Reliance
Industries Limited
Growth is Life

PTA 5/6 OPERATION MANUAL

Process Air Compressor

(Document No. RIL_PTA-5/6_OPMAN-001)

(Revision 0)

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TABLE OF CONTENTS:

GLOSSARY:

1. BD: Bursting disc
2. CW: Cooling Water
3. DCS: Distributed Control System
4. DOR: Direction of rotation
5. DSS: Duplex Stainless Steel
6. ELP: Extra Low Pressure
7. FCV: Flow Control Valve
8. FI: Flow indicator
9. FO: Flow Orifice
10. FT: Flow Transmitter
11. GCU: Gas Control Unit
12. HP: High Pressure
13. HS: Hand Switch
14. LCV: Level Control Valve
15. LI: Level indicator
16. LP: Low Pressure
17. LS: Level Switch
18. LT: Level Transmitter
19. MCMS: Machine Condition Monitoring System
20. MOC: Material of Construction
21. MSDS: Material Safety Data Sheets
22. OD: Outer Diameter
23. P&ID: Process and Instrumentation Diagram
24. PCV: Pressure Control Valve
25. PFD: Process Flow Diagram
26. PI: Pressure indicator
27. PLC: Programmable Logic Control
28. PT: Pressure Transmitter
29. PTA: Purified Terephthalic Acid
30. RPM: Revolutions per minute
31. RV: Relief Valve
32. ST: Speed Transmitter
33. TCV: Temperature Control Valve
34. TI: Temperature Indicator
35. TT: Temperature Transmitter
36. VLP: Very Low Pressure
37. VRV: Vacuum Relief Valve

1. SCOPE

Scope of this manual covers compression of Process air in Compressor and conveying of Compressed Air to the Oxidation Reactor, HPCCU unit and First CTA crystallizer. The Compressor run on 3 drives namely, Steam Turbine, Process gas Expander and Motor. The scope covers submission of LP, ELP and VLP steam via the Inlet Knockout Drums to turbine to generate Power. It also covers submission of Compressed Process Offgas into the Expander to generate power.

The scope also covers the Suction Air Filter House, Lube oil system, Interstage Coolers, Steam Condensing unit and the condensate drainage and lifting system.

This operating manual covers PTA 5 plant. PTA 6 process being identical to PTA 5 with same tag numbers, a separate operation manual shall not be issued PTA 6.

2. REFERENCE DOCUMENTS

This manual should be read in conjunction with following documents –

- Typical PFD and Stream Summary (attached in Annexure A)
- Following Process P&IDs

10005-G41-GPZ105-00101 Sh. 1
10005-G41-GPZ105-00104 Sh. 1
10005-G41-GPZ105-00106
10005-G41-GPZ105-00302
10005-G41-GPZ105-00401

- Following Vendor P&IDs:
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-002
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-003
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-004
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-005
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-006
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-007
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-008
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-009
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-010
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-011
    - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-012

  - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-013
  - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-014
  - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-015
  - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-016
  - Man Diesel & Turbo SE: 10005-GPZ105-MS0S01-7342371-C02-017

- Following hazardous area classification drawing
  - 10005-E66-GPZ105-001

- Following Fire & Gas Layout P&IDs:
  - 10005-U23-GPA105-001
  - 10005-U23-GPA105-002

- Following additional vendor documents need to be referred
  - Cause and Effect Diagram “10005-GPZ105-MS0S01-7342371-C03-001-00”
  - Operating Instructions Part I – “10005-GPZ105-MS0S01-7342371-N02-008-00”
  - Control Philosophy - “10005-GPZ105-MS0S01-7342371-C04-001-01”
  - User Manual LCI – “10005-GPZ105-MS0S01-7342371-N02-005”,
  - SFC Water cooling Unit control Overview – “10005-GPZ105-MS0S01-7342371-C04-002”

- Standard Operating Conditions (attached in Annexure B)
- Alarm and trip schedule (attached in Annexure C)
- Chemical information sheet / MSDS (attached in Annexure D)

3. PROCESS DESCRIPTION

The Process Air Compressor, C5-113, supplies air to the Oxidation Reactor, D5-301 and First CTA Crystallizer, D5-401 for the conversion of Para xylene and intermediates to TA. Air enters the Compressor from atmosphere via the Inlet Air Filter, M5-112 and the Inlet Air Silencer, S5-114. Air passes through the inlet guide vanes which are adjusted by the Compressor pressure controller in order to achieve the required compressor discharge pressure.

In the first three stages of compression, pressure is raised and at the end of every stage, the air is passed to an Intercooler where it is cooled before passing to the next stage of compression. There is no intercooler between the fourth and fifth (final) stage of compression. In the fifth stage, pressure is raised to ~17 barg and ~155 degC with the final air temperature leaving the compressor controlled by the adjustment of the air bypass flow around the Third Stage Intercooler.
Air leaving the compressor fifth stage has several possible routes:

- Via the cooling air line to the Expander.
- Via the blow off route through blow off valve FCV-01107 and silencer S5- 115 to atmosphere
- Via Air Compressor Discharge Silencer S5-120 line to the Oxidation Reactor, and (a significantly lower flowrate) to the First CTA Crystallizer
- Via Air Compressor Discharge Silencer and then to the air bypass route to the Catalytic Combustor & Expander

The destination of air from the compressor is dependent on the operating mode of the system.

At start-up, due to the limited turn down of the compressor, air is discharged to atmosphere via the blow off valve. At this stage some air is also sent to the Expander via the air bypass route and the cooling air route to ensure some flow and hence cooling of the Expander. Following start-up of the machine train, it is no longer necessary to blow off air to atmosphere as air is recycled to the Expander to minimize the electrical power consumption of the machine train.

The PAC train consists of Compressor coupled with the Steam Turbine, C5-140 and the Offgas Expander, C5-155.

The Offgas Expander, C5-155 is a five stage, axial machine with load gearbox which is supplied as part of the overall machine train. Power is recovered from the PTA process by passing the majority of the Offgas, through the Offgas Expander after treatment in the Catalytic Combustor. The remainder of the Offgas not used for power recovery is used within the plant for conveying of PTA powder and as an inert gas medium. Power is recovered by passing the hot treated Offgas from the Catalytic Combustor through the Offgas Expander. In order to prevent corrosion due to "dewing out" of brominated compounds, the outlet temperature of the Expander must be kept above 90 degC whilst operating on Offgas. During start-up when no bypass air or Offgas from the Oxidation Reactor is available, cooling air is supplied from the Process Air Compressor direct to the Offgas Expander.

The Steam Turbine is designed as a single-casing axial type machine provided with three steam inlets (LP, ELP and VLP steam admission). The purpose of the Steam Turbine is to recover energy from plant generated steam in order to reduce the overall power requirements of the machine train. Knock-out drums are provided in the plant LP, ELP and VLP steam lines to the Turbine. These remove droplets of condensate that are present in the steam and prevent these droplets passing forward to the Turbine and causing excessive erosion. The condensation of the steam is carried out in Vacuum Condenser, E5-141.

At normal plant rates in conjunction with the additional power recovery from the Offgas Expander, the machine train will export power into the plant electrical distribution system. In the event of an Oxidation Reactor trip, plant LP, ELP and VLP steam production will reduce dramatically and immediately. Trip valves are provided to prevent rapid depressurization of the steam raisers. Small flow of LP steam continues to be provided through the start-up route as cooling steam to prevent possible damage to the rotor. VLP steam continues dependent upon the status of the purification plant. Once the plant has been re-stabilized following a reactor trip any available steam is fed to the steam turbine.

A dedicated Lube Oil System is also provided for lubrication in bearings and other lubrication points of the machines.

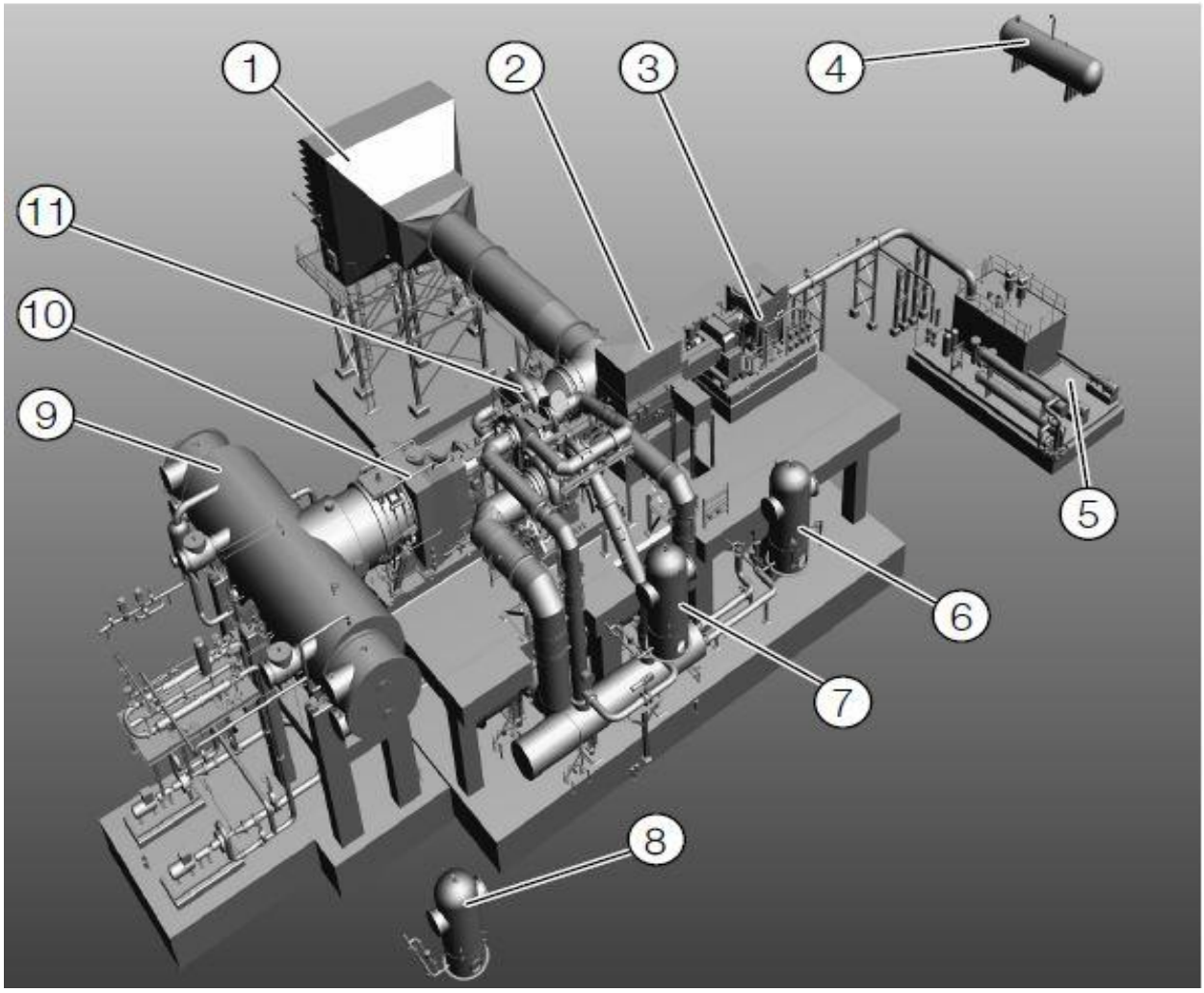


Figure 3.1 – Compressor House Overview (3D View)

1: Filter house, S5-114
2: Motor-generator, M5-113
3: Expander, C5-155
4: Oil rundown tank, F5-124
5: Oil system
6: LP Steam Knockout pot, FS-147
7: VLP Steam Knockout pot, FS-149
8: ELP Steam Knockout pot, FS-148
9: Condensing unit
10: Steam turbine C5-140
11: Compressor C5-113

4. EQUIPMENT LIST

ITEM No.	DESCRIPTION
M5-112	Inlet Air Filter
C5-113	Process Air Compressor
M5-113	Motor Generator
S5-114	Air Compressor Inlet Silencer
S5-115	Air Compressor Blow off Silencer
E5-116	1st Interstage cooler
E5-117	2nd Interstage cooler
E5-118	3rd Interstage cooler
L5-119A/B/C	Air compressor lube oil Heater
S5-120	Air Compressor Discharge Silencer
F5-121A/B	Lube oil Accumulator
E5-122A/B	Lube oil Cooler
F5-123	Air Compressor Lube Oil tank
F5-124	Lube oil Overhead tank
G5-125A/B	Lube Oil Pump
C5-126A/B	Lube oil Demister fan
M5-127A/B	Lube oil Demister
M5-128A/B	Lube oil Filter
M5-129	Air Compressor lube oil Conditioner
G5-131	Wash water pump
G5-134A/B	Air Compressor Jacking Oil pump
A5-135	Intercooler Condensate Pit
G5-136	Intercooler Condensate pump
C5-140	Steam turbine
E5-141	Steam turbine condenser
G5-142A/B	Steam turbine condensate pump
E5-143A/B	Steam turbine ejector interchanger
G5-144A/B/C	Condensate Pumping traps
F5-147	LP steam knockout pot
F5-148	ELP steam knockout pot
F5-149	VLP steam knockout pot
H5-150A	Steam turbine ejector (1st stage main)
H5-150B	Steam turbine ejector (1st stage secondary)
H5-151A	Steam turbine ejector (2nd stage main)
H5-151B	Steam turbine ejector (2nd stage secondary)
H5-152	Steam turbine hogging ejector
S5-153	Steam ejector blow-off silencer
F5-154	Steam Condensate drain collection tank
E5-2234	Feed water recycle cooler

5. EQUIPMENT DESCRIPTION

5.1 Suction Air Filter, M5-112

5.1.1 General Information

The Suction Air Filter, M5-112, located in the suction line of the PAC is used to filter out the atmospheric dust from the Air. It has a total filtration area of 11232 m3. The main filtration element consists of filtration Candles (Conical and Cylindrical) which are arranged horizontally and are provided with time based self-cleaning (Pulse Jet type). Instrument Air is used for online cleaning of the cylindrical / conical filter elements. 4 nos. of Dust Removal fans are provided for knocking down accumulated dust from the Filter house. It is also provided with Inlet Silencer, S5-114 downstream of the filter elements.

The carryover of dust particles is harmful for the operation of the compressor unit and will result in high vibration of the compressor stages. Hence, it is important to monitor the cleaning of the air filter elements provided.

Additional equipment details are provided below:

- Operation Mode: Continuous
- Gas handled: Atmospheric Air
- Gas Flowrate: 523086 m3/hr
- Operating Pressure (Inlet/Outlet): 1.005 atm/ 0.999 atm
- Operating Temperature (normal/min/max): 33 degC/ 5.6 degC/ 45 degC
- Solids to be separated: Atmospheric Dust
- Differential Pressure: 0.0019 bar (Clean) by max. flow rate (High Alarm at 0.01 bar)
- Maximum Design Pressure drop across filter elements: 0.03 bar
- Filter Superficial Velocity: less than 0.13 m/s
- Element Efficiency: minimum 97% of particles of 1 micron
- Noise level at 1m: 85 dB(A)
- Number of Filtration stages: 1
- Inlet arrangement: Horizontal
- Filter model: CO-2612 + CY2612
- No. of Conical Filters: 240
- No. of Cylindrical Filter elements: 240
- Cleaning System: Self Cleaning Pulse Jet
- Cleaning Air (Pressure/Temperature/Flowrate): 5.4 to 6.4 barG/ 35degC/ 80 kg/hr
- Dust Removal Fans (Type/Nos./Motor Power) : Axial type/ 4 nos./ 3.7 kW per motor
- Silencer (Type/Orientation): Absorption type/Horizontal
- Silencer Design Pressure/Temperature: 0.025 bar differential/ 80 degC

- Weight (Filters/Silencer/Housing/Total Installed): 3920kg/ 5000kg/ 12000kg/ 45000kg
- Dimensions for Filter (one element) CO 2612: 445(dia) mm x 334(dia) mm x 660(length) mm
  Dimensions for Filter (one element) CY 2612: 324(dia) mm x 324(dia) mm x 660(length) mm
- Dimensions for Silencer: 5355 mm x 3000 mm x 3000 mm
- Overall Dimensions: 22090 mm x 10460 mm x 15310 mm

5.1.2 Instrumentation and Control

PDIA-01101 gives the Suction filter Differential pressure with High High and High alarm

5.1.3 Trips and Alarms

For Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.2 Process Air Compressor, C5-113

5.2.1 General Information

Compressor C5-113 is a five-stage multi-shaft centrifugal compressor with three intercoolers, E5-116, E5-117 and E5-118, in between the stages. E5-116 is the 1st stage intercooler between 1st and the 2ndstage. E5-117 is the 2nd stage intercooler between 2nd and the 3rd stage. E5-118 is the 3rd stage intercooler between the 3rd and the 4th stage. E5-118 is provided with a TCV in the bypass for temperature control. Intercoolers are provided for increasing the compressor Efficiency.

The compressor is provided with a Blow off valve FCV-01107 (Anti Surge Control valve) for flow control through the compressor at the 5th stage discharge. Also, Blow off flap valve FV-01158 is provided at 3rd stage discharge. Both the blow-offs are vented to atmosphere via Air Compressor Blow off Silencer, S5-115.

The normal rated flow through C5-113 is 379.23 m3/hr. (corresponding mass flow is 490 TPH). The flow to the compressor is controlled by the Inlet Guide Vane (IGV) opening. The nominal inlet and discharge (5th stage discharge) rated Pressure are 0.99bara and 18.3 bara. The Inlet and Outlet (5th stage) temperatures are 45 degC (max) and 153 degC.

The Process Air Compressor is driven by an electric motor (which can also act as a generator), Steam Turbine and an Expander. The motor will act as the Drive for the compressor at the start-up when there is no steam and Offgas generation from the process respectively. Once the plant is in operation, there is

steam and Process Offgas generation to run the Turbine and Expander and hence the Compressor will then be driven by the Steam Turbine and Expander. Also, at full capacity, there is excess generation of Power and the motor will act as a generator.

The compressor compresses the process gas by transmitting mechanical energy in the form of a swirl momentum. After an incremental increase in pressure in the individual compressor stages, the process air enters the downstream process (D5-301, D5-401 and HPCCU unit) at the specified discharge pressure via Air Compressor Discharge Silencer, S5-120.

Equipment details for C5-113 are as follows:

		Guarantee	**Rated**	**Start-Up**	**Turndown**
Normal Volume Flow	*N m³/h*	344.407	379.235	241.472	216.534
Mass Flow	*te/h*	445	490	312.000	279.778
INLET CONDITIONS					
Nominal Pressure	*bara*	0.999	0.999	0.999	0.999
Corrected Pressure	*bara*	0.99	0.99	0.99	0.99
Temperature	*°C*	33	45	12	33
Relative Humidity	*%*	87	60	87	87
Molecular Weight	*kg/kmol*	28.48	28.32	28.83	28.48
Compressibility factor at suction		0.9996	0.9997	0.9997	0.9996
Inlet Volume Flow	*m³/h*	413.224	479.836	261.127	259.800
Cp/Cv at suction		1.398	1.397	1.402	1.398
DISCHARGE CONDITIONS					
Corrected Pressure	*bara*	17.3	18.3	16.8	16.8
1st Stage	*°C*	121	145	89	109
2nd Stage	*°C*	120	120	127	128
3rd Stage	*°C*	106	105	112	113
4th Stage	*°C*	108	107	105	108
5th Stage	*°C*	154	153	161	165
PERFORMANCE					
Maximum Power Required	*kW*	45.092	51.252	33.229	31.094
kW/100 m³/h Air Delivered		13.09	13.51	13.76	14.36
Input Speed	*RPM*	100%	100.30%	100%	100%
Estimated Surge (At Above Speed)	*m³/h*	240.000	270.000	205.000	225.000

For additional equipment details refer ***vendor datasheet "Process Air Compressor datasheet – 10005-GPZ105-MS0S01-7342371-D01-001-02"***

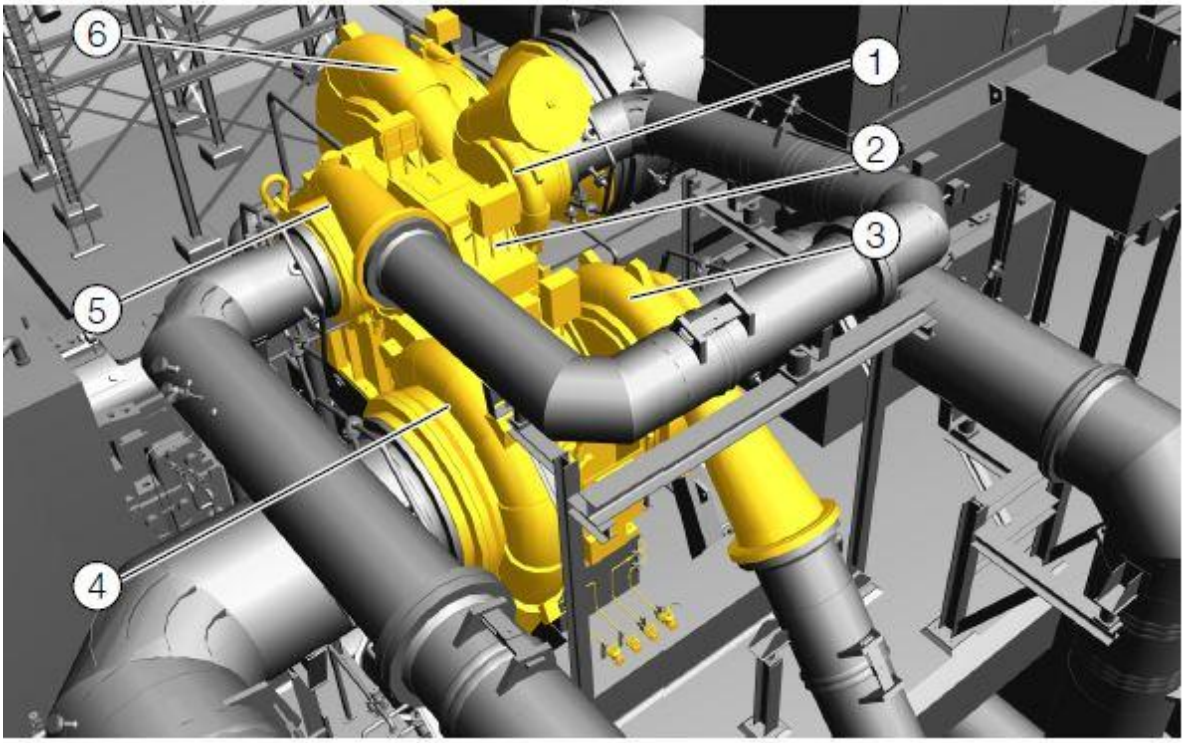


Figure 5.2.1.1 3D view of Compressor showing various stages

1: Compressor Stage 5
2: Compressor Gear unit
3: Compressor Stage 3
4: Compressor Stage 2
5: Compressor Stage 4
6: Compressor Stage 1

5.2.2 Instrumentation and Control

The 1st stage compressor Inlet Guide Vane opening is indicated in the DCS by GI-01102.

The flow in the Blow off (Compressor Anti-surge control) line is measured and indicated on DCS by FI-01107

The compressor Discharge pressure is measured by PT-01104 and indicated on DCS by PIA-01104 with a Low level alarm. The compressor Discharge temperature is measured by TT-01114 and indicated on DCS by TIA-01114 with High and Low alarm.

The compressor Discharge flow is measured by FT-01103 and indicated on DCS by FICA-01103 (with Low alarm) via FY-01103. FICA-01103 gives signal to FCV-01103 to control the flow to HPCCU unit.

FY01103 takes Input from FT-01103, PIA-01113 and TIA-01114 to calculate the pressure and temperature corrected flow. It gives output to FICA-01103.

The differential pressure between the PAC common discharge Pressure (PT-01113) and pressure on the 'Process Air to D5-301' common line (PT-03244) is indicated on DCS by PDSA-01120 with a low alarm.

For additional instrumentation in vendor scope, please refer corresponding vendor P&IDs.

5.2.3 Trips and Alarms

TRIP SYSTEM Z-150

1. PURPOSE / BACKGROUND
Z-150 provides the protective logic for the Process Air Compressor and the machine train, including the Expander.

2. RELATED SYSTEMS

- Z-111 D5-301 Oxidation Reactor trip
- Z-129 C5-140 Steam Turbine trip
- Z-175 D5-167 CCU trip
- I-120 Valve position check for Z-111 Oxidation Reactor trip

3. DESCRIPTION OF OPERATION

3.1. Initiators
The following initiators are external to the machine train and interface with Z-150 as shown on the logic diagram. (All the initiators for Z-150 that are required to protect the machine train in vendor scope are covered in vendor document)

- Z-129 C5-140 ELP Steam PCV closing alarm (XSA-01127)
- Z-129 C5-140 VLP Steam PCV closing alarm (XSA-01128)
- Z-111 D5-301 Oxidation Reactor trip (XSA-01119A&B)
- PDY-01120 Low differential pressure: C5-113 PAC to Reactor overheads from Z-111

3.2. Control and permissive signals

- HS-01116A Local open/close hand switch for XSV-01116
- HS-01116B DCS open/close hand switch for XSV-01116
- TICA-01608 DCS output to TCV-01608 must be 0% to permit PAC to start

3.3. Outputs
The machine train vendor will identify all the outputs for Z-150 that are required to protect the machine train; the following outputs are external to the machine train and interface with Z-150 as shown on the logic diagram.

