00 - DIAGRAMA UNIFILAR - CAMPO GRANDE.pdf	1-11-0485-100-059A-00
1-11-0485-100-060-00 - DIAGRAMA DE ARQUITETURA DO SISTEMA DE CONTROLE.pdf	1-11-0485-100-060-00
2-11-0485-000-105-00 - OFICINA DE MANUTENÇ╠O - CTMAIN.pdf	2-11-0485-000-105-00
2-11-0485-000-106-01 - PRÉDIO ADMINISTRATIVO - CTMAIN.pdf	2-11-0485-000-106-01
3-11-0485-100-023-02 - FLUXOGRAMA DO P╡TIO DE BIOMASSA CGB.pdf	3-11-0485-100-023-02 -
4-11-0485-000-120-00 REV B - Water intake and pipeline specification - GUAR╡ River.pdf	4-11-0485-000-120-00 REV B
4-11-0485-100-061-00 - BALANÇO DE MASSA E ENERGIA - SIEMENS.pdf	4-11-0485-100-061-00
APPENDIX B - UTE CAMPO GRANDE - SITE CONDITIONS.pdf	APPENDIX B
APPENDIX C - UTE CAMPO GRANDE - preliminary soil survey.pdf	APPENDIX C
CGB - EPC-Specification CAMPO GRANDE REV 06_coloured changes	-
DE-UTE-SGE-006-948-CTM-001 - A - CAPTAÇ╠O DE AGUA - RIO GUARA KM 00+00 AO KM10+000.pdf	DE-UTE-SGE-006-948-CTM-001 - A
DE-UTE-SGE-006-948-CTM-001 - B - CAPTAÇ╠O DE AGUA - RIO GUARA KM 10+00 AO KM16+638.pdf	DE-UTE-SGE-006-948-CTM-001 - B
EST-167-07-00-001 - Preliminary truck technical data.pdf	EST-167-07-00-001
TR-PM-207-E QAPs for biomass fired power plants_Rev00.pdf	TR-PM-207-E
UTE Campo Grande - Steam Turbine-Generator (Espec Leme)	-
ANEXO XV- Subcontratadas Permitidas	-
ANEXO II–ESPECIFICAÇÕES TÉCNICAS DO COMPLEXO September 2014 Rev7	-

We have made all efforts to submit a quotation for a steam turbogenerator in accordance with your document and, to a very large extent, we do comply with your specification.

For some items we propose comments, because of certain particular aspects of the design of our turbines. The most significant comments are given in the following pages and mentioned attachment, with items numbered in accordance with your documents.

In case further comments are applicable to this proposal, both parties shall in common agreement reach a common understanding.

General Remarks

1 – The equipment are designed according to International Standards. Please, inform us if there are different statutaries and regulation requirements that interfere with design, manufacturing, transport and erection of the equipment.

2 – The attached P&IDs and outline drawing are for reference only. For the correct scope of supply and terminal points please refer to the text of this proposal.

3 – The oil piping and valves are designed considering the plant operation and supplied as loose items. For a quicker and more efficient erection, it is not being considered the piping preparation (spool), once it should be mounted on field, incorporating the necessary small adjustments to the final dimension. Except if opposite is clearly stated in this proposal, the preparation/erection of the spools on field is the client's responsibility.

4 – Siemens considers that the place of installation of the equipment is free of asbestos, is a non hazardous area, a non seismic zone (earth quake factor <= 0,1 g) and indoor instalation.

5 – Pipe analysis responsibility

The PURCHASER is responsible for pipe flexibility analysis execution attached at the turbine, conform the maximum values of permitted strengthen in the machine flanges, informed by SIEMENS and in according with NEMA SM24 standard. The SIEMENS won't be responsible for any confirmation, analysis or verification of the calculations made by PURCHASER. In the case any turbine abnormal alteration due to problems that can be connect at lines flexibility, the PURCHASER shall show that the flexibility analysis was realized and that the installation is in according with it.

