CHAPTER 2 - DESIGN DATA

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1 Basic Conditions

1.1 Ambient Conditions

All components are designed for the following ambient conditions:

Altitude	< 1000 m above sea level
Maximum ambient air temperature (turbine hall)	< +40 °C
Average ambient air temperature (turbine hall)	< +25 °C
Minimum ambient air temperature (turbine hall)	+10 °C
Maximum relative humidity	< 70 %

1.2 Electricity

Required voltages for normal operation:

400 V AC; 3 phase 50 Hz
230 V AC; 2 phase 50 Hz
24 V DC or 230 V AC UPS for control cabinets
110 V DC or 220 V DC emergency supply for DC-oil pump (optional price)

1.3 Instrument Air

No compressed air consumers included in scope of supply.

1.4 Cooling Water

Cooling water pressure	max.	6	bar(g)
Mechanical design pressure		8	bar(g)
Design temperature		80	°C
Minimum inlet temperature		+ 15	°C
Maximum inlet temperature		+ 30	°C
Maximum temperature rise		5	°C
Glycol content		0 % (according to BAM spec.)	

Cooling water demand (for turbo-generator based on temperature rise 30-35°C):
- generator cooler: approx. 65 m³/h
- lubrication oil cooler: approx. 50 m³/h
- control oil cooler: approx. 2 m³/h
- leak steam condenser: approx. 250 m³/h (based on 1 t/h leak steam + safety factor of 2)
- Total: approx. 367 m³/h

2 Performance data

2.1 Working Conditions

Nominal steam characteristics at inlet of the steam turbine:

Start-up	min. 66 bar(a)	min. 350 °C
Normal operation at max.-load	99 bar(a)	400 °C
Maximum conditions at turbine inlet	99 bar(a) + IEC 45	400 °C + IEC 45

2.2 Terminal Output

Project AZN Moerdijk			**MARC 4-B00**	
Load point		**LP 1**	**LP 2**	**LP 3**
Characteristics		**Maximum**	**Nominal**	**Minimum**
Guarantee Point			x	
Weighing		0%	100%	0%
Live steam				
Pressure	bar(a)	99	99	99
Temperature	°C	400	400	400
Flow	t/h	129.2	113.4	85.7
Enthalpy	kJ/kg	3,102.1	3,102.1	3,102.1
Exhaust				
Pressure	bar(a)	7	8	9
Temperature	°C	165	171	176
Flow	t/h	129.2	113.4	85.7
Enthalpy	kJ/kg	2,633.6	2,657.2	2,716.3
Terminal output	kWe	16,230	13,470	8,690

3 Power Consumption

Number	Drive for	Need KW	Current	Voltage V
2	Lubrication oil pump	15	AC	400
1	Emergency oil pump	7.5	DC	110 or 220
1	Lubrication oil heater (option)	7.5	AC	400
1	Oil mist blower	0.75	AC	400
2	Control oil pump	11	AC	400
1	Control oil circulation pump	1.5	AC	400
1	Turning gear	12	AC	400
1	Generator standstill heating	4	AC	230
2-3	Control cabinets	1	AC	230
	Control cabinets' socket + lighting	0.5	AC	230
2	Noise hood fan (if option noise hood)	1	AC	400
several	Noise hood lighting (if option noise hood)	4	AC	400

The power demand of the delivered auxiliaries of the turbine unit that are continuously running (without occasionally operated drives and without any option) with turbine operation (nominal load case) is less than **37 kW.**

4 Design Conditions

4.1 Noise Level

The noise pressure level of the turbo-generator unit measured at one (1) m distance from the dimensions of the noise hood at 1.5 m height in accordance with DIN 45635 "*Geräuschmessungen an Maschinen*", free noise expansion conditions provided, will not exceed 85 dB(A).

When evaluating the measured data, the influence resulting from other sources has to be taken into account. The final guaranteed values are obtained by transformation of these data into free-field conditions *(“Freifeldbedingungen”)*.

A noise protection hood is included in our offer as an option. With this device the noise level will be limited to 80 dB(A), free noise expansion conditions provided.

4.2 Insulation Surface Temperature

All surfaces with a temperature exceeding 60°C during normal operation will be thermally insulated. Exceptions will be made for oil supply, gearbox, safety valves and similar components whose function is limited by insulation.

4.3 Vibration Measurement

Vibrations will be measured as follows:

- Turbine:
  - ∗ Shaft vibration measurement front and rear with 2 sensors positioned in a 90° angle in 1oo1 configuration.
  - ∗ If option “BoB24”: bearing pedestal vibration measurement front and rear in 1oo1 configuration.
- Epicyclic gear box:
  Housing measurement in 1oo1 configuration (if option BoB24: 1oo2 configuration).
- Generator:
  Bearing pedestal vibration measurement front and rear in 1oo1 configuration (if option BoB24: 1oo2 configuration).

<u>Shaft vibrations</u>

The turbine will be designed in accordance with DIN ISO 7919-3 *"Mechanical vibration of non-reciprocating machines – Measurements on rotating shafts and evaluation criteria"* and will be within the boundaries of class A/B. An absolute value is not available by now as it is depending on the real rotor speed. This value will be provided when the final design of the turbine is frozen.