- Z-111 D5-301 Oxidation Reactor trip including closure of air sparger valves in less than 2 seconds
- Z-175 D5-167 CCU trip to close the D5-301 Reactor air bypass route
- PCV-22119A Close LP Steam pressure control valve via SOV-22119A
- Z-129 C5-140 Machine Train trip to set HS-22119A to manual, 0% output
- Z-129 C5-140 Turbine trip to set HS-22119A to manual, 0% output
- PCV-22202 Close ELP Steam pressure control valve via SOV-22202
- Z-129 C5-140 ELP Steam line trip to set HS-22202 to manual, 0%
- PCV-22204A Close VLP Steam pressure control valve via SOV-22204A
- Z-129 C5-140 VLP Steam line trip to set HS-22204A to manual, 0% output
- XSV-01116 Close block valve, C5-113 PAC air discharge to D5-301 Reactor via ESD input to valve actuator (maintained signal).
- XSV-01116 Close block valve, C5-113 PAC air discharge to D5-301 Reactor via pulsed input to valve actuator.
- XSV-01116 Open block valve, C5-113 PAC air discharge to D5-301 Reactor via pulsed input to valve actuator.
- I-120 Valve position check for Z-111 Oxidation Reactor trip
- FICA-01701 Set controller to manual, 0% output (configured in the DCS as a one-shot action after a delay of 10 minutes)

3.4. Logic Operation

The initiator from Z-111 comprises two digital signals (XSA-01119A and XSA-01119B); both of these signals must be unhealthy before any action is taken by the vendor's trip system. If only one signal goes unhealthy then the vendor's trip system will initiate a DCS alarm via the serial link. XSV-01116 may be opened and closed using either the local hand switch HS-01116A or the DCS hand switch HS-01116B for normal operation. XSV-01116 is also closed by Z-150 in the event of a machine train trip, or by Z-111 in the event of low differential pressure between the PAC and the Reactor overheads. The valve actuator shall have a separate connection for the close signal from the ESD system, such that the local and DCS hand switches are overridden when the valve is required to close by Z-150 or Z-111. The trip signal to close XSV-01116 shall be effective regardless of the position of any operator-accessible switch on the valve actuator. If it is a standard feature of the valve actuator, the motor thermal overload protection shall be bypassed when the valve is closed by the ESD system; the thermal overload protection shall be active at all other times. Following a trip, the valve will remain closed, until HS-01116A or HS-01116B is used to open the valve.

For additional details on Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.3 Steam Turbine, C5-140

5.3.1 General Information

C5-140 is a single-casing horizontally split condensing steam turbine. It is a nine stage (3-3-3) axial type turbine. It utilizes various levels of steam produced in the plant (LP / ELP / VLP) to recover power. LP, ELP and VLP steam are knocked out in Knockout drums (F5-147, F5-148 and F5-149 respectively) to remove any condensate in the steam before admitting to the turbine. LP and VLP steam are admitted from the top of the turbine casing, whereas ELP steam is admitted from the bottom.

The steam turbine depressurizes high-energy steam, thus converting thermal energy into mechanical energy. The mechanical energy generated by the steam turbine is used to drive compressor C5-113 and generator-motor M5-113.

The turbine is provided with steam for sealing to prevent any entry of air into the steam turbine and is to be in operation until the vacuum prevails in the machine. Seal steam control valve PCV 01459 regulates seal steam pressure and flow to the steam turbine to the specified values.

		Guarantee	Rated		Start-Up	Turn down	Trip
STEAM CONDITIONS	**Units**		**(Rated steam 4.4 bara)**	**LP at 5.1 bara**			**Reactor trips**
LOW PRESSURE (LP) STEAM - INLET							
Flowrate	te/h	122	160	197	25	98	25
Inlet Pressure	Bara	4.4	4.4	5.1	4.4	4.4	4.4
Inlet Temperature	°C	147	147	153	147	147	147
EXTRA LOW PRESSURE (ELP) STEAM – ADMISSION							
Flowrate	te/h	143	144	119	0	91	0
Inlet Pressure	Bara	2.9	2.9	2.9	-	2.9	-
Inlet Temperature	°C	132	132	132	-	132	-
VERY LOW PRESSURE (VLP) STEAM – ADMISSION							
Flowrate	te/h	69	73	59	0	45	37
Inlet Pressure	Bara	1.1	1.1	1.1	-	1.1	1.1
Inlet Temperature	°C	102	102	102	-	102	102
EXHAUST							
Flowrate	te/h	334	377	375	25	234	62
Pressure	Bara	0.102	0.110	0.109	0.064	0.084	0.068
Temperature	°C	46.2	47.7	47.5	37.5	42.7	38.5
PERFORMANCE							
Shaft Power Output	kW	36.30	42.048	43.91	1.20	24.69	2.30

Shaft Speed (Normal)	Rpm	3021	3021	3021	3021	3021	3021
Mechanical Design Power	kW	48.5					
Shaft Power Output	kW	36.31					
Steam Rate	kg/kW.hr	92	90	85	208	95	270

For additional equipment details refer ***vendor datasheet "Steam Turbine datasheet – 10005-GPZ105-MS0S01-7342371-D01-015-02"***

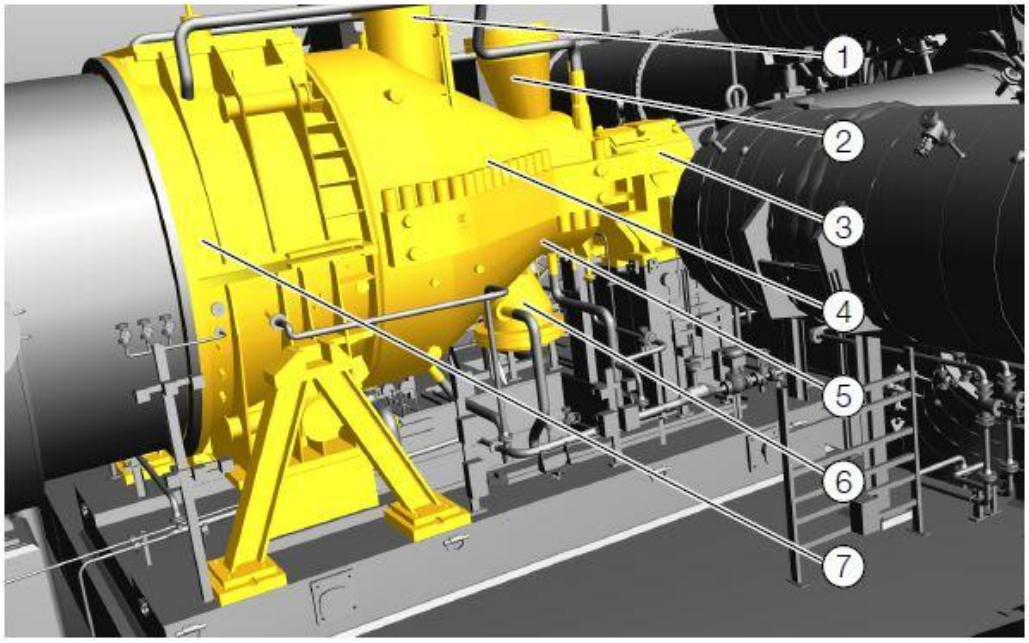


Figure 5.3.1.1 Steam turbine

1: ELP injection steam nozzle
2: LP live-steam nozzle
3: Bearing housing
4: Casing upper part
5: Casing lower part
6: VLP injection steam nozzle
7: Exhaust steam casing

5.3.2 Instrumentation and Control

The steam turbine speed indication on DCS is given by SI-01415 with High High, High, Low and Low Low alarm.

The steam turbine Exhaust Casing pressure indication on DCS is given by PI-01404 with High High and High alarm. The steam turbine Exhaust Casing temperature indication on DCS is given by TI-01405 with High High and High alarm

For additional instrumentation in vendor scope, please refer corresponding vendor P&IDs.

5.3.3 Trips and Alarms

TRIP SYSTEM Z-129

1. PURPOSE/BACKGROUND

Z-129 protects the Steam Turbine, C5-140, against carryover of either Boiler Feed Water or Steam Condensate. High level trips in the Third Reactor Condenser E5-305; Fourth Reactor Condenser E5-306; First Crystallizer Condenser E5-430; ELP Steam Flash Drum F5-2209; or the VLP Steam Drum F5-1444 initiate the trip. The trip differentiates between high levels in the ELP and VLP systems. If the high level is in the ELP system, the Turbine inlet ELP steam valve is closed; if the high level is in the VLP system then the Turbine inlet VLP steam valve is closed. A high level in the LP steam knockout pot is an input to the vendor supplied machine train trip, Z-150. All steam pressure control valves are closed directly by the Z-150 trip system via their solenoid valves; this trip system sets the associated DCS hand switches to manual mode with 0% output.

2. RELATED SYSTEMS

- Z-150 Process Air Compressor, C5-113
- I-337 Air/Offgas depressurization

3. DESCRIPTION OF OPERATION

3.1. Initiators

- LSS-03306 HH level in E5-305 shell side (ELP)
- LSS-04303 HH level in E5-430 shell side (ELP)
- LSS-22513 HH level in F5-2209 condensate flash drum (ELP)
- LSS-03436 HH level in E5-306 shell side (VLP)
- LSS-14322 HH level in F5-1444 steam drum(VLP)
- Z-150 C5-113 machine train trip (XSA-01111)
- Z-150 C5-140 turbine trip (XSA-01126)
- Z-150 C5-140 ELP steam line trip (XSA-01124)
- Z-150 C5-140 VLP steam line trip (XSA-01125)

3.2. Outputs

3.2.1. Trip actions

- Z-150 ELP valve closing alarm to vendor trip system (XSA-01127)
- Z-150 VLP valve closing alarm to vendor trip system (XSA-01128)

- I-337 Enable air and Offgas depressurization valves

3.2.2. Trip 'tidy up' actions

- HS-22119A Set Auto/Manual station for PCV-22119A to manual, 0%
- HS-22202 Set Auto/Manual station for PCV-22202 to manual, 0%
- HS-22204A Set Auto/Manual station for PCV-22204A to manual, 0%

3.3. Logic operation

In the event of a C5-113 machine train trip or C5-140 turbine trip, LP Steam valve PCV-22119A is closed by the Z-150 trip system and its associated auto/manual station HS-22119A is set to manual with 0% output. The machine train trip also enables the air and Offgas depressurization valves via interlock I-337.

The operation of any ELP steam system initiator shall trip PCV-22202 (ELP steam to C5-140) valve closed via the Z-150 trip system and shall set the associated auto/manual station (HS-22202) to manual with 0% output. No reset facility is required. On loss of the high level and the Z-150 trip system returning to the healthy state, the operator is permitted to open the valves (via the controller faceplates).

The operation of any VLP steam system initiator shall trip PCV-22204A (VLP steam to C5-140) valve closed via the vendor's trip system and shall set the associated auto/manual station (HS-22204A) to manual with 0% output. No reset facility is required. On loss of the high level and the Z-150 trip system returning to the healthy state, the operator is permitted to open the valves (via the controller faceplates).

For additional details on Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.4 Offgas Expander, C5-155

5.4.1 General Information

Offgas Expander, C5-155 is a five-stage axial expander having a radial inlet and outlet. The expander recovers energy from the hot treated Off-gas, which is supplied from oxidation reactor overhead system via HPCCU. The mechanical energy generated by the expander is used as drive power for the machine train. During start-up when no bypass air or Offgas from the Oxidation Reactor is available, cooling air is supplied from the Process Air Compressor direct to the Offgas Expander.

Additional equipment details are listed below:

PROCESS MATERIAL		**OFF-GAS**				**AIR**		
				Plant Turndown	**Max. Operation Temp.**	**Start-Up**		**Reactor Tripped**
		Guarantee	**Rated**			***Case A**	***Case B**	
INLET CONDITIONS								
Inlet Volume Flow (Actual)	A m³/h	56.206	61.588	38.316	57.776	46.800	52.728	66.248
Inlet Mass Flow	te/h	314	356	206	314	312	312	392
Nominal Pressure	Bara	10.4	10.8	10	10.8	10.8	10.8	10.8
Temperature	°C	360	360	360	400	290	360	360
DISCHARGE CONDITIONS								
Nominal Pressure	Bara	1.1	1.1	1.1	1.1	1.1	1.1	1.12
Temperature	°C	95	94	113	117	51	91	101
PERFORMANCE								
Maximum Power Output	kW	24.360	27.750	14.880	26.137	21.030	23.890	28.950
Output Speed	rev/min	4963	4963	4963	4963	4963	4963	4963

*-Case A: No heating in the HPCCU; Case B: Heating in HPCCU

For additional equipment details refer *vendor datasheet "Offgas Expander datasheet – 10005-GPZ105-MS0S01-7342371-D01-016-00"*

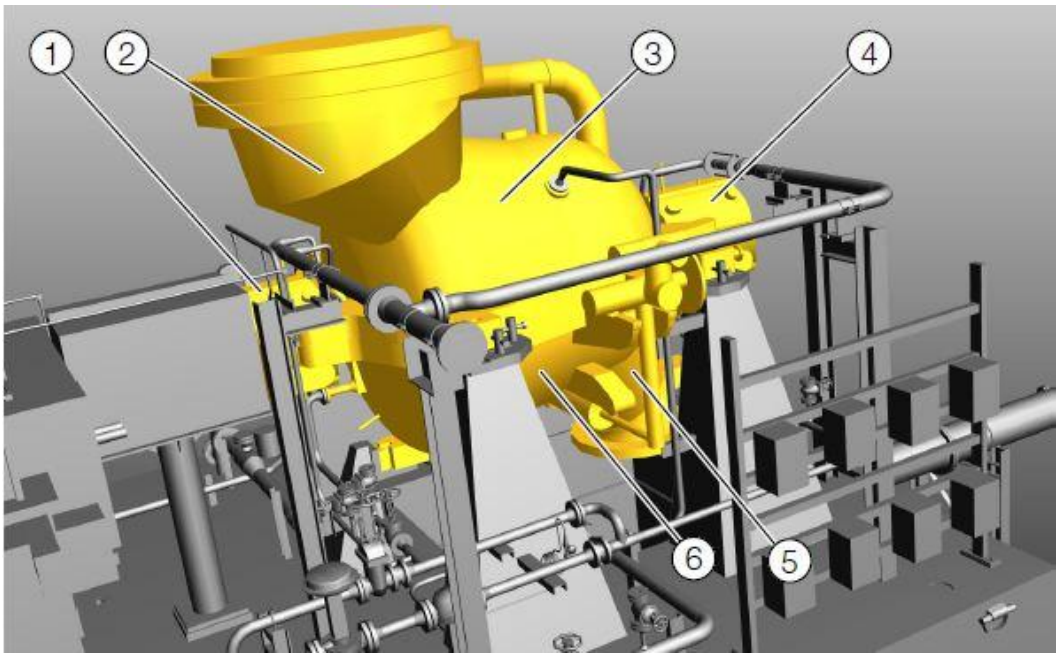


Figure 5.4.1.1 Offgas Expander

1: Bearing Housing
2: Inlet Nozzle
3: Casing Upper Part
4: Bearing Housing
5: Outlet Nozzle
6: Casing Lower part

5.4.2 Instrumentation and Control

Air/Offgas pressure at Expander inlet is indicated on DCS by PI-01171A/B/C, whereas at Expander exhaust it is indicated by PI-01109 provided with a high alarm

Air/Offgas temperature at Expander inlet is indicated on DCS by TI01115. Air/Offgas temperature at Expander exhaust is indicated on DCS by TI-01108 with a High and Low alarm indicated by TI-01108D.

Moisture measurement in Air/Offgas from expander outlet to D5-172 is indicated on DCS as AT01121 with High and Low alarm. Expander IGV opening is indicated on DCS as GI-01117

For additional instrumentation in vendor scope, please refer corresponding vendor P&IDs

5.4.3 Trips & Alarms

For Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.5 Lube Oil System

5.5.1 General Information

The lube oil system supplies the necessary lube oil and jacking oil. The lube oil cools and lubricates the bearings and other lubricating components of the machine unit which are supplied with lube oil, reduces corrosion effects and minimizes wear of the machine bearings. Jacking Oil is supplied to the Steam Turbine Rotor, Compressor Bull gear, Expander Bull gear and Motor Rotor during start up until hydrodynamic lubrication is achieved. It raises the shafts in the machine bearings at a high pressure to overcome the break-away torque and to minimize wear.

After shutdown/trip of the machine train, the oil system must remain in operation. The machine bearings must be supplied with oil until no more heat is dissipated from the insides of the machine casings through the shaft ends and into the bearings.

The entire oil system is designed for closed circulation which is maintained by oil pumps. The MOC for oil piping is SS316L. The lube oil supply and return temperatures are 45 degC and 67 degC respectively.

The Lube oil system comprises if the following sub-assemblies:

Lube Oil reservoir, F5-123
Lube Oil reservoir F5-123 holds the oil required by the machine unit components. During its dwell time in the reservoir the oil calms down, allowing the trapped air to escape. This air is discharged by the oil mist separator.

Additional equipment details for Lube Oil Reservoir, F5-123 are as provided under:

- Working Capacity: 17750 liter
- Retention Capacity: 28400 liter
- Normal Operating Capacity: 3550 liter
- Charge capacity: 5400 liter
- Tank Dimensions (L x W x H): 6m x 3.8m x 3m
- MOC: SS304L

Oil heater, L5-119A/B/C
Oil heater L5-119A/B/C heats the oil to the required start-up temperature before the machine train is started up. It also maintains the oil temperature in the set-point range while the machine train is at standstill.

Oil mist separator, M5-127A/B
Oil mist separators M5-127A/B are mounted on the oil reservoir and consists of a vacuum pump with electric drive motor C5-126A/B and a filter. The two oil mist separators are run alternatingly to balance their operating periods.
The oil mist separator serves the following purposes:

- Generation of a negative pressure in the oil reservoir and in the oil return lines to prevent any escape of oil mist at bearing points and coupling guards
- Expulsion of trapped gas from the returning oil to prevent spreading of an explosive atmosphere

If the first oil mist separator should fail, the standby oil mist separator generates the negative pressure that is required.

***Oil centrifuge,* M5-129**
Oil centrifuge M5-129 cleans the oil to remove any impurities and thus maintain the oil quality.

Lube Oil pumps, G5-125A/B
The oil system has two equivalent oil pumps G5-125A/B. The active oil pump delivers the oil pressure that is required by the machine unit components during normal operation. The inactive (standby) oil pump delivers the oil pressure that is required if the first oil pump should fail (Auto-start). The pump operates with pressure control via PCV-01362 to circulate oil back to the Lube Oil Tank in addition to the forward flow.

Additional equipment details for Lube Oil Pump, G5-125A/B are as provided under:

- Pump type: Screw (Horizontal)
- Capacity: 4774 liter/min
- Discharge Pressure (Normal/Maximum): 8.5/ 12 barG
- Design/Test Pressure: 12/18 barG
- Design Temperature: 100 degC
- Drive Motor Installed/ Maximum absorbed power: 132 kW/ 130kW
- Drive Motor speed: 1490 rpm
- MOC (Casing/Screw): CS/ 16MnCrS5 Nitritied 55HRC

Jacking oil pump, G5-134A/B
Jacking oil pump G5-134A/B provides high oil pressure to jack up the shaft in the machine bearings before start-up and during shut-down of the machine train in order to overcome the break-away torque during start-up more easily and to reduce wear. This will be the case whenever the rotors of the machine train rotate at a speed between 0 and 800 rpm. The Jacking oil pump will stop automatically when Turbine shaft speed (SI-01415) climbs over 800 rpm.

Additional equipment details for Jacking Oil Pump, G5-134A/B are as provided under:

- Pump type: Gear
- Capacity: 56.9 liter/min
- Discharge Pressure (Normal/Maximum): 180barG / 210 barG
- Design Temperature: 100 degC
- Drive Motor Installed/ Maximum absorbed power: 30 kW/ 24kW
- Drive Motor speed: 1450 rpm
- MOC (Casing/Gear): GGG/ Spheroidal graphit iron

Lube Oil overhead tank, F5-124

Oil also flows to the Overhead Lube Oil Tank, F5-124, which acts as an emergency reservoir for oil. The tank is maintained full by a continuous overflow back to the Compressor Oil Tank and is elevated, such that it can feed the lube oil system by gravity in the event of a loss of electrical power or multiple lube oil pump failure (which will trip the machine train on low lube oil pressure) to prevent bearing damage as the machine runs down.

The material of construction for the tank is SS304L.

Additional equipment details for Overhead tank, F5-124 are as provided under:

- Type: Cylindrical, Horizontal
- Pressure: Atmospheric
- Capacity: 17000 liter
- Capacity for: 20 min
- Dimensions: 1800 mm (dia) x 7200 mm (TT)

Bladder accumulator, F5-121A/B

Bladder accumulator F5-121A/B buffers the oil pressure when the oil pumps are switched over. It is constructed of SS316L.

Additional equipment details for Accumulator, F5-121A/B are as provided under:

- Type: Bladder
- Capacity: 2 x 450 liter
- Design Pressure: 12 barG

Double oil cooler, E5-122A/B

The water-cooled double oil cooler E5-122A/B cools the oil. The double design allows changeover of cooling during operation. The material of construction for tubes, tube sheets and Shell is Admiralty brass, Naval brass and CS respectively.
Cooling water is used for cooling the lube oil. The normal required flowrate of cooling water is 396 m3/hr. The supply and Return water temperature are 34degC and 39degC respectively.

Additional equipment details for Lube Oil Coolers, E5-122A/B are as provided under:

- Exchanger type: Shell and Tube
- Tube side fluid:
- Shell side fluid:
- Shell side Design Temperature/ Design Pressure: 100 degC/ 12 barG
- Tube side Design Temperature/ Design Pressure: 100 degC/ 7 barG
- TEMA class: AEW
- Number of passes: 2
- Heat Duty: 2298 kW
- Tube water velocity: 1.73 m/s
- Fouling factor (water side/ oil side): 0.0004/ 0 m2K/W

Oil filter, M5-128A/B

Double oil filter M5-128A/B filters the circulating oil to remove dirt particles. The cross-filter differential pressure instrument monitors the degree of filter fouling. If the set limit value is reached, the monitoring system triggers an alarm. The double filter design makes it possible to change over filtering during operation.

The filter shell and Filter elements are made of CS and Glassfibre respectively.

Additional equipment details for Lube Oil Filters, M5-128A/B are as provided under:

- Filter type: Cartridge, Duplex
- Capacity: 4000 liter/min
- Micron size (Nominal/Absolute): 10/15
- Pressure drop (Clean/Fail): 0.3 bar/1 bar

For additional details of equipment in lube oil system, refer vendor document ***"10005-GPZ-105-MS0S01-7342371-D01-025 – PAC Lube Oil System 5,6-193 Technical Datasheet"***

5.5.2 Instrumentation and Control

For instrumentation and control in vendor scope, please refer corresponding vendor P&IDs

5.5.3 Trips and Alarms

For Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.6 Knockout Pots, F5-147, F5-148 & F5-149

5.6.1 General Information

Knock-out drums F5-147, F5-148 and F5-149 are used to knock out liquid from LP, ELP and VLP steam respectively, inlet to the steam turbine. This ensures that no liquid droplets can get into the steam turbine and thus prevent any damage to the turbine blades due to erosion. The Knock-out drums are positioned upstream of the pressure control valves in the respective steam mains. This positioning is to ensure the Knock-out drums are always operating at constant pressure and above vacuum. The Knock-out drums F5-

147, F5-148 and F5-149 are designed as vane separators.

Additional equipment details for F5-147 are listed below:

- Operation mode: Continuous
- Operating Fluid: LP steam/ Condensate
- Operating Temperature : 147.2 °C
- Operating Pressure (Normal/ maximum) : 3.4 barg/ 4.1 barg
- Design Pressure/ Temperature: 5.5 barG and Full Vacuum/ 185 degC
- Flow rate (Rated/ Maximum): 160 TPH/ 197 TPH
- Vessel Capacity (Gross/High level/ Low level): 10.223 m3/ 2.77 m3/ 1.393 m3
- Outside Vessel diameter: 1900 mm
- Head type: Torispherical heads
- MOC for Shell, Heads: ASTM SA 516 Gr.60
- Weight installed full of water: 17569 kg
- Dimensions (L x W x D): 5280 mm x 2325 mm x 2600 mm.