In case of lines flexibility analysis made by PURCHASER doesn't consider the design or installation/construction as responsible for eventual problems, SIEMENS can provide, by itself, a verification of PURCHASER's flexibility analysis and check of lines installed as well. Before to start this verification SIEMENS shall submit for the PURCHASER a list with all activities to be developed and any commercial adjustment due to these activities. If after these verifications, SIEMENS proves that lines are correctly supported, SIEMENS will assume all costs relatives to the verification. Otherwise, the PURCHASER shall be responsible for all costs spent by SIEMENS and shall proceed with the installation revision in according with SIEMENS determination.

6 – The technical descriptions on chapter Part 2 and 5 of this offer are general information only and might be subject of small constructive changes on the design of the equipment during Engineering execution after order, in order to meet specific requirements of each project.

7 – Drain header and flash tank: Turbine casing and bleed piping steam drains have to be routed to a drain header and from there to a closed tank (flash tank) under vacuum and with condensate spray in order to be flashed back to liquid. This condensed steam shall then be routed back to condenser shell (by pumps – included in Siemens supply) or to another type of condensate recovery system. Siemens will provide a drain header and a flash tank according to the Steam P&ID attached to this proposal.

8 – According to customer request, the Generator auxiliary panels (control, protection, excitation, synchronizing panel, surge protection cubicle, grounding cubicle) is not included in the scope. Therefore, in order to allow a proper integration into Siemens supplied equipment & system, customer shall fulfill the minimum requirements described for such panels. Please, refer to the description attached to the proposal, which refers to standard equipment usually considered by Siemens. Variations from such description shall be subject of Siemens evaluation and agreement between the parties during project execution, in order to mitigate any technical risk to the generator and other auxiliaries.

Comments to specification: Please, refer to clarifications inserted in Part 2 of this proposal.

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Part 13

Subject :

Enclosures

13. Enclosures

Item	Document	No. Ref.
1	Steam Turbine data-sheet	Rev 10
2	Inspection and Tests Plan	Rev 1
3	Painting Plan	-
4	Outline drawing (For reference only)	Rev_1
5.0	Graphical Symbols	-
5.1	Steam flow diagram Rev1 (For reference only)	-
6.1	Oil flow diagram - Consumers (For reference only)	-
6.2	Oil flow diagram – Hydraulic Unit(For reference only)	-
7.1	Control and safety oil flow diagram - Consumers (For reference only)	-
7.2	Control and safety oil flow diagram – Hydraulic Unit (For reference only)	-
8	Condensate diagram Rev1 (For reference only)	-
9	Reference List – Multistage steam turbines from Brazil	-
10	Main subsupplier List	Rev_1
11	Steam Quality	-
12	Erection supervision prerequisites	-
13	Assembly supervision, commissioning , start-up schedule	-
14	Brazilian Generator inspection and test plan	-
15	Brazilian Generator datasheet - 62.5MVA 4 poles – brushless+PMG excitation	Rev_1
16	Control architecture	Rev 1
16_1	Scope of supply - Electrical	Rev 2
17	Heat Balance Diagram – 50 MW	HBD_39
18	Technical guarantee	Rev 7
19	Conservation in shut-down of Turbine Plants	-
20	Packing list (preliminary, for reference only)	Rev_1
21	Piping Blowing and Cleaning Procedure	-
22	General overview of equipments related to Bypass	-

	station	
23	Electrical consumers	Rev 2
24	Mechanical and electrical site erection - scope of supply description	Rev 2
25	Dehumidification system description	Rev 1
25.1	Dehumidifier catalogue	-
26	Siemens Condenser Datasheet	Rev 0
27	Cooling water recommendations for protecting industrial steam turbines	Rev 1
28	Cooling water recommendations for protecting industrial steam turbines	Rev 1
29	Measuring points diagram	-