<u>Bearing pedestal vibrations</u>

The generator will be designed in accordance with DIN ISO 10816-3 *"Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts"* and will be within the boundaries of class A/B in the category of elastic foundations. This corresponds to a max. value of 3.5 mm/s.

Manufacturers of gear boxes classify even higher values as uncritical. The following table shows the manufacturer standards for the stationary operation of the gear box.

Producer	Alarm value	Trip value	unit
BHS	4.5	7.1	mm/s
Renk	7.1	11.0	mm/s
Allen Gears	7.0	9.0	mm/s

As a result of long year experience with parallel shaft gear boxes we classify a limit value of 4.5 mm/s for alarm and 7.1 mm/s for trip as not critical independently of the manufacturer.

4.4 Generator Temperature Rise

The temperature rise of the generator will be guaranteed at 100% load and maximum cooling water temperature.

Applicable standards	:	IEC 34-1
Insulation class	:	F
Temperature rise stator within class	:	B

4.5 Standards, Codes and Regulations

The Standards, Codes and Regulations discussed in this Section serve as the basis for the technical specification of the systems and components forming part of this proposal. The latest applicable edition at the time of contract award of the following Standards, Codes, Regulations, Guidelines and Recommendation have been complied with. International as well as European harmonised Codes and Standards are applied as a good basis for systems and equipment design.

For equipment delivered by local Subcontractors local Standards and Codes shall apply. Design, engineering, production, fitting, and testing, are based on the appropriate German Standards, Codes and Regulation.

Technical rules are not only DIN Standards, but also documents published by other private-sector regulatory bodies and those legally binding provisions (laws, regulations, etc.) that contain technical specifications. The more important organisations that influence the standard works regarding the systems and components forming part of this proposal are listed below:

AD	Arbeitsgemeinschaft Druckbehälter (Association for Pressure Vessels)
CEN	Europäisches Komitee für Normung (European Committee for Standardisation)
DIN	DIN Deutsches Institut für Normung (German Institute for Standardisation)
DIN-ISO	DIN Deutsches Institut für Normung e.V. - Internationale Organisation für Normung (German Institute for Standardisation - International Organisation of Standardisation)
DruckbehV	Verordnung über Druckbehälter, Druckgasbehälter und Füllanlagen (Druckbehälterverordnung) (Regulation for Pressure Vessel, Vessels for Pressurecontainments and Filling Plants)
DVM	Deutscher Verband für Materialforschung und -prüfung e.V. (German Association for Material Research and Testing)
DVS	Deutscher Verband für Schweißtechnik e.V. (German Welding Association)
IEC	International Electrical Commission
SEP	Stahl-Eisen-Prüfblätter (Steel-Iron-Schedules of Testing)
SEW	Stahl-Eisen-Werkstoffblätter (Steel-Iron-Schedules of Materials)
TRD	Technische Regeln für Dampfkessel (Technical Rules for Steam Vessels)
VBG	Unfallverhütungsvorschriften der gewerblichen Berufsgenossenschaften (Industrial Co-operation for Provisions for Accident Prevention)
VDE	Verband Deutscher Elektrotechniker e.V. (Association of German electrical Engineers)

VDEW	Vereinigung Deutscher Elektrizitätswerke (Association of German Electrical Utilities)
VDI	Verband Deutscher Ingenieure (Association of German Engineers)
VDMA	Verband Deutscher Maschinen-und Anlagenbau e.V. (Association of German Machines and Plant Manufacturers)
VGB	Technischer Vereinigung der Großkraftwerksbetreiber e.V. (Technical Association of German Power Utilities)

In addition to the codes and standards issued by the organisations and associations mentioned above MAN TURBO has developed its own codes and standards. MAN TURBO's standards are based on the applicable sections of the more significant codes and standards listed above. Applying only such codes and standards could lead to a product less safe and suitable for the intended service, because most of these codes and standards have been developed for equipment other than turbine-generators. Therefore, MAN TURBO has added specialist knowledge based upon extensive research and development, and test results along with substantial experience in design, engineering and manufacturing to provide a product of the highest safety, quality, efficiency and an extended life cycle.

4.6 Start-up Time of Turbo-Generator

1. Temperature gradient at cold start-up

		MARC 2	MARC 4	MARC 6	MARC 8
Start-up to operating speed	:	7 K/min	6 K/min	5 K/min	4 K/min
Loading up to 35% of MCR	:	8 K/min	7 K/min	6 K/min	5 K/min
Loading 35% - 100% MCR	:	5 K/min	4,5 K/min	4 K/min	3,5 K/min

2. Turbine at service temperature

a) Rate of Load change

0 % - 35%	:	5 % per minute
35% - 100%	:	10 % per minute

b) Load jumps

Load jumps of 40% are possible with the turbine at service temperature in the range between 30% - 100% MCR. Further load jumps in same direction require an interval of 10 minutes.

3. Deviations in live steam temperature

Normal Service +/- 5 K
Exceptional cases +/- 10 K

4. Temperature gradient

Normal service < 5 K/min
Exceptional cases 10 K/min

5. Sudden fall of temperature Maximum 50 K

6. Note

Exceeding of the above mentioned values will not necessarily lead to damage. However, the life- time of the respective turbine parts will be influenced in relation to the number and value of exceeded conditions.