Additional equipment details for F5-148 are listed below:

- Operation mode: Continuous
- Operating Fluid: ELP steam/ Condensate
- Operating Temperature : 132 °C
- Operating Pressure (Normal/ maximum) : 1.9 barG
- Design Pressure/Temperature: 5.5 barG and Full Vacuum/ 185 degC
- Flow rate (Rated/ Maximum): 144 TPH/ 144 TPH
- Vessel Capacity (Gross/High level/ Low level): 10.223 m3 (full)/ 2.77 m3/ 1.393 m3
- Outside Vessel diameter: 1900 mm
- Head type: Torispherical heads
- MOC for Shell, Heads: ASTM SA 516 Gr.60
- Weight installed full of water: 17569 kg
- Dimensions (L x W x D): 5280 mm x 2325 mm x 2600 mm

Additional equipment details for F5-149 are as provided under:

- Operation mode: Continuous
- Operating Fluid: VLP steam/ Condensate
- Operating Temperature : 102 °C
- Operating Pressure (Normal/ maximum) : 0.1 barG
- Design Pressure/Temperature: 5.5 barG and Full Vacuum/ 185 degC
- Flow rate (Rated/ Maximum): 73 TPH/ 73 TPH
- Vessel Capacity (Gross/High level/ Low level): 10.223 m3 (full)/ 2.77 m3/ 1.393 m3
- Outside Vessel diameter: 1900 mm
- Head type: Torispherical heads
- MOC for Shell, Heads: ASTM SA 516 Gr.60

- Weight installed full of water: 17569 kg
- Dimensions (L x W x D): 5280 mm x 2325 mm x 2600 mm

5.6.2 Instrumentation and Control

Level for knockout pots F5,147, F5-148 and F5-149 is indicated on DCS as follows

- LA-01424 ST VLP-stage admission knockout pot with HIGH alarm
- LA-01418 ST ELP-stage admission knockout pot with HIGH HIGH and High alarm
- LI-01414 ST live steam water knockout pot with HIGH HIGH and High alarm

5.6.3 Trips and Alarms

*For Trips and alarms refer the vendor document - **Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.7 Steam Condensing and Ejector System

5.7.1 General Information

The condensing unit is a combined set of different subsystems. The condensing unit boosts the performance of steam turbine C5-140 by expanding the operating steam below atmospheric pressure. The lower the pressure in the condenser (i.e. higher the vacuum), the more efficient will be the utilization of steam energy. Condensate pumps, G5-142A/B, maintain a permanent flow of condensate, out of the condenser. The condensate controller ensures a constant flow of condensate within the condensing unit. Excessive condensate is supplied, via the drain control valve, to the steam/condensate circuit (to E-404 and E3-307) of the overall process plant.

Main condenser with condensate collecting tank
Main condenser E5-141 is a horizontal heat exchanger set up near the steam turbine. It is under vacuum and condenses the arising exhaust steam. Precipitating condensate is collected in the condenser hotwell. The design temperature and pressure for Shell is 120 degC and 1 barg/FV respectively. The design temperature and pressure for Tubes is 60 degC and 7 barg/FV respectively. There are 11434 numbers of tubes with tube length 11498 mm.

Additional equipment details for Condenser, E5-141 are as follows:

- Type : Shell and tube Circular
- Operation mode: Continuous
- Shell side Fluid: Steam
- Tube side fluid : Water

- Rated Steam flow: 377000 kg/hr
- Rated cooling water flow: 191937537 kg/hr
- Shell side fluid Operating temperature (Inlet/Outlet) : 47.7 degC/
- Tube side fluid Operating \temperature (Inlet/Outlet) : 25 degC/34 degC
- Shell side fluid Operating Pressure (Inlet/Outlet) : 0.11 bara/
- Tube side fluid Operating Pressure (Inlet/Outlet): 5 bara/ 3.5 bara(max.)
- Tube side Pressure drop: 0.44 bar
- Number of tube passes: 1
- Flow velocity: 2 m/s
- Heat duty: 191014634 kcal/hr
- Heat transfer coefficient:2521 kcal/hr m2 degC
- Heat transfer area: 9920m2
- Shell side MOC: SA516 Gr 70
- Tubes MOC: SA 249 TP304L
- Shell side outside diameter: 4432 mm
- Overall dimensions (LxWxD): 19950mm x 6600 mm x 4432mm
- Tube Bundle dimensions (LxWxD): 14668mm x 3635mm x 3485mm

For additional equipment details refer ***vendor datasheet "Condenser datasheet – 10005-GPZ105-MS0S01-7342371-D01-003"***

Condensate pumps, G5-142A/B

G5-142A/B are Centrifugal Pumps which transports the Steam condensate from the condenser hotwell to De-aerator, F5-2212 via the Exchangers, E5-404 and E5-307.

Additional equipment details for G5-142A/B are as follows:

- Operation mode: Continuous
- Fluid pumped: Steam Condensate
- Operating temperature (Normal/maximum): 45 degC / 80 degC
- Capacity (Design) at BEP : 530 m3/hr
- Number of stages: One
- Recirculation capacity: 140 m3/hr (minimum continuous flow)
- Suction Pressure (Design): 0.84 bara
- Discharge Pressure: 11.6 bara
- Differential Head: 122.8 m
- Efficiency (Rated/Maximum): 73.5%/ 74%
- NPSHA: 6.8 m (at suction centerline)
- NPSHR: 2.9 m (at pump suction centerline)
- Pump speed (Normal/1st critical): 1486 rpm/ 3675 rpm
- Impeller Diameter: (Minimum/rated/maximum): 500mm/ 617mm/ 648mm
- Absorbed Power (at rated impeller): 238.62 kW
- MOC (Casing/Impeller/Shaft): A 351 Gr. CF3M/ A 743 Gr. CF3M/ A 276 S 31803

- Impeller type: Closed type

Condenser hotwell, F5-154
Condenser hotwell F5-154 is a vessel to collect condensate that accumulates in the evacuation and drain lines of the steam turbine.

Flash box
The flash tank separates condensate and steam. Feed water (Recirculated water from E5-2234) is carried into the flash box where the steam still contained in the feed water is separated. This steam is carried to the condensing section of main condenser E5-141 while the condensate is carried directly to the hotwell of condenser E5-141.

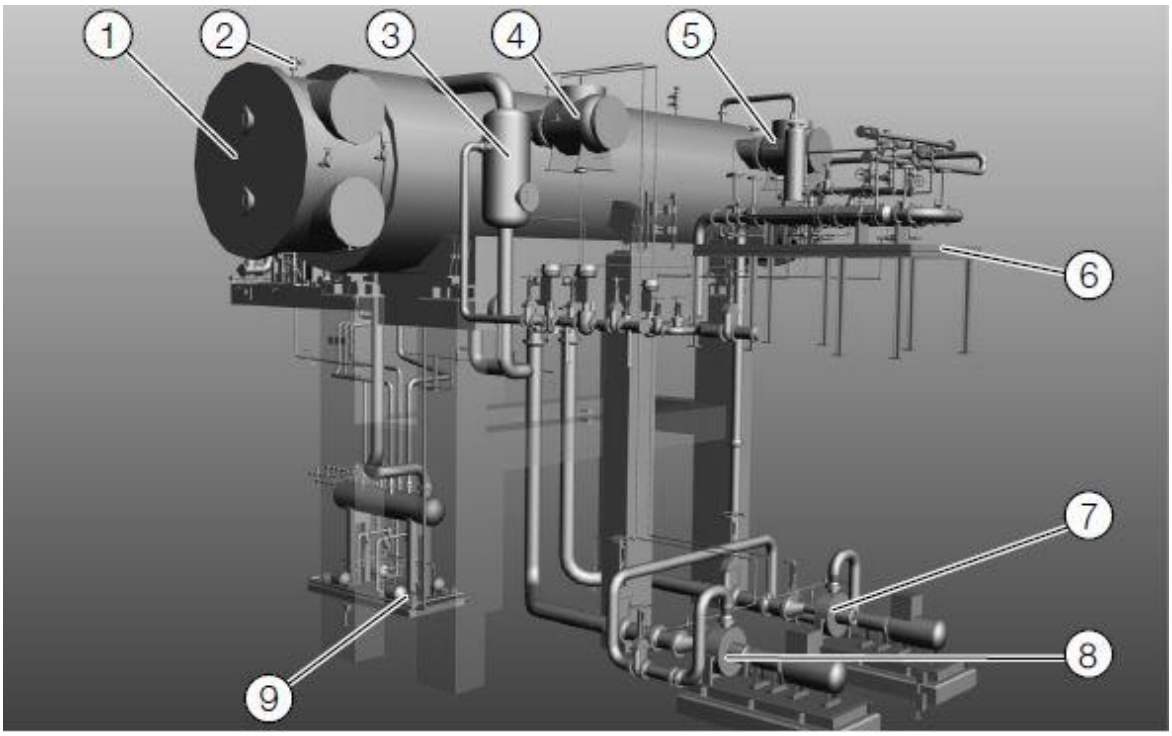


Figure 5.7.1.1 Steam Condensing Unit

1: Main condenser with hotwell E5-141
2: Vent Valve
3: Flash Box
4: Emergency Exhaust valve PSV01570B
5: Emergency Exhaust valve PSV01570A
6: Evacuation unit
7: Condensate pump G5-142B
8: Condensate pump G5-142A
9: Condensate lifting system

Evacuation unit

The vacuum unit consists of a two stage ejector set, each stage having two individual steam jet ejectors. Both the First and Second Stage Ejectors and Condensers operate on the principle of one on-line, one spare. A separate steam jet ejector, Start-Up Ejector (Hogging Ejector), H5-152, is provided for start-up purpose. This ejector discharges directly to atmosphere and has a discharge silencer, Steam Ejector Silencer, S5-153, associated with it.

Inerts, saturated with water vapor are drawn from the top of the Steam Turbine Condenser through Ejector H5-151A/B. LP steam is used as motive fluid, passing through the throat of the ejectors and creating vacuum. Motive fluid and process fluid discharged from the ejector passes to the front end of condenser E5-143A/B where condensation takes place. Condensate is discharged via a liquid trap back to the Turbine Condenser, E5-141 and Inerts & remaining vapor pass to the associated Ejector H5-150A/B which also utilizes LP steam as the motive fluid. Discharge from these Ejectors also passes to the back-end of the associated Condenser E5-143A/B where again, condensation takes place with condensate being returned to E5-141. Inerts, saturated with vapor at the condensing temperature pass to atmosphere via Silencer S5-153. A large Start-Up Ejector, H5-152 (Hogging ejector) is used for rapid evacuation of air from the system prior to machine train start-up. Following this, operation is switched to the normal system to achieve the required vacuum prior to start-up.

Following subassemblies are present in Evacuation unit:

- *Start-up ejector*

Start-up ejector H5-152 generates the minimum vacuum in the condenser prior to start-up of steam turbine C5-140.

- *Ejector stages*

Ejector stages H5-150A/B (main, first/second) and H5-151A/B (secondary, first/second) increase the vacuum to the desired condenser pressure after steam turbine C5-140 was started up for normal operation.

- *Ejector steam condenser*

Ejector steam condensers E5-143A and E5-143B convert the ejector steam to condensate and separate condensate and inert gas. Condensate from the condenser is used for cooling.

- *Silencer on start-up ejector*

The silencer on start-up ejector S5-153 reduces noise as steam is discharged to the atmosphere.

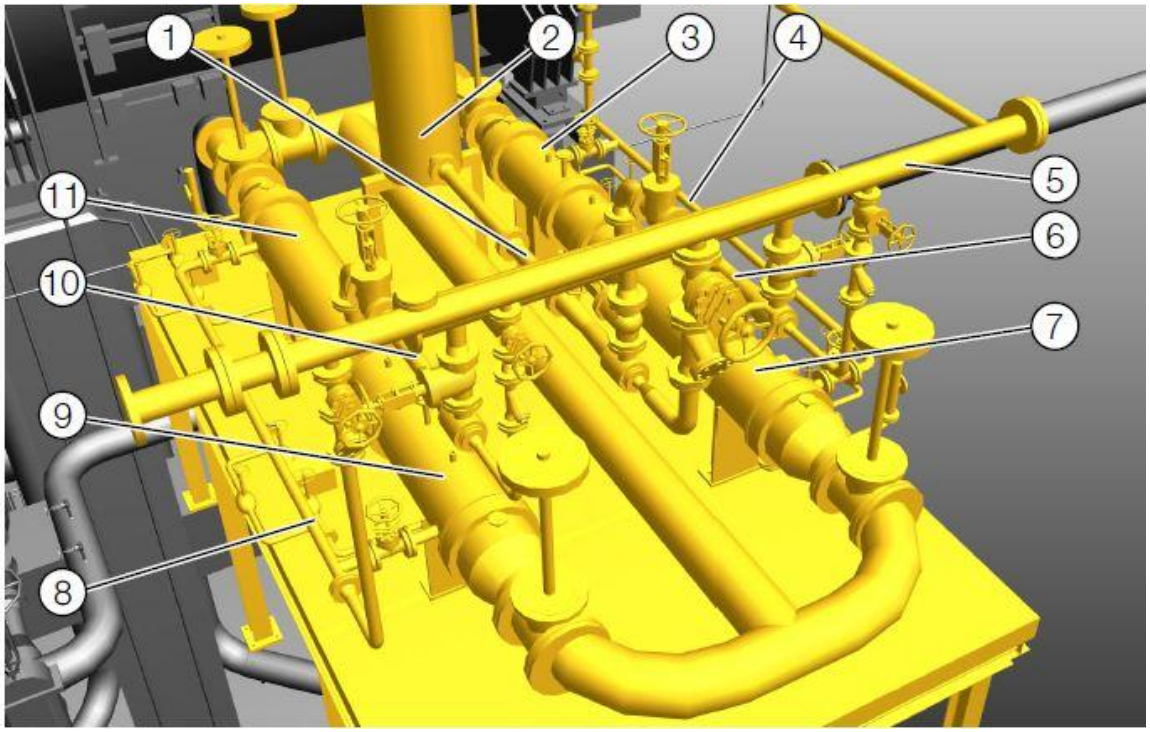


Figure 5.7.1.2. Evacuation Unit

1: Start-up ejector H5-152
2: Silencer Sy-153 on start-up ejector H5-152
3: Secondary condenser E5-143B
4: 2nd (secondary) ejector stage
5: Motive-steam pipe
6:1st (secondary) ejector stage
7: Interstage condenser E5-143B
8: 2nd (main) ejector stage
9: Secondary condenser E5-143A
10:1st (main) ejector stage
11: Interstage condenser E5-143A

5.7.3 Instrumentation and Control

pH of condensate from ST main condenser is indicated on DCS by AIA-01585A with High alarm. Conductivity of condensate from ST main condenser is indicated on DCS by AIA-01585B with High alarm

Condenser Hotwell level is indicated on DCS as LICA-01401 with high and low alarm

5.7.4 Trips and Alarms

TRIP SYSTEM Z-152

1. PURPOSE / BACKGROUND

Z-152 provides the protective logic associated with the additional condensate feed into the Steam Turbine Condenser E5-141. The condensate valve inlet the condenser is closed in the event of high high level or failure of the condensate pumps.

2. RELATED SYSTEMS

None

3. DESCRIPTION OF OPERATION

3.1. Initiators

- LSS-01426 HH level E5-141 Steam Turbine Condenser
- YA-01425 G5-142A/B Steam Turbine Condensate pumps both stopped

3.2. Outputs

- TCV-04228 Close condensate valve into E5-141 Steam Turbine Condenser
- TICA-04228 Set DCS controller to manual, 0% output (one-shot)

3.3. Logic Operation

If pumps G5-142A/B are both stopped as detected by YA-01425, or a high high level is detected by LSS-01426, then condensate valve TCV-04228 shall close via its solenoid and the associated DCS controller shall be set to manual with 0% output (one-shot action)

*For additional details on Trips and alarms refer the vendor document - **Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.8 Turbine condensate Drain collection system and condensate lifting unit

5.8.1 General Information

The drainage system of the steam turbine removes condensate from the steam turbine and the connected piping. The condensate drains separate the steam/condensate mixture and continuously remove the collected condensate via the headers into the condensing unit. The condensate drains condensate can be continuously drained from connecting pipes and casing parts of the steam turbine even after its start-up while no steam can escape via the drain lines. Every condensate drain is equipped with a bypass valve for

removing large quantities of accumulating condensate directly into the header. This usually occurs during warm-up of the steam turbine. Orifices are fitted upstream of the bypass valves to reduce the steam loss.

The shut-off valves in the drain lines without condensate traps are provided for manual draining of condensate. Headers, which are also referred to as lance pipes and which lead to the condensing unit, carry the drained condensate to hotwell F5-154 of the condensate lifting station.

Condensate lifting station
The condensate lifting station raises the condensate from the drainage system to the condenser level, thus making up for the lack of geodesic downward gradient

Condensate lift
Condensate lifts G5-144A/B/C/D work on the principle of power fluid displacement. The flow energy required for the delivery process to work is generated by incoming steam. The delivery process is controlled by the condensate itself. When the pressure body is full, the inlet for active steam is opened and condensate is displaced by the delivery pressure. The lift works while condensate is accumulating and stops automatically, and starts automatically as soon as liquid enters through the inlet port again.

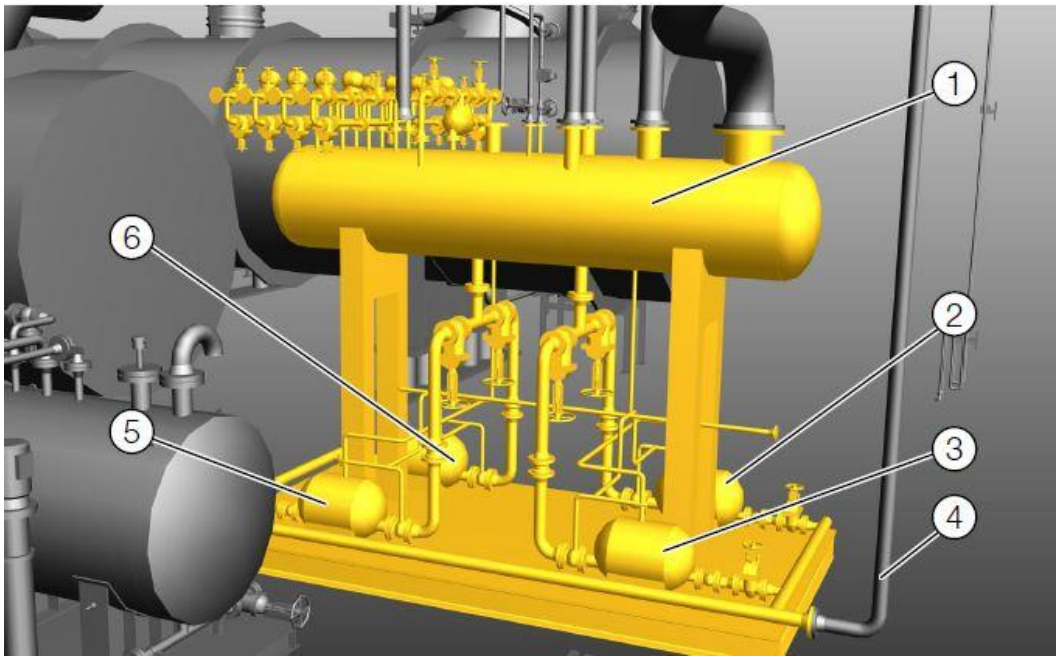


Figure 5.8.1.1. Condensate lifting Station

1: Condenser hotwell F5-154
2: Condensate lift G5-144D
3: Condensate lift G5-144C
4: Manifold to main condenser E5-141
5: Condensate lift G5-144A
6: Condensate lift G5-144B

5.8.3 Instrumentation and Control

For instrumentation in vendor scope, please refer corresponding vendor P&IDs

5.8.4 Trips and Alarms

For Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.9 Interstage Coolers E5-116, E5-117 and E5-118

5.9.1. General Information

Intercoolers E5-116, E5-117 and E5-118 cool the process air upstream of the second, third and fourth stages of the compressor to enhance compressor efficiency. At the same time, the moisture of the compressed process gas (air) is reduced by condensation in the process gas coolers.

Additional equipment details of E5-116 are as provided under:

- Type: Shell and Tube/ Plate fin
- Number of passes (Shell/tube): 1/ 2
- Operation mode: Continuous
- Tube side Fluid: Cooling water at inlet pressure of 5 bara
- Tube side Fluid Temperature (In/Out): 34 degC/44 degC
- Shell side Fluid: Air at an inlet pressure of 2.27 bara
- Shell side Fluid Temperature (In/Out): 129 degC/40 degC
- Tube side Flow: 1350 m3/hr
- Shell side Flow (Vapor/Liquid): 13762/504.11 m3/hr
- Heat Load: 15788 kW
- Overall Heat transfer coefficient: 765 W/m2/degC
- Allowable/Calculated pressure drop (Tubeside): 0.9 bar/ 0.09 bar
- Allowable/Calculated pressure drop (Shellside): 0.04 bar/0.04 bar
- Effective Heat Transfer Area: 13602.4 m2 (finned)
- Separator efficiency: 98%
- Shell outside diameter: 3000 mm
- Shell Design Temperature/ Pressure:165 degC/ 3 barg &FV
- No. of tubes:1498
- Tubeside Design Temperature/ Pressure: 60 degC/ 7 barG & FV
- MOC for Shell, Shell cover: CS
- MOC for tubes/Fins: A904L & A316L/ AL with phenolic ring

Additional equipment details of E5-117 are as provided under:

- Type: Shell and Tube/ Plate fin
- Number of passes (Shell/tube): One/Two
- Operation mode: Continuous
- Tube side Fluid: Cooling water at inlet pressure of 5 bara
- Tube side Fluid Temperature (In/Out): 34 degC/44 degC
- Shell side Fluid: Air at an inlet pressure of 4.44 bara
- Shell side Fluid Temperature (In/Out): 119.5 degC/40 degC
- Tube side Flow: 1290 m3/hr
- Shell side Flow (Vapor/Liquid): 10220/500.57 m3/hr
- Velocity (Tube side/Shell side): 2.3 /1.91 m/s
- Heat Load: 14970 kW
- Overall Heat transfer coefficient: 1547 W/m2/degC
- Allowable/Calculated pressure drop (Tubeside): 0.9 bar/ 0.09 bar
- Allowable/Calculated pressure drop (Shellside): 0.04 bar/0.04 bar
- Effective Heat Transfer Area: 13606.4 m2 (finned)
- Separator efficiency: 98%
- Shell outside diameter: 2600 mm
- Shell Design Temperature/ Pressure: 165 degC/ 6 barg & FV
- No. of tubes: 1305
- Tube length: 10886 mm
- Tubes Design temperature/Pressure: 60 degC/ 7 barG & FV
- MOC for Shell, Shell cover: CS
- MOC for tubes/Fins: A904L & A316L/ AL with phenolic ring

Additional equipment details of E5-118 are as provided under:

- Type: Shell and Tube/ Plate fin
- Number of passes (Shell/tube): 1/ 2
- Operation mode: Continuous
- Tube side Fluid: Cooling water at inlet pressure of 5 bara
- Tube side Fluid Temperature (In/Out): 34 degC/44 degC
- Shell side Fluid: Air at an inlet pressure of 7.9 bara
- Shell side Fluid Temperature (In/Out): 105 degC/40 degC
- Tube side Flow: 800 m3/hr
- Shell side Flow (Vapor/Liquid): 4277/426.8 m3/hr
- Heat Load: 9181 kW
- Overall Heat transfer coefficient: 894 W/m2/degC
- Allowable/Calculated pressure drop (Tubeside): 0.9 bar/ 0.09 bar
- Allowable/Calculated pressure drop (Shellside): 0.04 bar/0.036 bar
- Effective Heat Transfer Area: 8451.5 m2 (finned)
- Separator efficiency: 98%
- Shell outside diameter: 2000 mm
- Shell Design Temperature/ Pressure: 165 degC/ 12 barg &FV

- Number of tubes: 825
- Design Temperature/Pressure: 60degC/ 7 barg &FV
- Tube length: 10954 mm
- MOC for Shell, Shell cover: CS
- MOC for tubes/Fins: A904L & A316L/ AL with phenolic ring

5.9.2 Instrumentation and Control

For instrumentation and control in vendor scope, please refer corresponding vendor P&IDs

5.9.3 Trips and Alarms

There are no trips and alarms related to intercoolers.

5.10 Motor-Generator, M5-113

Motor-generator M5-113 is a water-cooled synchronous motor-generator. Acting as an electric main drive motor, M5-113 converts electrical energy into mechanical rotational energy. This rotational energy is used to drive the machine train.

Acting as a generator, the motor-generator converts mechanical energy into electrical energy. This is performed by the induction of electromagnetic forces in a conductor. The motor-generator is driven by the machine train and converts part of the drive power into electrical energy which is fed into the grid of the plant

Static Frequency Controller (SFC):

The MEGADRIVE-LCI is a variable speed drive for continuous operation and soft starting of synchronous machine (PAC motor-generator).

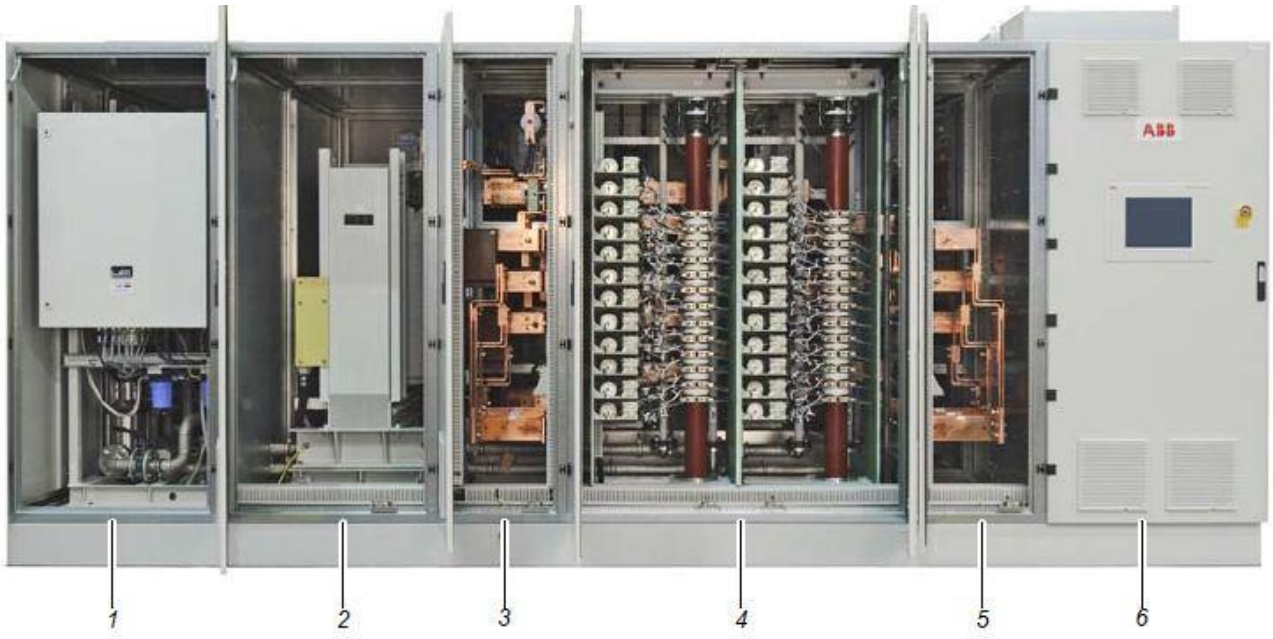


Figure 5.10.1 Various units of Mega-drive

1: Water cooling unit
2: DC link Reactor
3: Line-side connection unit
4: Frequency Converter unit
5: Machine side connection
6: Control Unit

The following sections provide general units of the MEGADRIVE-LCI:

1. Frequency Converter unit
2. Line-side and machine-side connection unit
3. DC link reactor
4. Control unit
5. Water cooling unit

1. Frequency Converter unit

A frequency converter unit of a MEGADRIVE-LCI consists of a rectifier and an inverter. Both the rectifier and the inverter use thyristor stacks of identical design and also comprise heat sinks, snubber circuits and gate firing circuits.

The rectifier converts the supply current to direct current. The inverter then converts the direct current into a three-phase alternating current that modulates into variable frequency and voltage depending on the process requirements

2. Line-side and machine-side connection unit

The standard connection unit (one installed for each 3-phase system) consists of the following main components:
• Power cable connection points from the transformer or to the machine respectively (bus bars)
• Gland plate (cable entry)
• Required measuring and protection equipment (current and voltage transformers, surge arrestors)
• Control Interface (LIN)

3. DC link reactor

The DC link reactor interconnects the rectifier and inverter and smooths the rectified current. With water-cooled drives, the DC link reactor is integrated with the converter unit, and has an iron core.

4. Control unit

The control unit comprises the hardware for drive control, monitoring and protection as well as a control terminal, customer connection interfaces and interface units.
The control unit consists of the following main components:
• AC 800PEC control and protection system
• MEGADRIVE-LCI Control Terminal (LCT)
• Customer connection interfaces
• Power supply units for 24Vdc and 48 Vdc
• Low voltage distribution

5. Water cooling unit

The MEGADRIVE-LCI uses a water cooling unit to cool the active components of electrical machines and equipment (e.g. generators, converters and other equipment). It maintains the equipment within safe operating temperatures and ensures optimal operation.
The water cooling unit consists of the following components:
• Water-to-water heat exchanger (deionized to raw water), E5-137A/B
• Two redundant water pumps for internal water circuit, G5-157A/B
• Three-way valve
• Ion exchanger (deionizer), G5-159
• Expansion vessel, F5-158
• Mechanical filters (fine sieve)
• Control and monitoring devices

For more details on the Frequency Converter refer vendor documents- **"User Manual LCI - 10005-GPZ105-MS0S01-7342371-N02-005", "SFC Water cooling Unit control Overview - 10005-GPZ105-MS0S01-7342371-C04-002" and vendor PID "10005-GPZ105-MS0S01-7342371-C02-017"**

The motor speed indication on DCS is given as SI-01862

For Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.11 Feed water recycle cooler, E5-2234

5.11.1 General Information

Feed water Recycle cooler is a Shell and Tube Heat Exchanger (1,2-STHE) which cools the condensate coming from steam turbine condensate via E5-404.
Condensate from Steam Turbine Condenser, E5-141 is pumped by G5-142A/B through Third CTA Crystallizer Condenser, E5-404 and then through BFW preheater, E5-307 to De-aerator F5-2212. Excess condensate is exported from downstream of E5-404 on temperature control (TICA04228) via recycle condensate cooler E5-2234 in to Feed Water flash vessel F5-2223, which is connected to the turbine condenser/hot-well.

Design pressure and temperature for tube side is 7 barg/FV and 185 degC. Whereas, design Pressure and temperature for shell side is 14.7 barg/FV and 185 degC.

Additional Equipment details are as follows:

- Fluid circulated (Tube side/shell side): Cooling water/ Steam condensate
- Operating Pressure Shell side: 8.3 bara
- Operating Pressure Tube side: 5.5 bara
- Operating Temperature Shell side (In/Out): 80/55 degC
- Operating Temperature tube side (In/Out): 34/ 44 degC
- No. of passes (Shell/Tube): One/Two
- TEMA type: BEU

5.11.2 Instrumentation and Control:

Condensate return from E5-404 is exported under level control to OSBL. Main Condenser hotwell level controller LICA-01421 controls the condensate export via LCV 22313A on the condensate line from E5-307 to F5-2212.

PI-01419 and TI01423 gives the Local Pressure and Temperature indication on condensate export line. The flow is indicated on DCS as FI-01428 and the temperature is indicated as TI-01427

5.11.3 Relief Description:

A) RV/40237- E5-2234, Feed water recycle cooler (Shellside)

Shell Side of the E5-2234, Feed water recycle cooler is protected from overpressure with Pressure Safety valve RV/40237. The relieved fluid (water) from the PSV's is directed to drain.

Additional details are as provided under:

- No. of Safety valves: 1
- Safety Valve RV/40237 Set Pressure: 14.5 barg

B) RV/E1 -2234, Feed water recycle cooler (Tubeside)

Tube Side of the E5-2234, Feed water recycle cooler is protected from overpressure with Pressure Safety valve RV/E1-2234. The relieved fluid (water) from the PSV's is directed to drain.

Additional details are as provided under:

- No. of Safety valves: 1
- Safety Valve RV/E1-2234 Set Pressure: 7 barg

5.12 Washing water system

The wash water system allows the injection of wash water into the stream of process gas. Soiling of impellers at the process gas inlet into the compressor reduces the process gas flow and, as a consequence, compressor efficiency, and also increases the risk of vibration resulting from unevenly distributed deposits on the impeller. This can be avoided by periodic washing of the impellers. Spray nozzles are attached to the suction pipe of each compressor stage to inject the wash water for cleaning the impellers and the flow-guiding parts. The wash water operation is manual. The compressor stages are cleaned only one by one to prevent too much wash water to enter the stream of process gas. Cleaning is only possible during operation. During the washing process, care is taken to ensure that spaces which carry process gas are adequately drained to prevent wash water entering the overall process plant.

The wash water system consists of the subassemblies below:

Wash water tank

Wash water tank F5-130 holds wash water for the washing cycle.

Wash water pump

Wash water pump G5-131 delivers the wash water from the wash water tank to the wash nozzles.

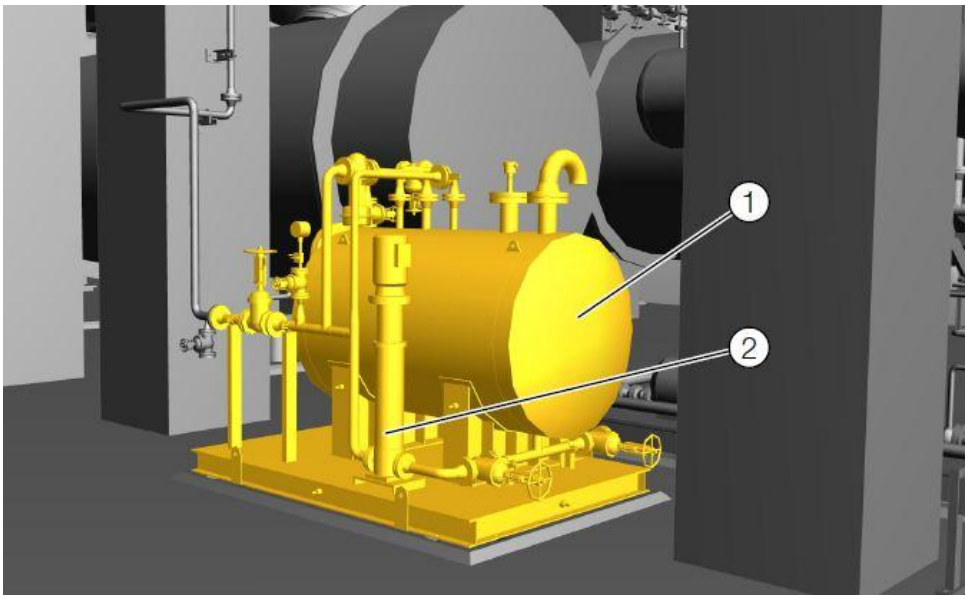


Figure 5.12.1.1 Wash water Tank

1: Wash water tank

For Trips and alarms refer the vendor document - ***Cause and Effect Diagram "10005-GPZ105-MS0S01-7342371-C03-001-00"***

5.13 Gear Unit

There are two Gear Units in the PAC

A) Rotor turning gear, M5-132
B) Intermediate Gear Box unit, M5-146

Intermediate Gear Box unit M5-146 converts and transmits movement and torque from the expander and from the rotor turning gear to motor-generator M5-113.
Rotor turning gear M5-132 consists of a motor, an auxiliary/intermediate gear unit and an overriding clutch. The rotor turning gear is coupled to the pinion shaft (expander) of gear unit M5-146 and rotates the rotors of the machine train by means of the gear unit. The rotor turning gear rotates the rotors after shutdown to avoid bending of the rotor in the hot state. During start-up, the rotor turning gear is used to overcome the start-up torque. During normal operation the clutch of the rotor turning gear is disengaged. The duration of operation of Turning gear is determined depending on the operating state of the steam turbine on the basis of diagram "Restart rotor turning gear operation".

The rotor turning gear is equipped with a facility for manual operation, e.g. during power failure.

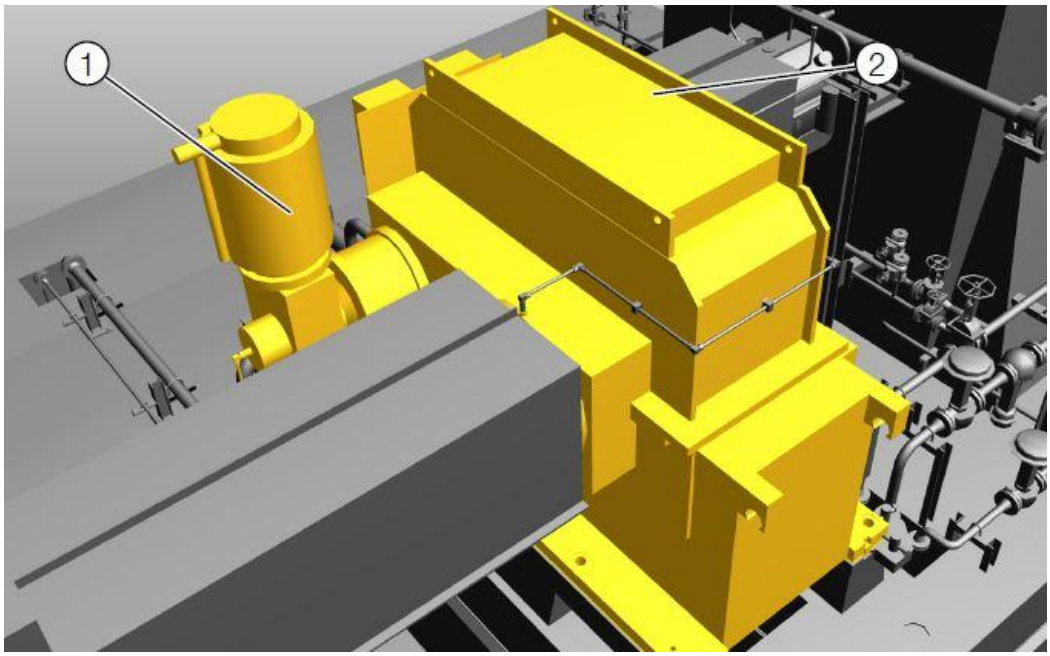


Figure 5.13.1.1. Gear Unit

1: Rotor Turning Gear, M5-132
2: Gear Unit, M5-146

Additional Equipment details for Gear unit, M6-146 are as follows:

- Operation mode: Continuous
- Type: Double Helical Parallel Shaft Gearbox, Single Stage
- Driver type: Offgas Expander
- Driven Equipment: Motor/Generator
- Gear Unit Rated Power: 32000 kW
- Rated speeds (Input/Output): 4963 rpm/ 1000 rpm (Nominal)
- Number of teeth (Pinion/Gear): 27/134
- Gear ratio: 4.96
- Required Gear Service Factor: 1.6
- Mechanical Efficiency: 98.8 %
- Lubrication oil flow required: 30.9 m3/hr
- Jacking oil flow required: 0.08 m3/hr

For additional equipment details refer ***vendor datasheet "Intermediate Gear box datasheet – 10005-GPZ105-MS0S01-7342371-D01-027"***

5.14 Intercooler condensate Pit, A5-135 & Intercooler condensate Pump, G5-136

5.14.1 General Information

The moisture in the process air is condensed when cooled across the Interstage coolers, E5-116, E5-117 and E5-118. This condensed water is removed and collected in the Intercooler Condensate pit, A5-135. Intercooler condensate pump, G5-136 takes suction from this Intercooler condensate pit, A5-135 and discharges the condensed water to cooling water return header. It operates on a continuous mode. It has a Carbon steel casing and impeller. The shaft is made up of SS316L. The casing design Temperature and pressure are 80 degC and 16 barG.

Additional equipment details for G5-136 are as follows:

- Operating Temperature (Min/Normal/max): 20/40/50 degC
- Capacity(Rated/Normal): 18.3/ 18.3 m3/hr
- Minimum continuous flow: 1.3 m3/hr
- Suction Pressure (Rated/ Maximum): 0.7/ 1.01 bara
- Discharge Pressure: 5 bara
- Differential Head: 44.2 m
- NPSHA/NPSHR: 5m/1.1m at impeller centerline
- Pump speed (Normal/1st critical): 2930/12238 rpm
- Impeller diameter (min/rated/max): 168/172/210 mm
- Pump Efficiency (Rated/max): 50.1/ 52.56 %
- Absorbed power (at rated flow and rated impeller): 4.34 kW
- Absorbed power max (at rated flow and rated impeller): 7.19 kW

5.14.2 Instrumentation and Control

Discharge Pressure is locally indicated as PI-01137 on Pressure Gauge. It is provided with a ROP FO-01141 in Kickback line to Intercooler condensate pit.

The level in the condensate pit, A5-135 is controlled by LCV-01139 on the pump discharge line.

Motor stopped indication is given in DCS as YA-01140

5.14.3 Trips and alarms

No trip is associated with this pump.

Motor stopped alarm is given by YA-01140

6) PAC Train

6.1 Operation Philosophy

The startup, shutdown and normal operation of PAC train is described as following subtopics in the vendor document ***Operating Instructions Part I - 10005-GPZ105-MS0S01-7342371-N02-008***

- Prerequisites for Start-up:
  - Preparing the machine unit
  - Starting up the seal air system and the purge air system
  - Checking the wash system before start-up
  - Starting up the oil system
  - Determining the conditions for rotor turning gear operation
  - Determining the conditions for rotor turning gear operation when the rotor is hot
  - Operating the rotor turning gear during start-up of the machine train
  - Pressurizing the seal steam seals with seal steam
  - Starting up the evacuation unit
  - Starting up the condensing unit
  - Preparing the steam turbine for warm-up
  - Establishing the operating conditions

- Start-up
- Shutdown in an Emergency
- Shutdown from Normal Operation

For detailed Operating Philosophy, refer ***topic - 4 'Normal Operation' in vendor Document "Operating Instructions Part I - 10005-GPZ105-MS0S01-7342371-N02-008"***

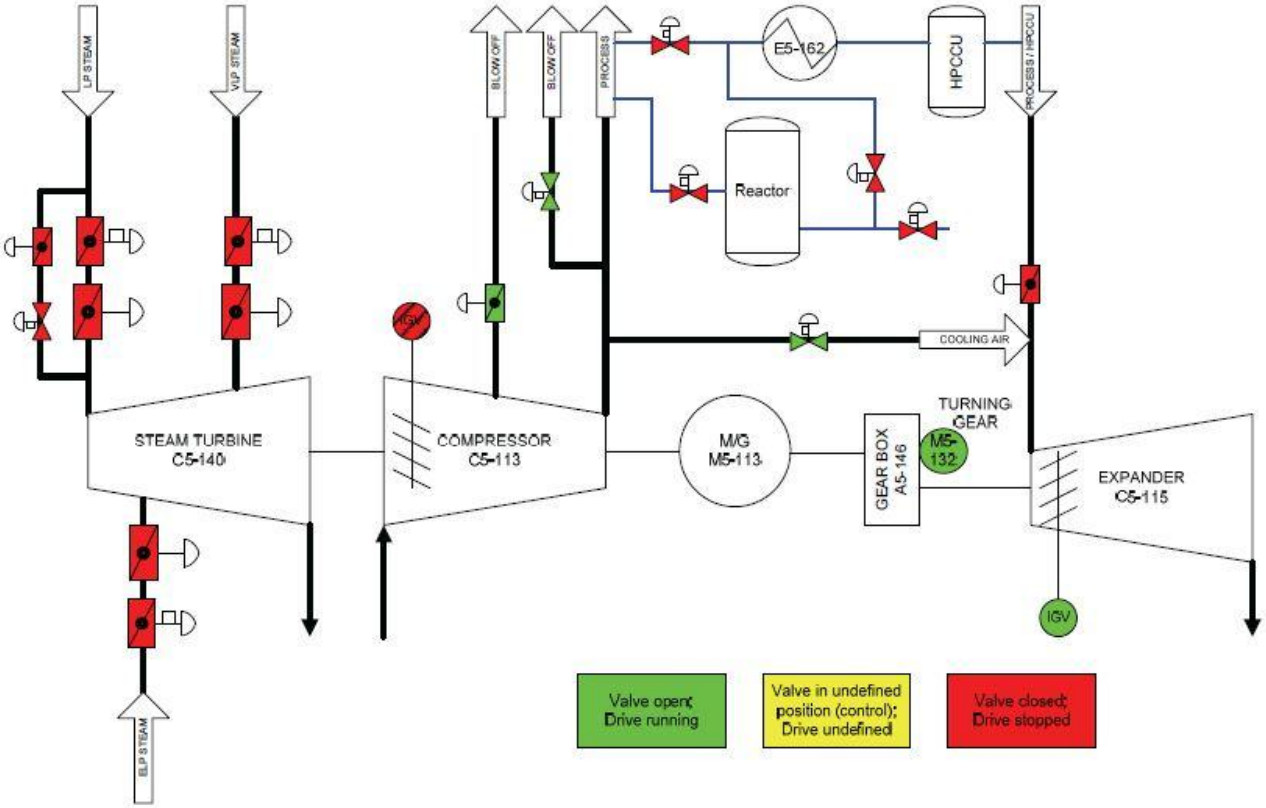
6.2 Control Philosophy

The control philosophy for the PAC train operation is described henceforth for the following sequence of operation of the PAC train.

01. Start on Turning Speed
02. Acceleration to Idle speed
03. Acceleration to Normal speed
04. Motor Loadable
05. Expander warm up from ambient to 150degC
06. Expander warm up to 250 degC
07. Closing of Cooling Air
08. Compressor Discharge Pressure Control On

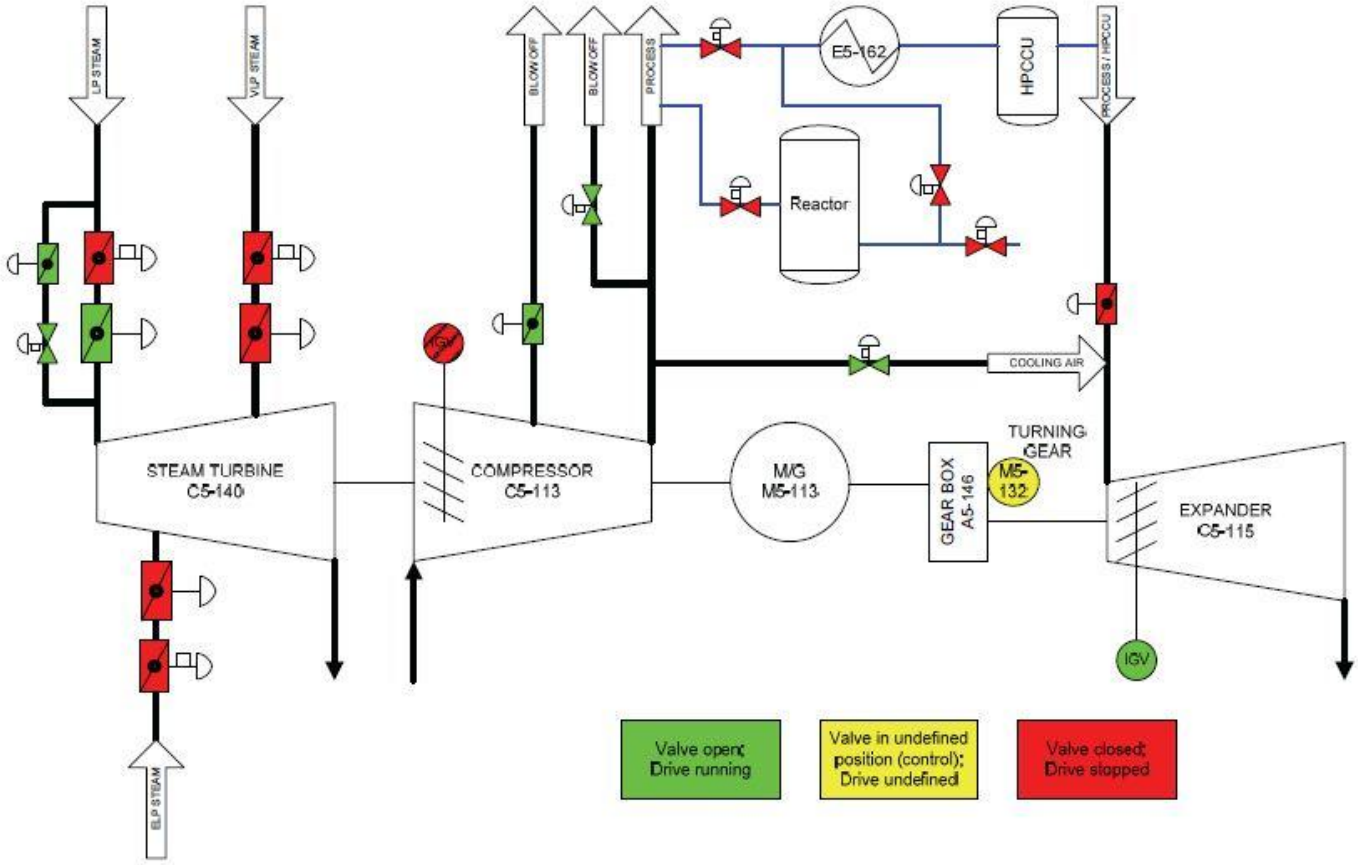
09. Expander warm up to 360 degC (turndown)
10. Reactor Start
11. Reactor online “Offgas mode”
12. Normal Operation (Guarantee)
13. Reactor Trip “Power swing”
14. HPCCU Trip
15. Shutdown of PAC train
16. a) Hot Restart (Turning Speed)
    b) Hot Restart (Acceleration to IDLE speed)
    c) Hot Restart (Acceleration to Normal Speed)
    d) Hot restart (Motor Loadable)
    e) Hot Restart (Subsequent)

01. Turning Speed



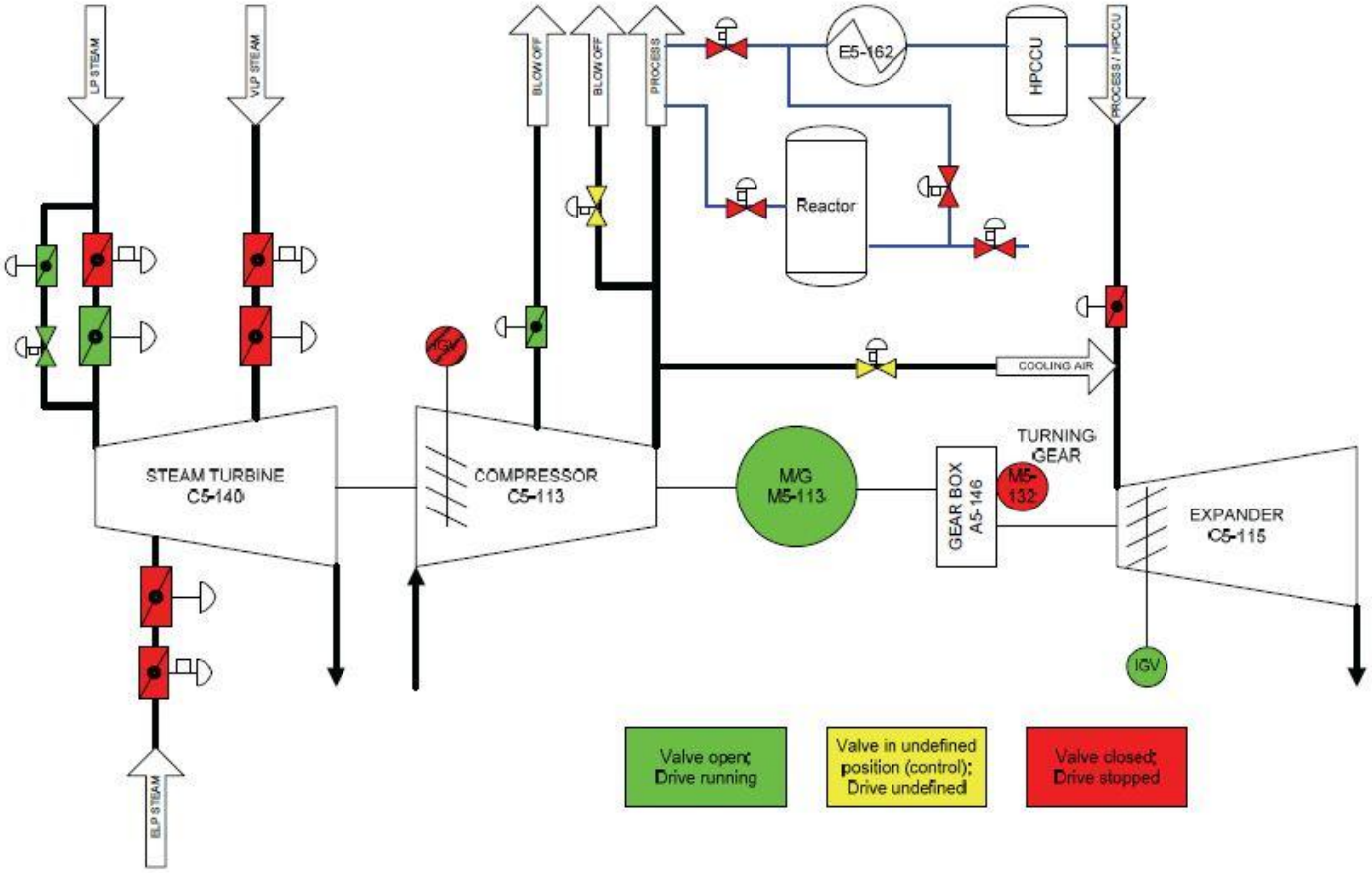
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve FCV-1132	Motor / Gen.	Other	Remarks
01	Turning-Speed	The train is running on turning gear with approx. 50 rpm.	All ST inlet valves are closed. The seal steam is activated already. In this mode the ST and all steam lines are warmed up and drained. The ST vacuum system must be in operation.	The Blow-Off valve FCV-01107 (BOV) and the interstage unload flap (FV-01158) are fully open. The IGV GY-01102 are set for "motor start" (approx 80°). All coolers should be activated.	The expander inlet flap (XSV 01105) is closed. Expander IGV ET-01117 fully open. Seal air is not active (XSV-01180 closed).	The cooling air mode is active already. Because of very low compressor discharge pressure the cooling air valve (FCV-01132) will be fully open but in control mode.	The motor / gen. is in "no load" operation. The cooling water flow must be activated. The frequency converter should be "ready to start" with cooling active.	The lube and jacking oil supply must be active.	All start up interlocks should be met. Before a "Restart" of the train the expander vibrations should be monitored closely. If the vibration level has risen significant already the "Restart" will not succeed.
		Process Data:							NOTE: Emitted coupling power will be "+"; absorbed coupling power will be "-".

02. Acceleration to Idle speed



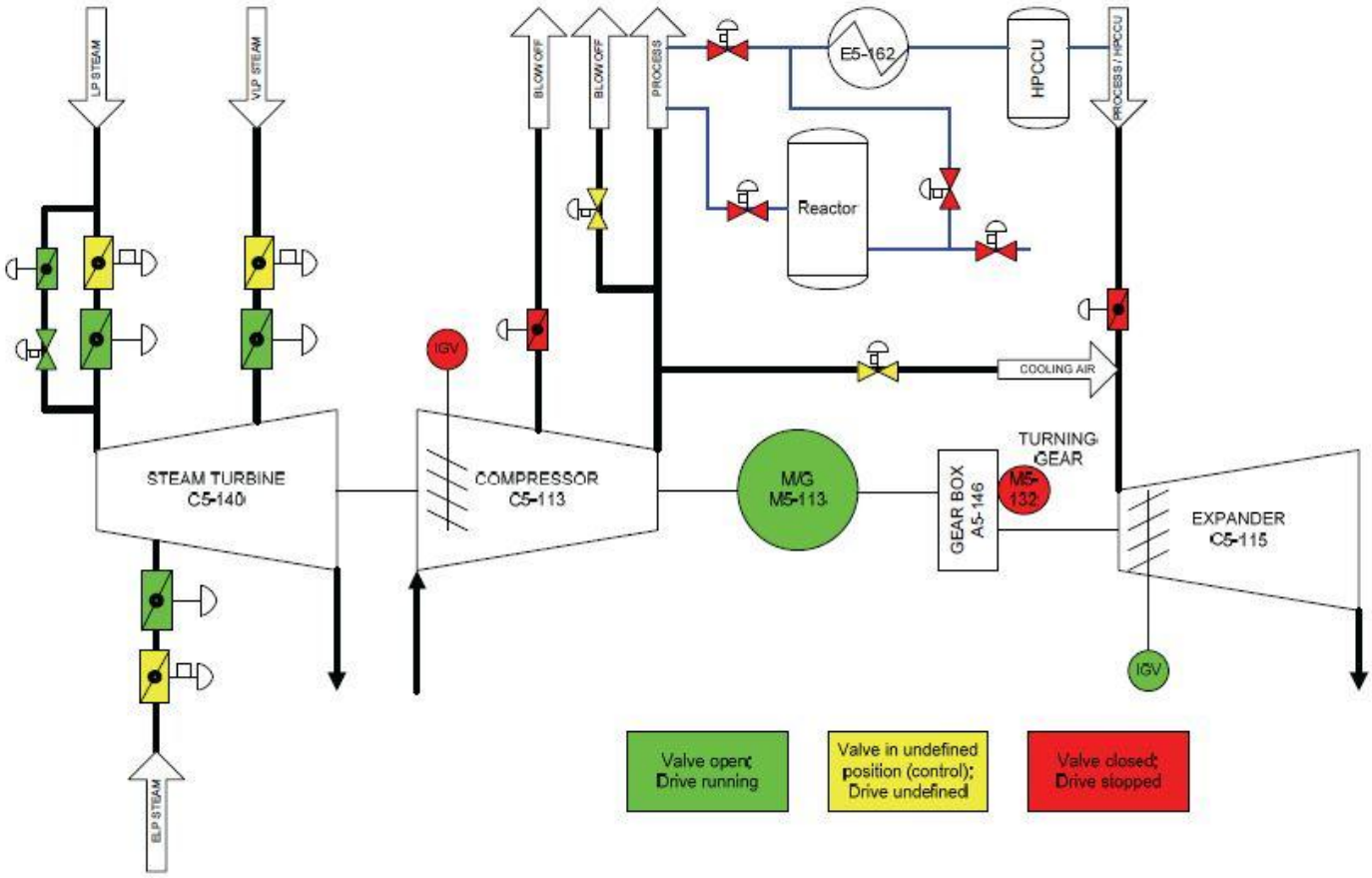
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
02	**Acceleration to "Idle Speed"**	After start of the train some trip valves of the steam turbine will open and the lines between trip valve and control valve should be warmed and drained. The acceleration of the steam turbine has to be initiated manually by the operators. With full cooling steam flow the train will reach approx. 23% of speed (~700 rpm).	The Cooling Steam valve PCV-01435 will be opened controlled. With a LP cooling steam flow of approx. 25 t/h the train will be accelerated to roughly 23% speed. Check condenser level control at this step.	With rising speed the discharge pressure will rise slightly.	No changes.	With rising compressor discharge pressure the cooling air flow will rise. But it will not reach the set point of 65 t/h.	No changes.	The turning gear will be disengaged automatically when the train speed will exceed turning speed.	The train can run unlimited on idle speed.
		Process Data: **(All values are roughly calculated or estimated.)**	**LP Flow: approx. 25 t/h** **Power: +??? kW**	**Discharge pressure: < 2 bar (a)**	**Inlet pressure: not predictable.**	**Cooling air temp.: approx. 150° C**			**NOTE: Emitted coupling power will be "+"; absorbed coupling power will be "-".**

03. Acceleration to Normal speed



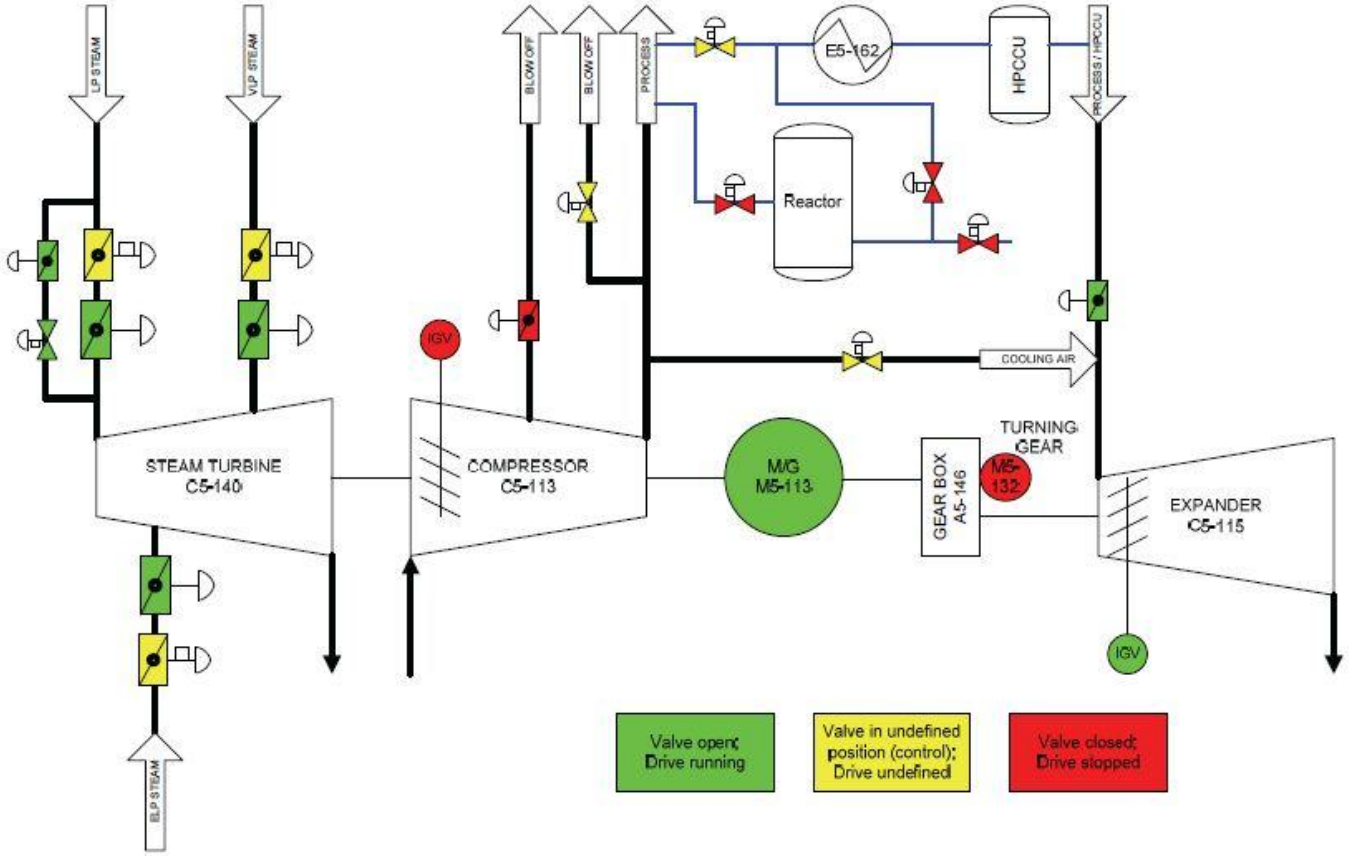
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
03	**Acceleration to "Normal Speed"**	After the steam turbine has finished its ramp up, the converter will bring the motor up to the normal speed.	The cooling steam valve PCV-01435 stays open. With increasing speed the turbine power will decrease on constant cooling steam flow.	With rising speed the discharge pressure will rise more. **Eventually the BOV will be throttled to raise the discharge pressure and allow more flow tom the expander.** Still interstage unload flap is fully open. IGV are on 80° position.	No changes.	The cooling air flow may reach 65 t/h depending on the compressor discharge pressure. If the pressure will exceed, the cooling air valve will start to throttle to control flow.	The frequency converter picks up the train at the actual speed and brings it up to full speed.	When the ST speed climbs over 800 rpm the turning gear motor and the jacking oil pumps will be stopped automatically.	The compressor IGV are still on 80°. Therefore the discharge pressure and flow are quite low. The actual compressor power consumption is not calculable.
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: < 10 bar (a) Power: unknown Flow: ~180 t/h	Power: unknown	Cooling air temp.: approx. 150° C	Converter Power: +18500 KW	Overall loss: approx. -400 kW	**To allow a start up with reduced converter power the compressor IGV must be set to "Motor Start" position (~80°).**

04. Motor Loadable



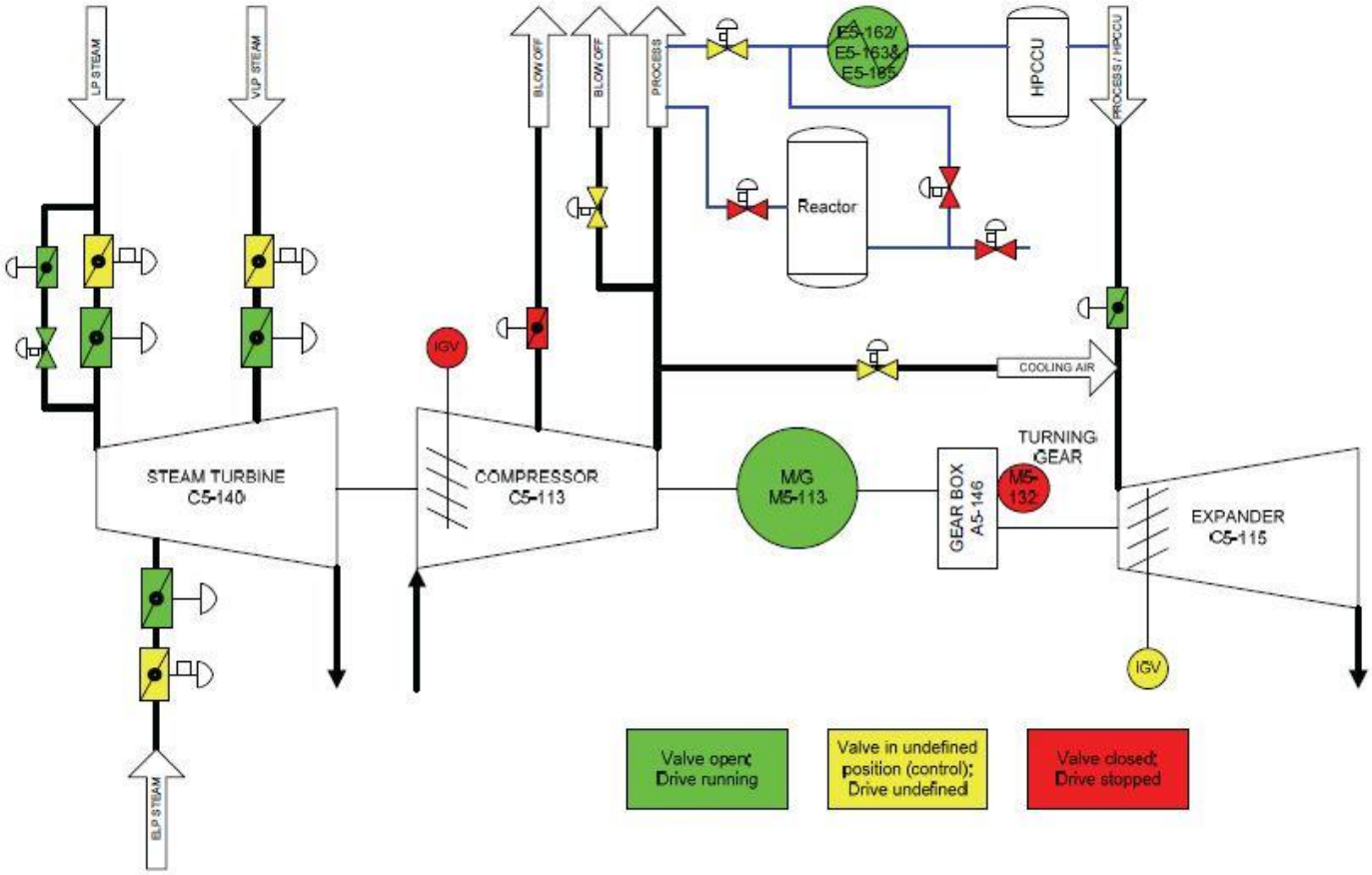
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
04	Motor load-able	After the motor has reached a speed of 100% for some seconds, a signal "motor loadable" will be provided form the SFC. The compressor is released to take load.	The cooling steam valve PCV-01435 keeps the cooling steam flow constant at 25 t/h. **Optional:** With the speed fixed to the converter frequency, the steam line inlet valves could be switched to pressure control already. If any steam is available it will be used to reduce to motor load.	The compressor IGV will move to "Min. control pos." position (~70°). **Afterwards** the interstage unload flap will be closed. Finally the anti-surge controller (ASC) will be released and will close very slowly the BOV until the control line is reached.	No changes.	The cooling air flow will be constant 65 t/h. Because of the high compressor discharge pressure the cooling air valve will throttle more.	The frequency converter has brought the motor to the normal speed.	The compressor discharge temperature control TC 01155 will remain in manual mode (with TCV 01155 fully closed) until the interstage unload flap will reach the closed position (GSC 01158).	From the approx. 250 t/h of compressor dis-charge flow only 65 t/h will be used for expander cooling air. Therefore approx. 185 t/h will be vented by the BOV.
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 10 bar (a) Flow: ~250 t/h Power: approx. -24600 kW	Power: unknown	Cooling air temp.: approx. 150° C Flow: 65 t/h	Converter Power: +23350 KW	Overall loss: approx. -400 kW	

05. Expander warm up from ambient to 150degC



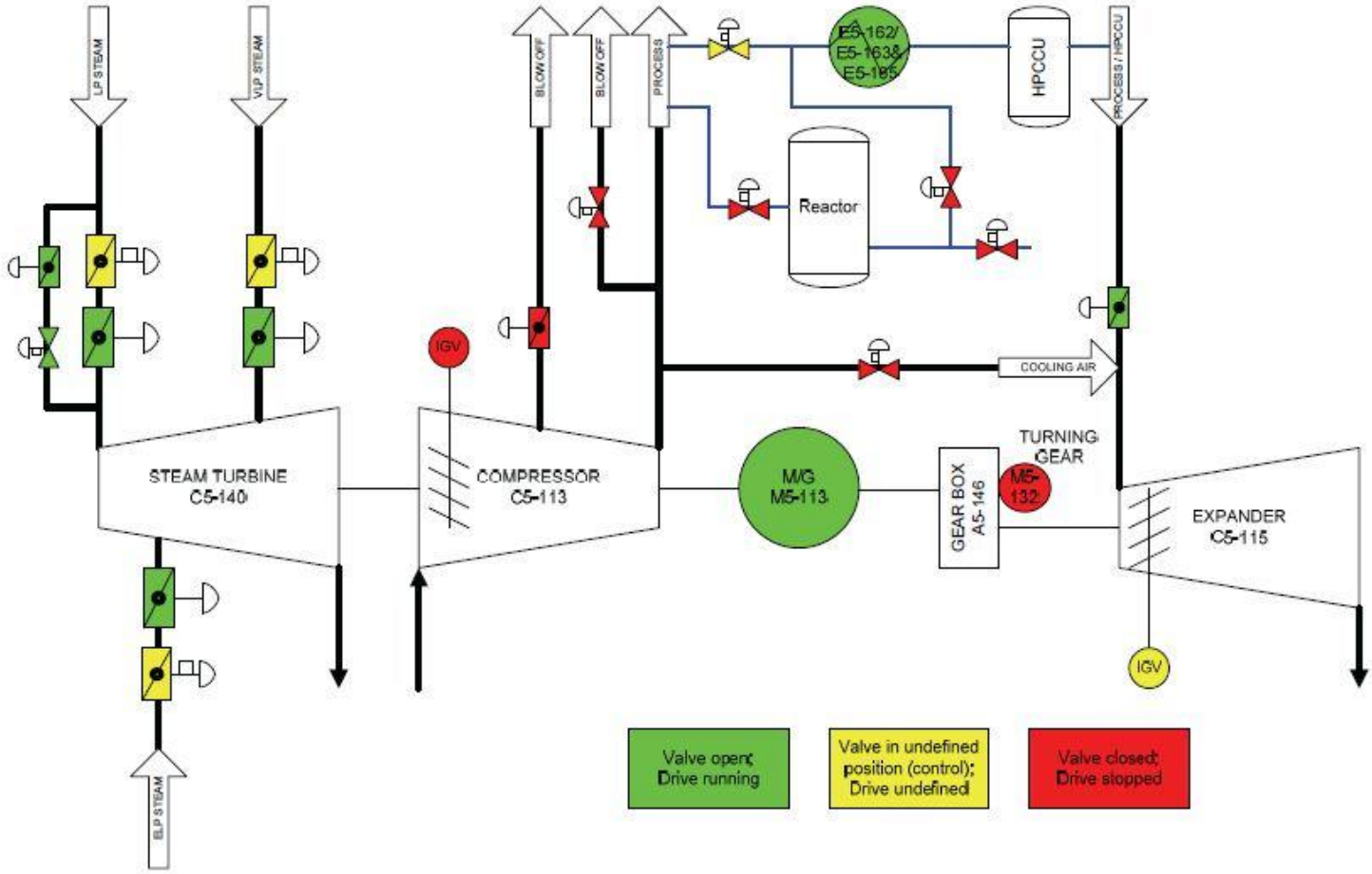
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
05	Expander Warm up from ambient to 150° C	The operator pressurizes the HPCCU line up to the expander inlet. After the line is pressurized the operator can open the expander inlet flaps to allow a controlled flow to the expander.	No changes.	The compressor flow will be increased manual to 275t/h. Depending on the bypass air flow the BOV will close more and more. No change to load.	After opening of the expander inlet flaps a not defined amount of air with unknown temperature will access the expander passing the HPCCU. The release of the inlet flaps will be interlocked until the upstream pressure (PI-01171) is higher than the downstream pressure (PI-01106).	The cooling air (160° C) will be mixed with the expander inlet flow. It is essential to bring all of the cooling air flow to the expander (no flow back to HPCCU).	Wit any additional flow to the expander the expander power will increase and reduce the motor load.	Note: The expander inlet pressure too low trip PALL-01171 is only active on train in operation and cooling valve FCV 01132 fully closed.	The operator will manually control the amount of HPCCU air flow to keep the expander outlet temperature above the trip set point for air (Trip below 8° C).
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 12 bar (a) Flow: ~275 t/h Power: approx. -27600 kW	Flow: 0 to 210 t/h Power: approx. +3508 kW with Temp.: 150°C	Cooling air temp.: approx. 150° C Flow: 65 t/h	Converter Power: +23300 KW	Overall loss: approx. -400 kW	

06. Expander warm up to 250 degC



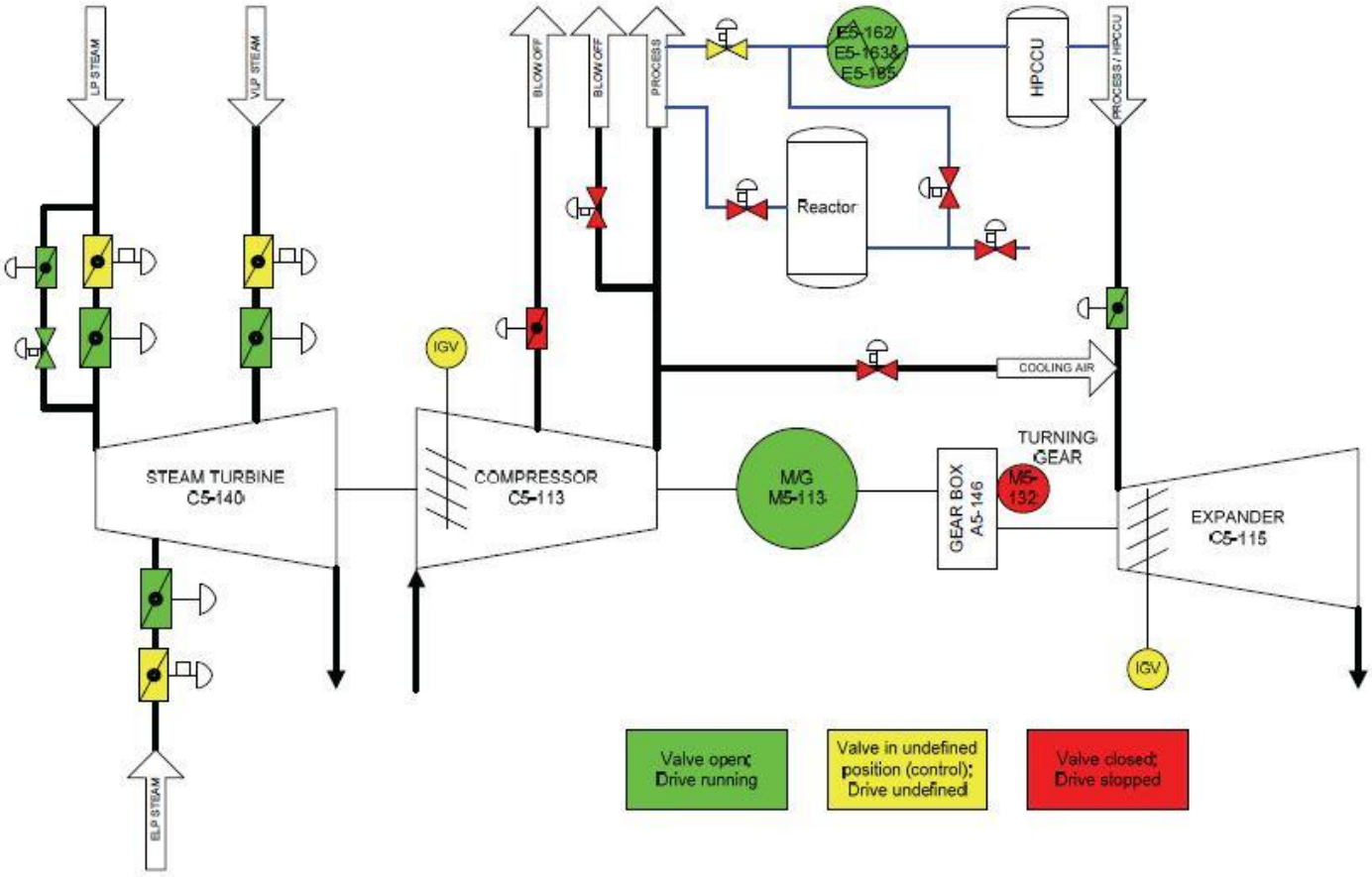
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
06	Expander Warm up to 250° C	The Heaters E5-162, E5-163 and E5-165 will warm up the air flow to HPCCU up to 290° C	No changes.	No changes.	The expander inlet flow temperature will increase. The expander IGV will be released if the inlet pressure reaches more than 5 bar (g).	No changes. (The closing of the cooling valve will be interlocked with the expander inlet flap open, an expander casing temperature above 270°C and an expander inlet pressure (PT-01171) of 3.0 bar(a) or more.)	The increase in expander recovery power will reduce the motor load.		The temperature increase of the expander inlet flow will produce additional power.
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 12 bar (a) Flow: ~275 t/h Power: approx. -27600 kW	Flow: 0 to 210 t/h Power: approx. +10000 kW with Temp.: 250°C	Cooling air temp.: approx. 150° C Flow: 65 t/h	Converter Power: +16800 KW	Overall loss: approx. -400 kW	

07. Closing of Cooling Air



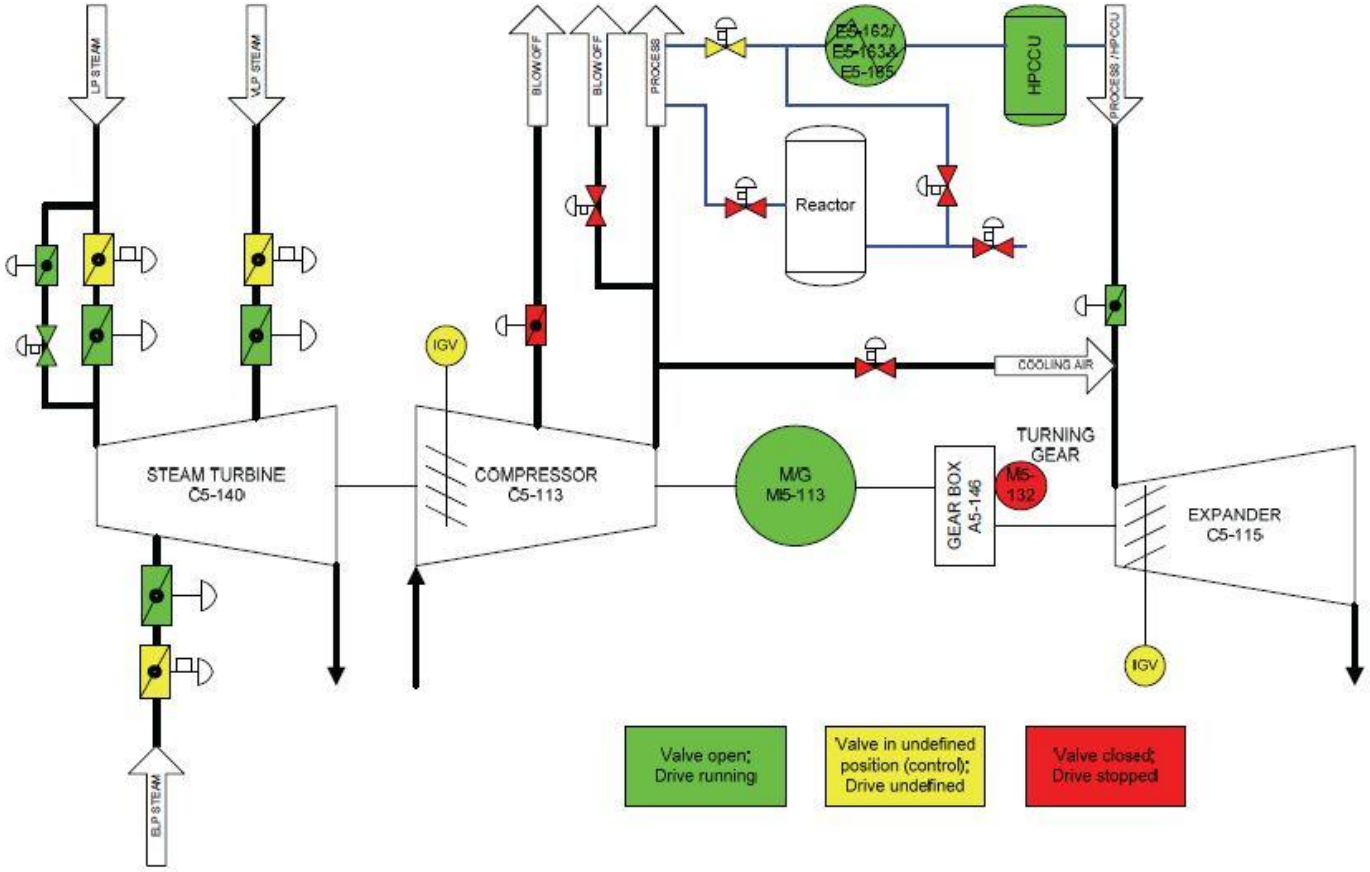
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
07	Close Cooling Air Valve	Because the expander flow over the HPCCU line is quite high, the cooling air flow could be stopped.	No changes.	The bypass air valve will open proportionally to the closing of the cooling air valve. The BOV will stay closed that way.	The expander inlet flow (passing the HPCCU) will now be up to 275 t/h. ~~Still the expander IGV are fully open and not released.~~	The operator manually will deactivate the cooling air mode. The control will close the cooling air valve very slowly to allow the bypass air valve to open proportionally. The closing release will be interlocked with the expander inlet flap open, an expander temperature above 270°C and an expander inlet pressure (PT-01171) of 3.0 bar(a) or more.	No changes.		The expander cooling mode would be required again, if the expander inlet flap will leave the "open" position or the expander inlet pressure PT-01171 will fall below 4.0 bar (a) (approx. 75 t/h). **But MAN DIESEL&TURBO was ask not to reactivate the cooling air mode, but to trip the train.**
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 12 bar (a) Flow: ~275 t/h Power: approx. -27600 kW	Flow: 275 t/h Power: approx. +10000 kW with Temp.: 250°C	-	Converter Power: +16800 KW	Overall loss: approx. -400 kW	

08. Compressor Discharge Pressure Control On



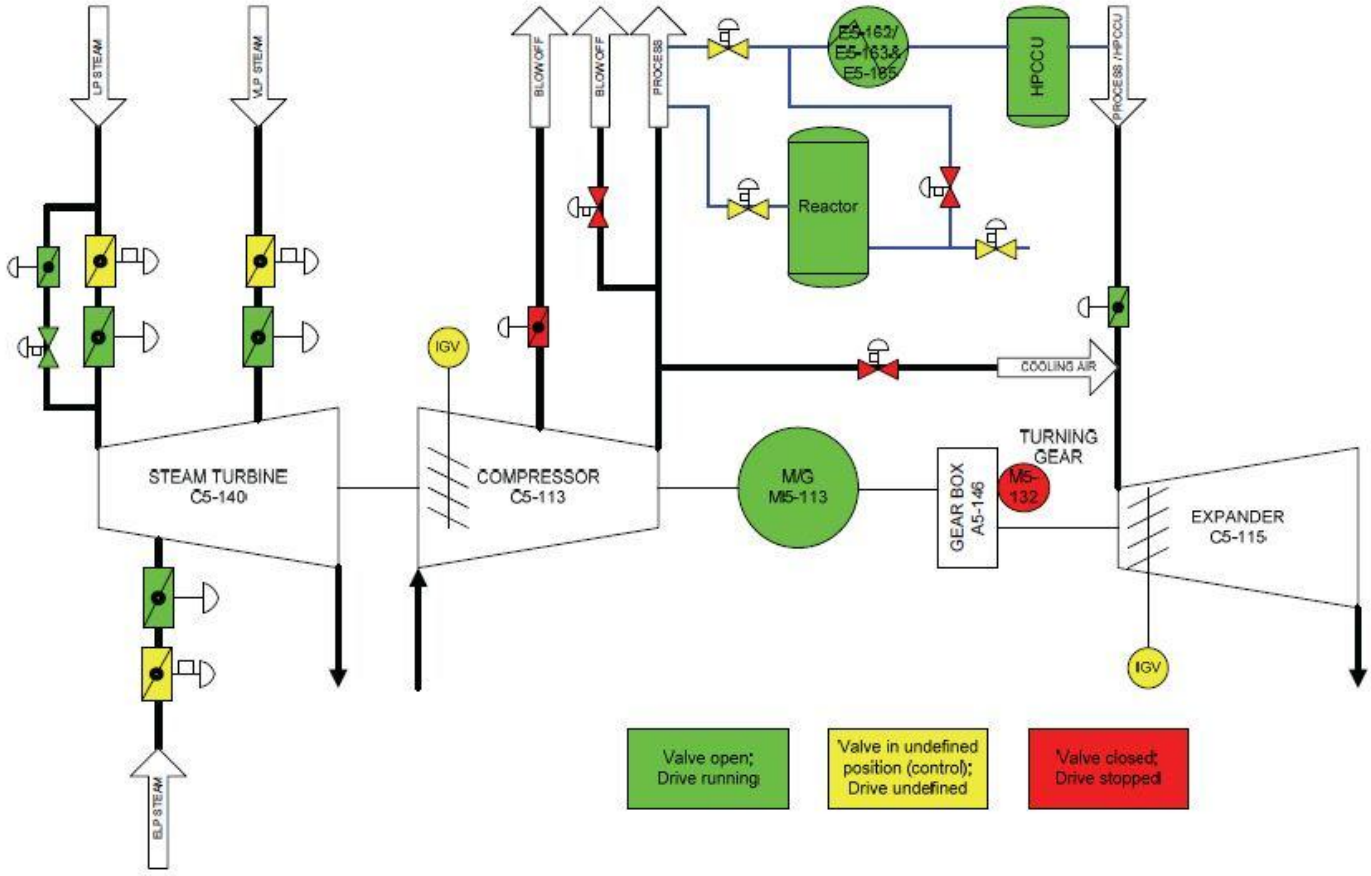
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
08	Compressor Discharge Pressure Control On	The pressure controller PC-01104 will be switched to "auto mode" by the operator.	No changes.	The operator will switch the discharge pressure controller to "auto". The actual value will be stored as set point to keep the IGV position. The discharge pressure set point can be changed now on the HMI of the MAN DIESEL&TURBO control panel (local mode). Usually a set point of 16 bar (g) will be set.	No changes, if compressor discharge pressure set point is not changed.	Not active.	No changes, if pressure set point is not changed.	Before activating the compressor discharge pressure control automatic mode, the trip valve in the process bypass line will be opened by the operators.	This step could be done earlier, but will have a direct impact to the power balance. With "auto mode" of the compressor discharge control and the expander inlet pressure (PT 01171) higher than 6 bar(a), the expander IGV control will be released in "manual and local mode".
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 16 bar (g) Flow: ~312 t/h Power: -33229 kW	Flow: 312 t/h Power: +21000 kW	-	Converter Power: approx. +11400 KW	Overall loss: approx. -400 kW	

09. Expander warm up to 360 degC (turndown)



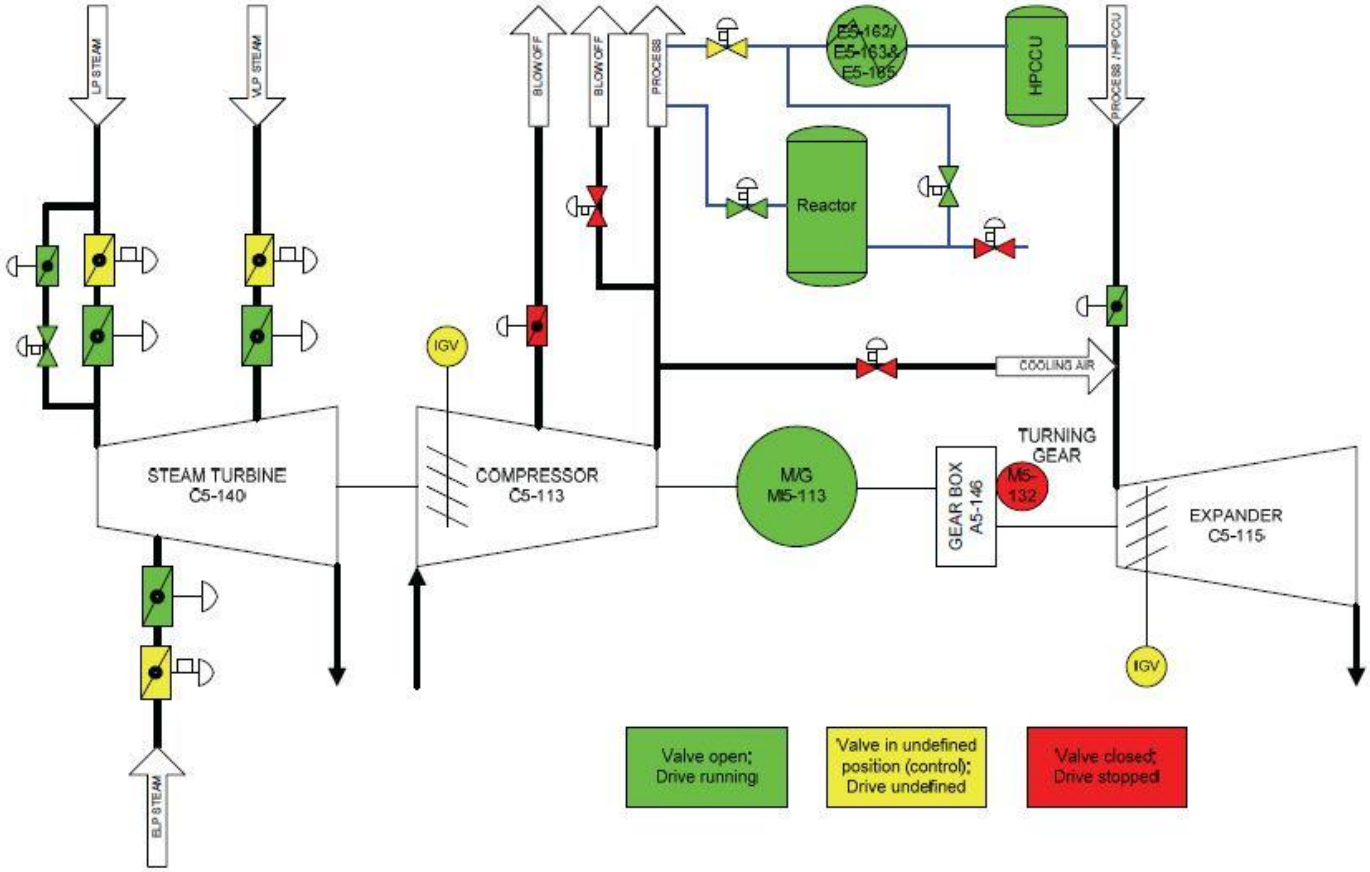
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
09	**Expander Warm up to 360° C (Turndown)**	With fuel combustion the HPCCU will heat up so the air coming to the expander will be approx. 360° C.	No changes.	No changes	The expander inlet temperatures will rise to 360° C. This will give extra expander power. The expander IGV might be moved manually to increase HPCCU line pressure. The expander IGV are released with a inlet pressure of more than 5 bar (g).	Not active.	A higher compressor flow will lead to an increase of motor power demand. But the increase of expander recovery power will keep the change small.	Bypass air pressure controller will be adjusted proportionate to bring all additional flow to the HPCCU. While increasing the HPCCU temperature the expander flange differential temperature (TDI-01280) should be monitored closely.	With the higher flow passing the HPCCU the fuel injection could be started to increase HPCCU temperature. To keep the fuel combustion alive a minimum flow to the HPCCU is required.
		Process Data:	**Speed: approx. 3021 rpm** **LP Flow: ~25 t/h (Cooling Steam)** **Power: +1200 kW**	**Discharge pressure: approx. 16 bar (g)** **Flow: ~312 t/h** **Power: -33229 kW**	**Flow: 312 t/h** **Power: +23900 kW** **With Temp. 360°C**	-	**Converter Power: approx. +8500 KW**	**Overall loss: approx. -400 kW**	

10. Reactor Start



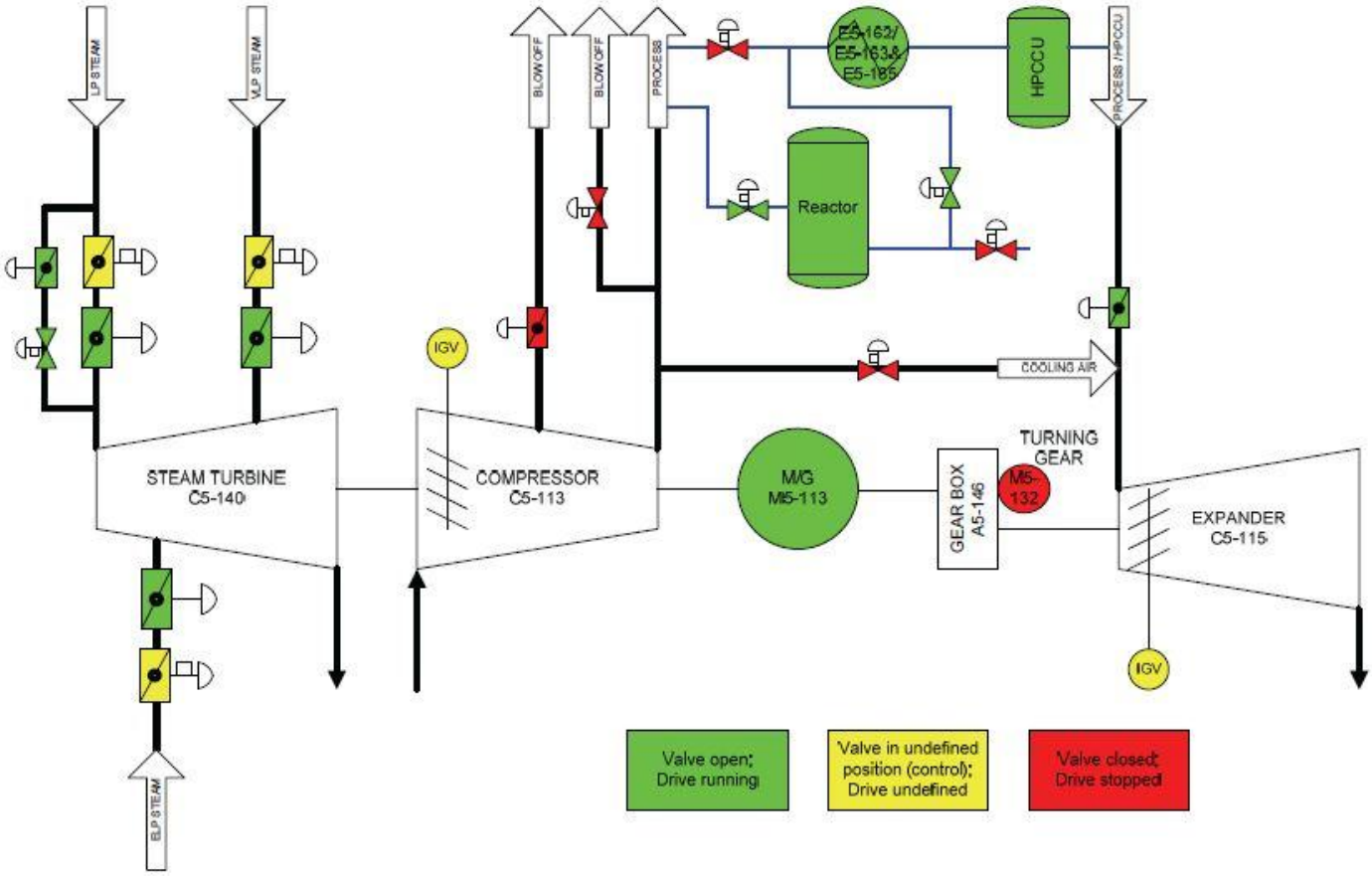
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
10	Reactor Start	During the first 3 to 4 minutes of reactor start the reactor will request a fixed air flow (16 te/h) and the expander air flow will be reduced by the same amount. During the next minute the air flow is ramped up to about 30 te/h and, again, the expander air flow will fall correspondingly.	No changes.	The compressor discharge pressure will be ramped in steps to 17.30 bar (a) for process requirements. The discharge pressure controller will equalize the air flow demand by opening the compressor IGVs, if the expander flow is not reduced equivalent. The compressor should not change.	Nearly 30 t/h will be send to reactor .	Not active.	Any increase of compressor air flow with constant air flow to the expander will lead to a rise of electrical motor power.	Inlet valves to the reactor will be opened within 4 minutes for a start-up flow of approx. 36 t/h.	The reactor air flow will not be send to the expander for energy recovery at this moment.
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 17.3 bar (a) Flow: ~445 t/h Power: -45000 kW	Flow: ~314t/h Power: +24200 kW	-	Converter Power: approx. +15171 KW	Overall loss: approx. -400 kW	

11. Reactor online “Offgas mode”



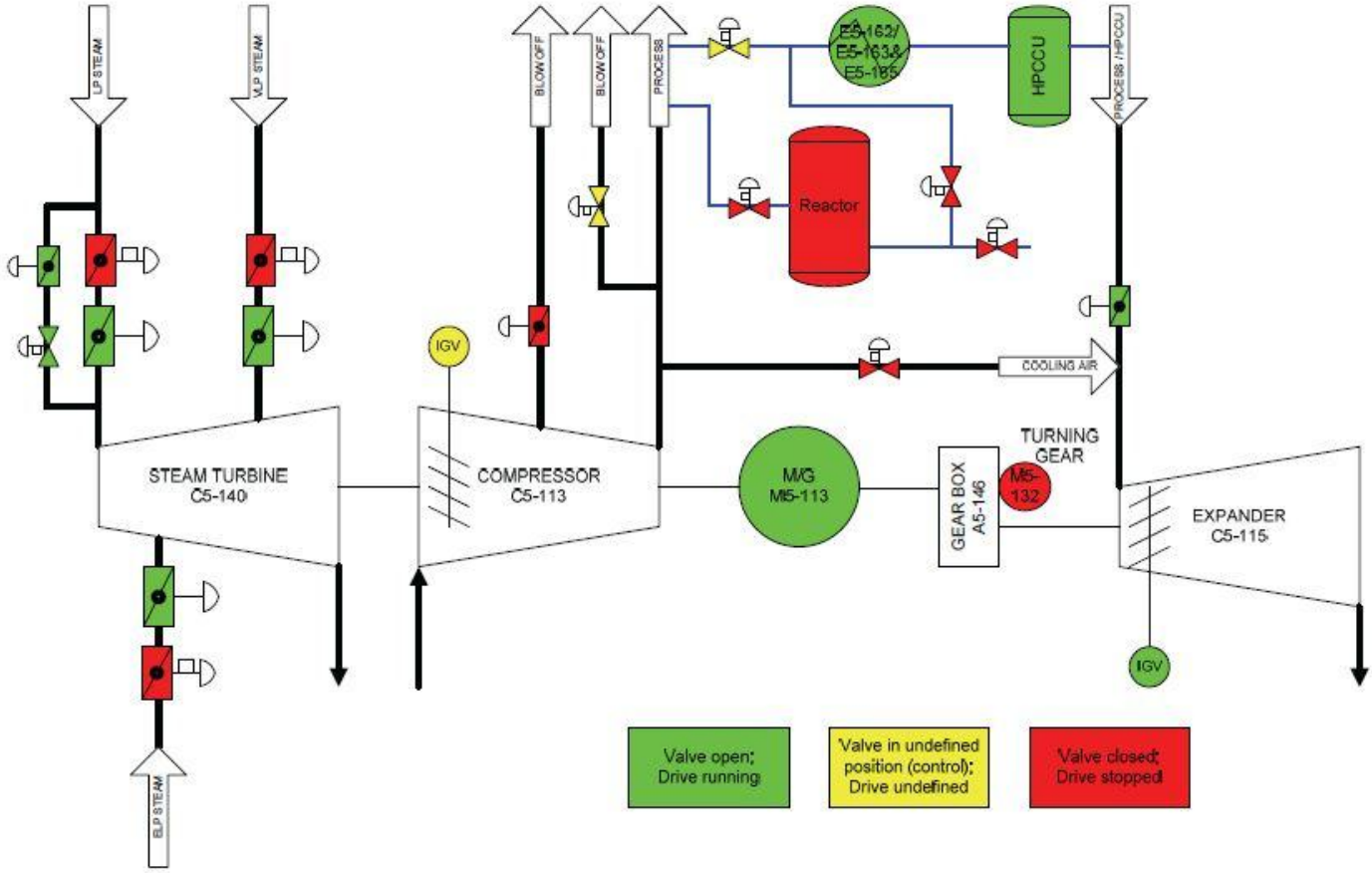
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
11	Reactor Online “Off-gas Mode”	Towards the end of the 4th or 5th minute (after reactor start) about 24 te/h of offgas will be fed to the expander in addition to the bypass air. In the next 3 to 4 minutes the air flow to the reactor continues to be increased at about 30 te/h per minute until it reaches 120 to 150 te/h. The air flow to the expander is reduced to keep the total flow from the compressor approximately constant and the offgas flow to the expander increases to about 96 to 120 te/h. After about 8 minutes the air flow to the reactor and offgas flow to the expander are stabilised for a period while other plant systems are established.	Any steam flow available will be brought to the ST by the steam line pressure controls. See remarks.	When the reactor off-gas is brought to the HPCCU, the bypass air control will keep the pressure / flow constant. So the compressor discharge flow should not be changed by that.	A mixture of off-gas and bypass air is give to the expander. The amount of air is depending on the actual reactor flow rate. With reactor online (no reactor trip), the expander exit temperature trip will be switched to “process gas” set point.	Not active.	The motor load will be reduced with the increase of expander flow. Depending on the available steam flow to motor power could be reduced even more. On high steam flow the power could be negative (generator mode).		Because the amount of steam is not known, the power balance is not clear at this point. However, the shown motor load is the worst case estimation. If more steam is available the motor can switch into generator mode.
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 17.3 bar (a) Flow: ~445 t/h Power: -45000 kW	Flow: ~314t/h Power: +24200 kW	-	Converter Power: approx. +15171 KW	Overall loss: approx. -400 kW	Approx. 80% of the reactor air flow will be usable for off-gas flow.

12. Normal Operation (Guarantee)



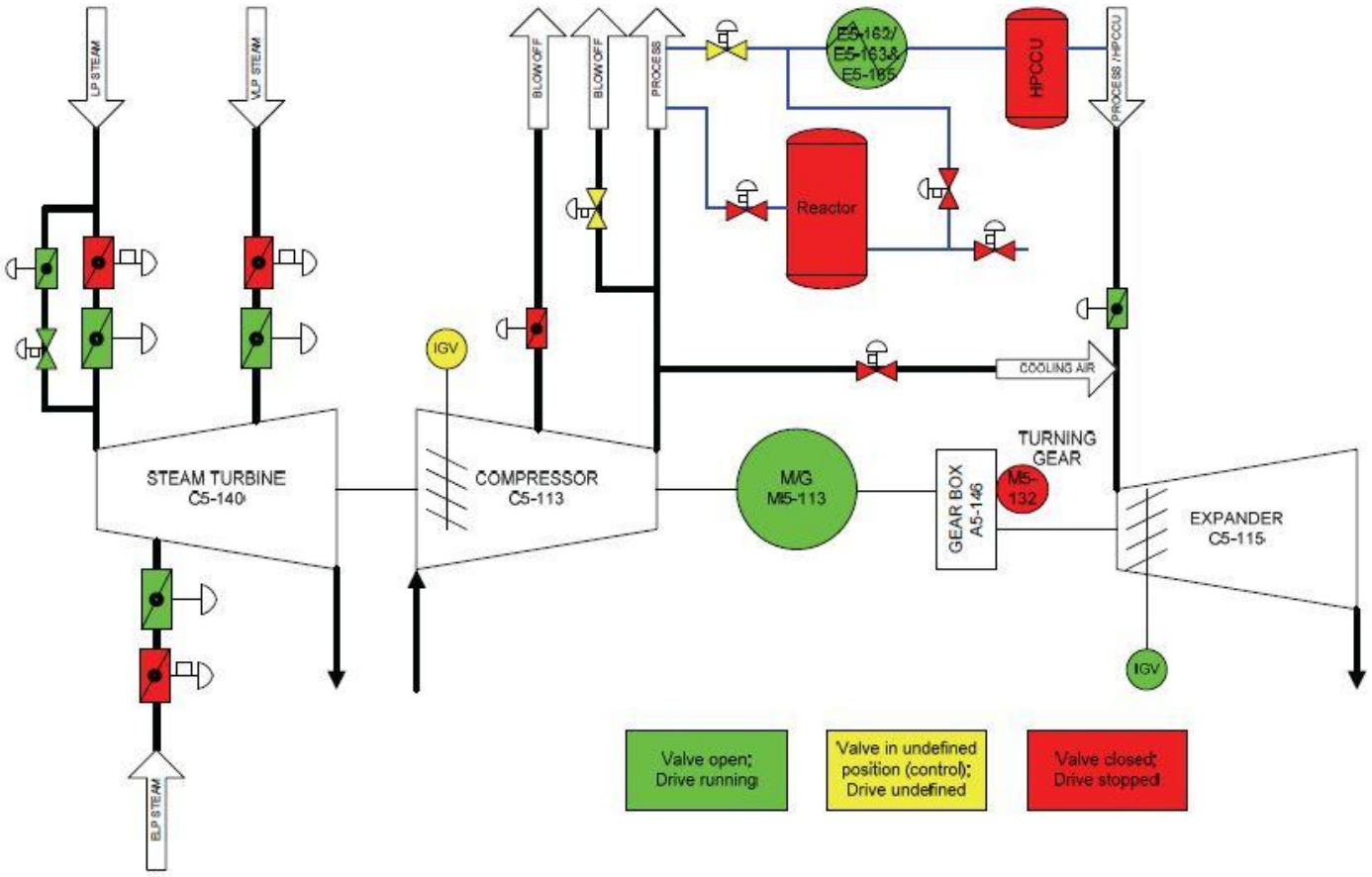
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
12	Normal Operation (Guarantee)	The compressor is operating at the "normal" point. (With amb. temperature of 33°C)	On normal operation the steam amount will be for LP at 122 t/h, ELP at 143 t/h and VLP at 69 t/h flow.	The "normal" compressor flow will be 445 t/h of air.	Only a reduced amount of the compressor flow will reach the expander as off-gas.	Not active.	The "motor" will generate electrical power at the latest now.		
		Process Data:	LP: 122 t/h ELP: 143 t/h VLP: 69 t/h Power: approx. +36300 kW	Flow: 445 t/h Power: approx. -45000 kW	Flow: 314 t/h Power: approx. +24360 kW	-	Power: approx. -15171 kW	Overall loss: approx. -400 kW	Approx. 80% of the reactor air flow will be usable for off-gas flow.

13. Reactor Trip "Powerswing"



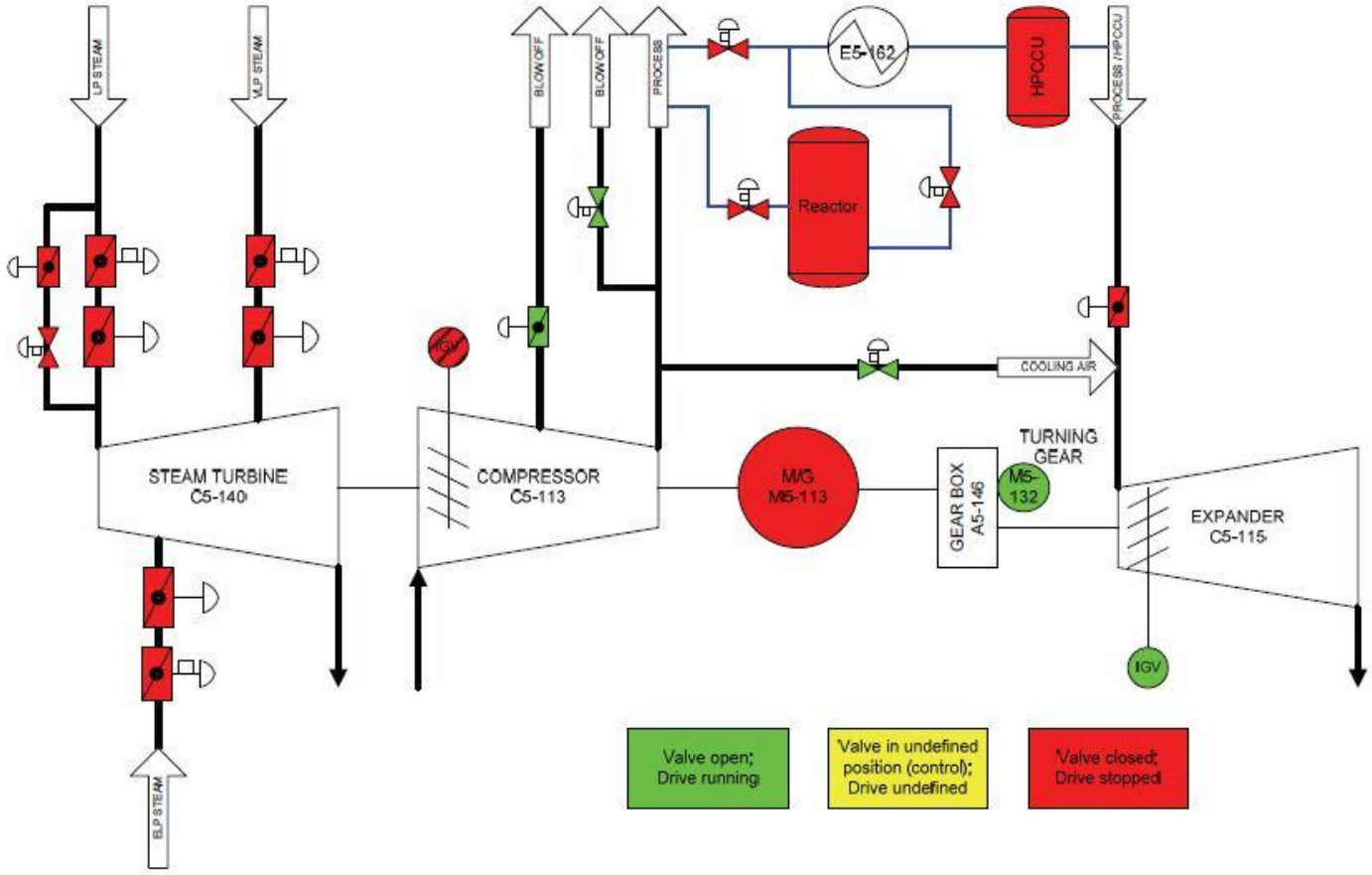
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
13	Reactor Trip "Powerswing"	The trip of the reactor will be indicated by XS-01197. Simultaneously the reactor will be isolated within 6 seconds (to 0% flow). The bypass air control will open the valves in two to five seconds to keep the HPCCU flow above the required flow. The air consumption will drop quite fast to 312 t/h only.	The cooling steam valve PCV-01435 will be kept completely open. All other turbine inlet valves will close by pressure control, except PCV222004A which will remain partly open because some VLP steam is still available.	On reactor trip the compressor discharge controller output will be switched to a fixed set point of 16.3 bar (g) for 30 seconds and "auto local mode". If the compressor flow was above 380 t/h on reactor trip, the blow-off valve will open additional 10% for 7 seconds	The expander inlet flow will switch from off-gas (via reactor) to air (via HPCCU). The overall flow will change to 312 t/h. On reactor trip the expander IGV will be forced to approx. 48° position and set to manual control.	Not active Note: If the expander inlet pressure will fall during switch over from reactor to bypass flow, the cooling will not be reactivated but a **train trip** will be initiated.	The motor/generator has to take care of a power swing starting with generator mode to motor mode within 4 seconds. On reactor trip the motor excitation should be activated to allow a powerswing.		Any reactor trip will bring the train to **"Turndown" operation (09).**
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) VLP: 37 t/h Power: +2300 kW	Discharge pressure: approx. 16 bar (g) Flow: ~392 t/h Power: -40325 kW	Flow: 392 t/h Power: +28900 kW	-	Converter Power: approx. +9500 KW	Overall loss: approx. -400 kW	

14. HPCCU Trip



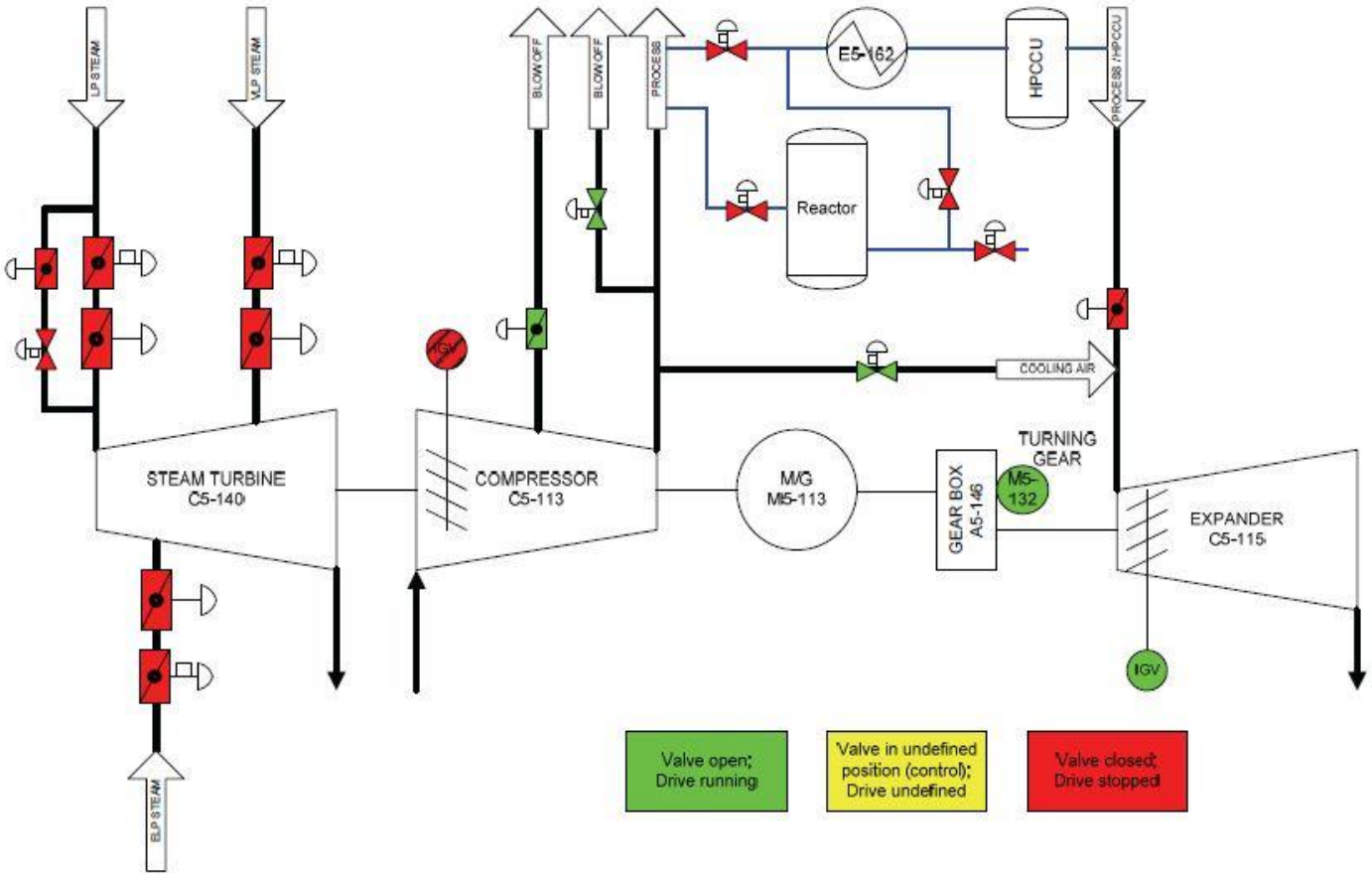
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
14	HPCCU-Trip (No indication to MAN DIESEL&TURBO)	On a trip of the HPCCU the reactor will be tripped immediately. A "HPCCU-trip" signal will not be give to the UCP. But because of the forced reactor trip the PAC train will react identical to step 16 "reactor trip".	See "Reactor Trip".	See "Reactor Trip".	See "Reactor Trip". The bypass air temperature will be reduced slowly.	See "Reactor Trip".	See "Reactor Trip". Reduced air temperature will lead to higher motor power consumption.		See "Reactor Trip".
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) VLP: 37 t/h Power: +2300 kW	Discharge pressure: approx. 16 bar (g) Flow: ~392 t/h Power: -40325 kW	Flow: 392 t/h Power: +28900 kW going down	-	Converter Power: approx. +9500 KW and more	Overall loss: approx. -400 kW	

15. Shutdown of PAC train



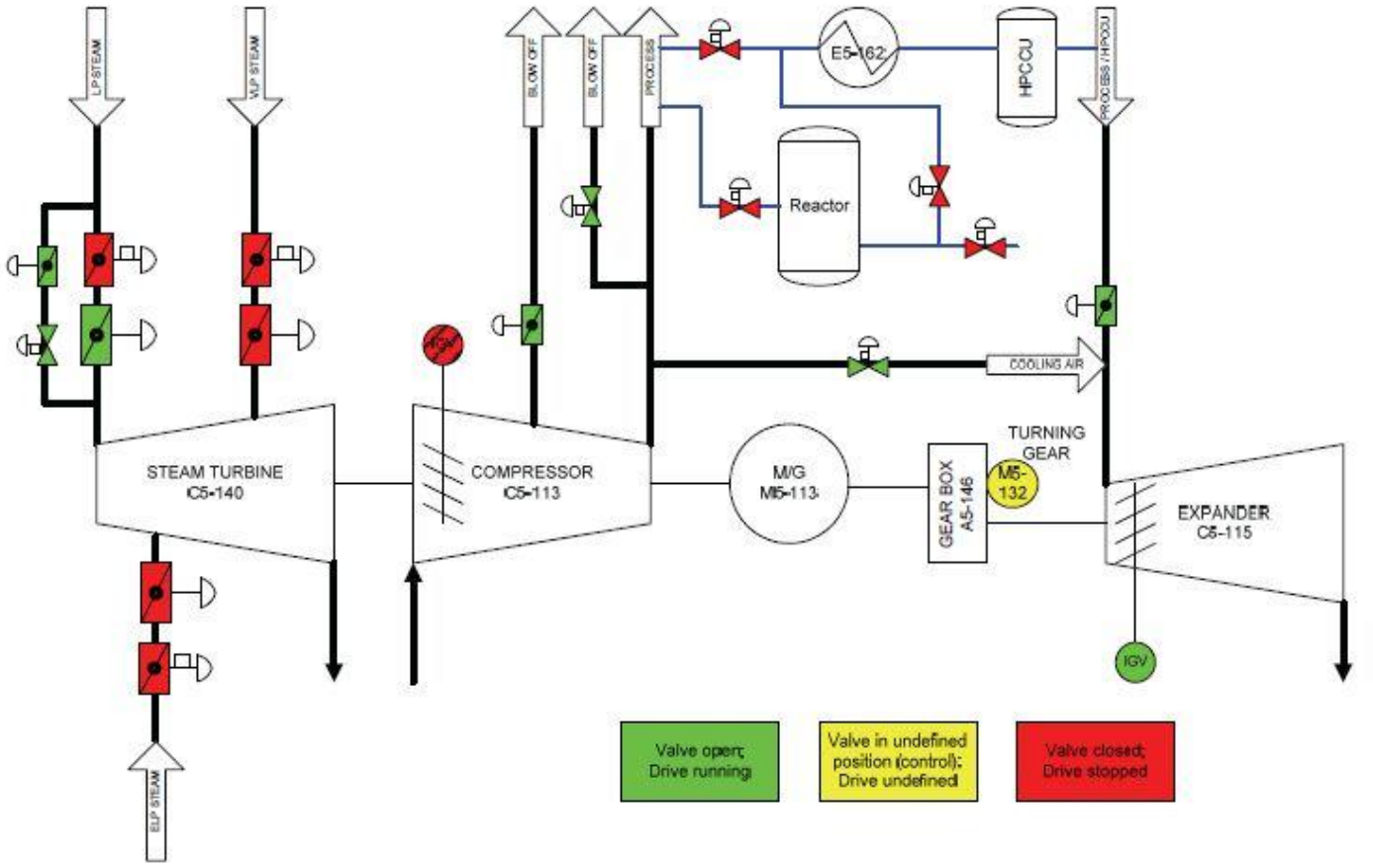
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
15	SHUT DOWN of PAC train	A shut down of the train will be initiated either by the operator (emergency shut down or normal stop) or by the UCP shut down system. On a normal shut down compressor and expander load will be reduced by the operators. First the reactor flow will be reduced, afterwards the HPCCU will be tripped and the heater E5-162, E5-163 and E5-165 stopped. In the end the train will be stopped manually when the expander exit temperature will fall to approx. 20° C.	All ST inlet valves will be quick closed within 2 seconds.	The BOV will be quick opened (< 2 sec.) and the interstage unload flap will open afterwards. The compressor IGV will be moved to start up position (80°) with a delay of 30 Seconds.	The expander inlet flaps will be closed within 1 second only.	The cooling air valve will be used on the train run down to clear the expander from off-gas remains (purge). The amount of air required could be less than the minimum cooling air (65 t/h). On falling discharge pressure of the compressor the cooling valve will open more and more until it will be completely open.	The motor/gen. will be switched to "no load" immediately. A shut down will initiate the deenergizing of the converter.	With the shut down signal the expander sealing air supply will be switched to external supply. When the expander flange temperature will fall below 150° C the expander gland seal gas will be activated for 30 minutes after a shut down. The turning gear will be started below 1000 rpm and engage automatically when the shaft speed is reaching turning speed.	The UCP shut down system will distinguish between a delayed shut down (BOV will open immediately and the drives will be stopped with 2 seconds delay) and an undelayed shut down (e.g. ESD).
		Process Data:							

16a. Hot Restart (Turning Speed)



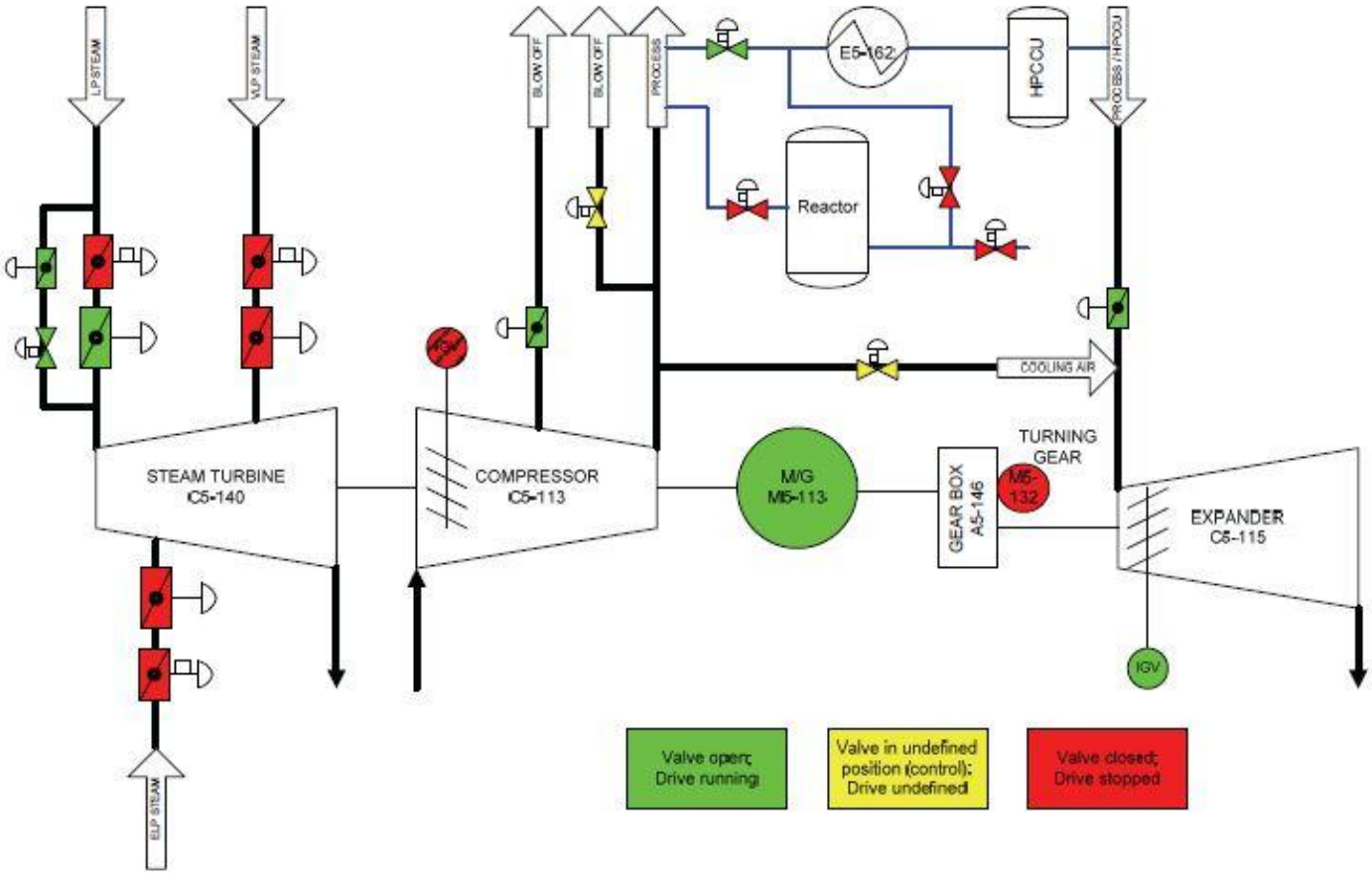
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve FCV-1129	Motor / Gen.	Other	Remarks
16a	Hot-Restart Turning-Speed	The train is running on turning gear with approx. 50 rpm. For a "Hot-Restart" the bypass air line valves (by others) XSV 01604 and HS 01118 must be open in an early stage.	All ST inlet valves are closed. The seal steam is activated already. In this mode the ST and all steam lines are warmed up and drained. The ST vacuum system must be in operation.	The Blow-Off valve FCV-01107 (BOV) and the interstage unload flap (FV-01158) are fully open. The IGV GY-01102 are set for "motor start" (approx 80°). All coolers should be activated.	The expander inlet flap (XSV 01105) is closed. Expander IGV ET-01117 fully open. Seal air is not active (XSV-01180 closed).	The cooling air mode is active already. Because of very low compressor discharge pressure the cooling air valve (FCV-01132) will be fully open but in control mode.	The motor / gen. is in "no load" operation. The cooling water flow must be activated. The frequency converter should be "ready to start" with cooling active.	The lube and jacking oil supply must be active.	All start up interlocks should be met. Before a "Restart" of the train the expander vibrations should be monitored closely. If the vibration level has risen significant already the "Restart" will not succeed.
		Process Data:							NOTE: Emitted coupling power will be "+"; absorbed coupling power will be "-".

16b. Hot Restart (Acceleration to IDLE speed)



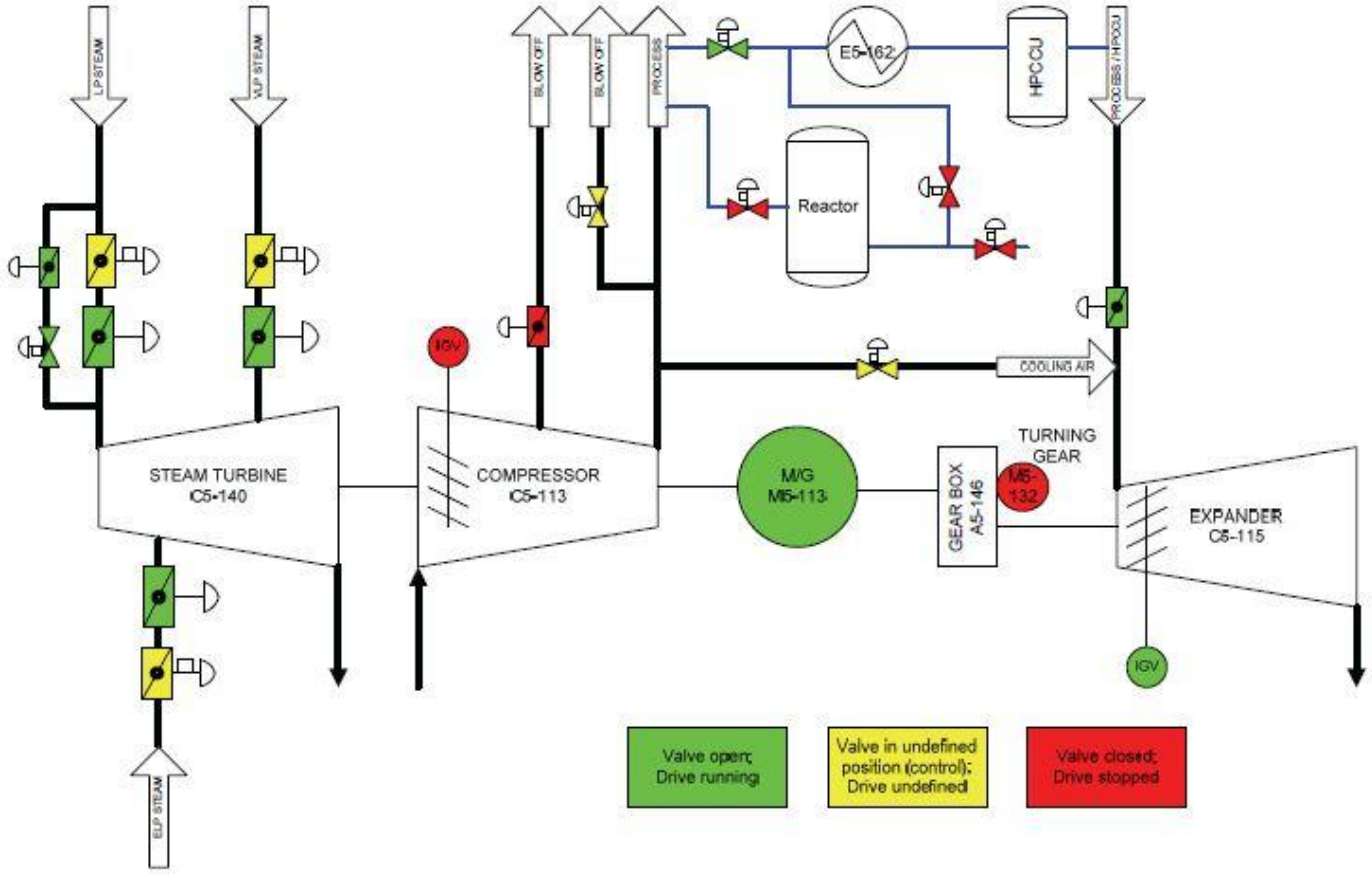
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
16b	Hot-Restart Acceleration to "Idle Speed"	After start of the train some trip valves of the steam turbine will open and the lines between trip valve and control valve should be warmed and drained. The acceleration of the steam turbine has to be initiated manually by the operators. With full cooling steam flow the train will reach approx. 23% of speed (~700 rpm).	The Cooling Steam valve PCV-01435 will be opened controlled. With a LP cooling steam flow of approx. 25 t/h the train will be accelerated to roughly 23% speed. Check condenser level control at this step.	With rising speed the discharge pressure will rise slightly.	On a "Hot Restart" (start with an expander casing temp. above 270°C) the expander inlet flap will open with the train start signal.	With rising compressor discharge pressure the cooling air flow will rise. But it will not reach the set point of 65 t/h.	No changes.	The turning gear will be disengaged automatically when the train speed will exceed turning speed.	The train can run unlimited on idle speed.
		Process Data: **(All values are roughly calculated or estimated.)**	**LP Flow: approx. 25 t/h** **Power: +??? kW**	**Discharge pressure: < 2 bar (a)**	**Inlet pressure: not predictable.**	**Cooling air temp.: approx. 150° C**			**NOTE: Emitted coupling power will be "+"; absorbed coupling power will be "-".**

16c. Hot Restart (Acceleration to Normal Speed)



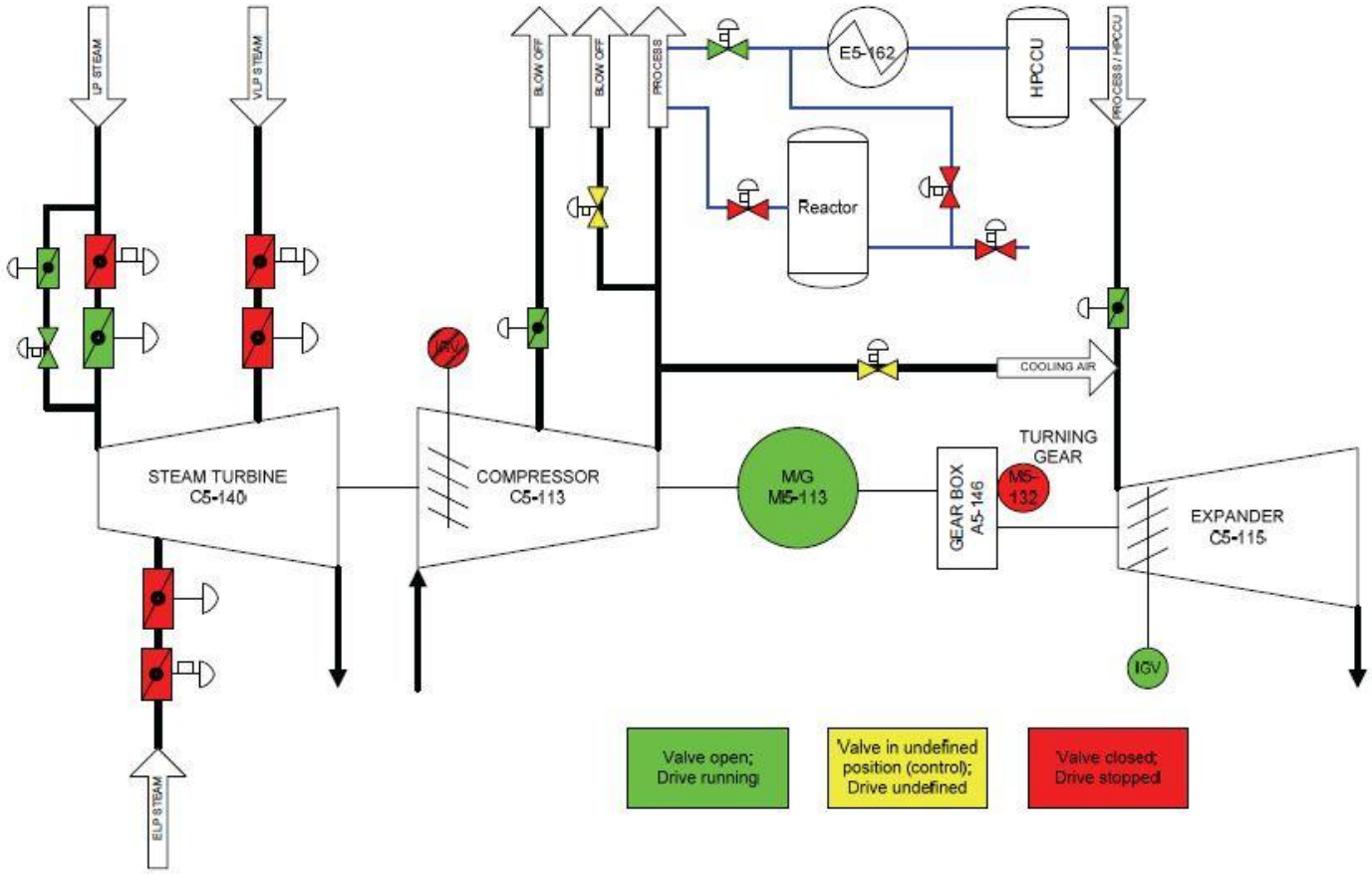
No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
16c	Hot-Restart Acceleration to "Normal Speed"	The converter will bring the motor up to net frequency only (approx. 100% speed), after the steam turbine has finished its ramp up, the expander inlet is already open and the bypass air line valves XSV 01604 and HS 01118 are open (by others). Otherwise the train will stay in idle speed until all requirements are fulfilled.	The cooling steam valve PCV-01435 stays open. With increasing speed the turbine power will decrease on constant cooling steam flow.	With rising speed the discharge pressure will rise more. **Eventually the BOV will be throttled to raise the discharge pressure and allow more flow tom the expander.** Still interstage unload flap is fully open. IGV are on 80° position.	No changes.	The cooling air flow may reach 65 t/h depending on the compressor discharge pressure. If the pressure will exceed, the cooling air valve will start to throttle to control flow.	If released, the frequency converter picks up the train at the actual speed and brings it up to full speed.	When the ST speed climbs over 800 rpm the turning gear motor and the jacking oil pumps will be stopped automatically.	The compressor IGV are still on 80°. Therefore the discharge pressure and flow are quite low. The actual compressor power consumption is not calculable.
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: < 10 bar (a) Power: unknown Flow: ~180 t/h	Power: unknown	Cooling air temp.: approx. 150° C	Converter Power: +18500 KW	Overall loss: approx. -400 kW	**To allow a start up with reduced converter power the compressor IGV must be set to "Motor Start" position (~80°).**

16d. Hot restart (Motor Loadable)



No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
16d	Hot-Restart Motor load-able	After the motor has reached a speed of 100% for some seconds, a signal "motor loadable" will be provided form the SFC. The compressor is released to take load.	The cooling steam valve PCV-01435 keeps the cooling steam flow constant at 25 t/h. **Optional:** With the speed fixed to the converter frequency, the steam line inlet valves could be switched to pressure control already. If any steam is available it will be used to reduce to motor load.	The compressor IGV will move to "Min. control pos." position (~70°). **Afterwards** the interstage unload flap will be closed. Finally the anti-surge controller (ASC) will be released and will close very slowly the BOV until the control line is reached.	No changes.	The cooling air flow will be constant 65 t/h. Because of the high compressor discharge pressure the cooling air valve will throttle more.	The frequency converter has brought the motor to the normal speed.	The compressor discharge temperature control TC 01155 will remain in manual mode (with TCV 01155 fully closed) until the interstage unload flap will reach the closed position (GSC 01158).	From the approx. 250 t/h of compressor dis-charge flow only 65 t/h will be used for expander cooling air. Therefore approx. 185 t/h will be vented by the BOV.
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 10 bar (a) Flow: ~250 t/h Power: approx. -24600 kW	Power: unknown	Cooling air temp.: approx. 150° C Flow: 65 t/h	Converter Power: +23350 KW	Overall loss: approx. -400 kW	

16e. Hot Restart (Subsequent)



No.	Name	Description	Steam Turbine	Compressor (Discharge)	Expander (Inlet)	Cooling Air Valve	Motor / Gen.	Other	Remarks
16e	**Hot-Restart subsequent**	Because the expander flow over the HPCCU line is quite high, the cooling air flow could be stopped. Afterwards the compressor discharge pressure controller will be activated **in the same way as shown in step 7 and 8 of a normal start-up.**	No changes.	The operator will switch the discharge pressure controller to "auto". The actual value will be stored as set point to keep the IGV position. The discharge pressure set point can be changed now on the HMI of the MAN DIESEL&TURBO control panel (local mode). Usually a set point of 16 bar (g) will be set.	No changes, if pressure set point is not changed.	Not active.	No changes, if pressure set point is not changed.	Before activating the compressor discharge pressure control automatic mode, the trip valve in the process bypass line will be opened by the operators.	The expander cooling mode would be required again, if the expander inlet flap will leave the "open" position or the expander inlet pressure PT-1171 will fall below 4.0 bar (a) (approx. 75 t/h). **But MAN DIESEL&TURBO was ask not to reactivate the cooling air mode, but to trip the train.**
		Process Data:	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW	Discharge pressure: approx. 16 bar (g) Flow: ~312 t/h Power: -33229 kW	Flow: 312 t/h Power: +21000 kW	-	Converter Power: approx. +11400 KW	Overall loss: approx. -400 kW	Speed: approx. 3021 rpm LP Flow: ~25 t/h (Cooling Steam) Power: +1200 kW

7. Pressure Relief Systems

A) RV/10101A and RV10101B Relief Valves PAC Air Common Discharge

Process Air Compressor is provided with two Pressure Safety valves RV/10101A and RV10101B on the common discharge line from PAC. The air from the PSV's is vented to safe location during relief. The PSV's are Pilot operated.

Additional details are as provided under:

- No. of Safety valves: 2
- Safety Valve RV/10101A Set Pressure: 20.2 barg
- Safety Valve RV/10101A Set Pressure: 19.8 barg

B) RV/E5-141A and RV/E5-141B Relief Valves Steam Turbine Condenser

Tube Side of the Steam turbine condenser, E5-141 is provided with Pressure Safety valves RV/E5-141A and RV/E5-141B on both the Cooling water return lines. The relieved fluid (water) from the PSV's is directed to drain.

Additional details are as provided under:

- No. of Safety valves: 2
- Safety Valve RV/E5-141A Set Pressure: 6.8 barg
- Safety Valve RV/E5-141B Set Pressure: 6.8 barg

8. Safety Aspects

8.1 Hazardous Area Classification

The entire PAC area is classified as Non-hazardous zone (Zone 0).

8.2 Fire and Gas Detection System

Several manual alarm call points (05 nos.) are provided at different elevations the details of which can be seen from the reference P&IDs mentioned earlier.

Due to use of Offgas (containing nitrogen as a major component and also hazardous Carbon monoxide in very small quantity) in Expander, hazard can arise in case of leakage of this Offgas to cause deficiency of oxygen. Hence Oxygen Deficiency detectors are provided to monitor the Oxygen inside the PAC

house.

Flame detectors (2 nos.), Oxygen Deficiency detectors (2 nos.), Methanol Gas detector (1 nos.) are also provided to warn personal of abnormal situations.

Multi-tone sounders (02 nos.) are provided to alert personnel about various situations.

9. Troubleshooting

For troubleshooting refer ***topic - 6.6.4 Troubleshooting in vendor Document "Operating Instructions Part I - 10005-GPZ105-MS0S01-7342371-N02-008-00"***

Annexure A: PFD and Stream Summary

DRAWING No 11010/00/10/00002 REV P11

SUPPORT FUEL FROM G5-2801A/B 00025

SUPPORT FUEL FLOW CONTROL 00025

H5-169 OFFGAS STATIC MIXER

H5-166 SUPPORT FUEL INJECTOR

E5-165 COMBUSTOR INTERHEATER

D5-167 CATALYTIC COMBUSTOR

VLP STEAM 00014

ELP STEAM 00014

LP STEAM 00014

HP STEAM 00014

E5-163 THIRD COMBUSTOR PREHEATER

CONDENSATE 00014

MP STEAM 00014

E5-162 SECOND COMBUSTOR PREHEATER

CONDENSATE 00014

NNF

LP STEAM 00014

E5-161 FIRST COMBUSTOR PREHEATER

CONDENSATE 00014

FROM D5-310 00003

F5-160 OFFGAS KNOCKOUT DRUM

TO PROCESS DRAIN

INTERCOOLERS CW CWR

C5-113 PROCESS AIR COMPRESSOR

MOTOR/ GENERATOR

C5-155 OFFGAS EXPANDER

C5-140 STEAM TURBINE

E5-141 STEAM TURBINE CONDENSER CW CWR

G5-142A/B STEAM TURBINE CONDENSATE PUMP

M5-112 INLET AIR FILTER

WATER FROM INTERCOOLER DRAINS

BLOW OFF

A5-135 INTERCOOLER CONDENSATE PIT

G5-136 INTERCOOLER CONDENSATE PUMP

VENDOR PACKAGE DETAILS VENDOR DEPENDENT

TO E5-927 00012

VENT TO ATMOSPHERE

FROM C5-540 00006

FROM M5-921A/B 00012

FROM D5-928 00012

NNF

D5-172 OFFGAS SCRUBBER

LP 5% CAUSTIC

DEMIN WATER

FROM G5-632A/B 00008

X5-180 SODIUM FORMATE

TO D5-928 00012

FROM E5-930 00012

FROM E5-927 00012

FROM D5-310 00003

G5-173A/B OFFGAS SCRUBBER RECIRCULATION PUMP

TO ETP BUFFER TANKS 00031

FROM E5-2234 00014

TO FEED WATER HEATING 00014

TO D5-301 00003

TO D5-401 00004

CW RETURN

NOTES:
1. STACK EMISSIONS FROM D5-172 WILL DETERMINE WHETHER OXIDATION WASTE WATER FROM G5-632A/B OR DEMIN WATER IS USED AS THE NORMAL SUPPLY.

LINE IDENTIFICATION NUMBERS THUS ARE FOR REFERENCE TO MASS BALANCE SHEET 11010/00/11/00001

ISSUE	REVISION	GRID	DRN	APP	DATE	FILMED
P11	HPCCU CONTROL SCHEME CORRECTED	B2-J4	RR		14.10.10	
P10	FLAG RELABELLED.	A2	APJL		27.09.10	
P9	FLAG CORRECTED.		APJL		06.09.10	
P8	REVISED FOLLOWING RIL TELECON.		JO'B		02.08.10	
P7	REVISED TO REFLECT P7 DEVELOPMENT.		JO'B		15.06.10	

DRG TITLE: PROJECT No: 11010

RIL PTA PLANT 5 1120kte – Pure Terephthalic Acid Plant
OXIDATION – PROCESS AIR COMPRESSION & OFFGAS TREATMENT
PROCESS FLOW DIAGRAM

WORKS: BUILDING: PLANT: SECTION:
GEOG. AREA: SYSTEM No:
P.L.C'S:
SCALES:
DRG TYPE: DO LOC:
DRAWN BY: DATE:
CHECKED: DATE:
APPROVED SECTION DATE
PROCESS
PROJECTS

INVISTA

DRG SIZE A0

DRAWING No 11010/00/10/00002 REV P11

CONFIDENTIAL TO INVISTA

Stream Number	1	2	3	20	25	27	28	29a	29b	29c	30	31
	Total Plant Air	Reactor Air	Secondary Oxidation Air	HP Absorber Offgas	Offgas Spray Water	Offgas KO Drum Vapor	Offgas KO	Offgas Exit 1st Preheater	Offgas Exit 2nd Preheater	Offgas Exit 3rd Preheater	Offgas Exit Interchanger Cold Side	Combustion
ACETIC ACID	0.0	0.0	0.0	27.3	0.0	9.9	17.3	9.9	9.9	9.9	9.9	0.0
WATER	4219.1	4104.9	114.2	1723.8	1200.0	1786.2	1137.6	1786.2	1786.2	1786.2	1786.2	0.0
OXYGEN	103287.0	100492.0	2795.6	14534.8	0.0	14534.7	0.0	14534.7	14534.7	14534.7	14534.7	0.0
NITROGEN	341128.0	331895.0	9233.2	339830.0	0.0	339829.0	0.2	339829.0	339829.0	339829.0	339829.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	1542.8	0.0	1542.8	0.0	1542.8	1542.8	1542.8	1542.8	0.0
CARBON DIOXIDE	203.4	197.9	5.5	7189.1	0.0	7188.9	0.2	7188.9	7188.9	7188.9	7188.9	0.0
HYDROGEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PARAXYLENE	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.0
TA SOLIDS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CBA SOLID	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P- TOLUIC ACID	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BENZOIC ACID	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METHYL ACETATE	0.0	0.0	0.0	235.7	0.0	234.9	0.8	234.9	234.9	234.9	234.9	0.0
PROPYL ACETATE	0.0	0.0	0.0	0.3	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.0
COBALT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANGANESE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROMIDE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METHYL BROMIDE	0.0	0.0	0.0	27.7	0.0	27.7	0.0	27.7	27.7	27.7	27.7	0.0
PROPANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	367.4
BYPRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OXALATE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SODIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CARBONATES	0.0	0.0	0.0	0.000	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL (kg/hr)	448837.0	436689.0	12148.5	365111.0	1200.0	365155.0	1156.3	365155.0	365155.0	365155.0	365155.0	367.4
MEAN MOL. WT. (kg/kmo	28.7	28.7	28.7	28.3	18.0	28.3	18.2	28.3	28.3	28.3	28.3	32.0
TEMPERATURE (°C)	160	160	160	44	40	43	43	130	170	290	351	40
PRESSURE (bara)	17.50	15.64	14.07	13.14	21.00	12.33	12.33	11.96	11.85	11.58	11.37	15.00
DENSITY (kg/m3)	13.9	12.4	11.2	14.2	995.4	13.3	993.0	10.1	9.1	7.0	6.2	774.9
ENTHALPY (kW)	720	700	19	-24789	-5271	-25027	-5034	-15731	-11447	1510	8184	-729
SOLIDS (%w/w)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VISCOSITY (Cp)	0.0241/	0.0240/	0.0240/	0.0187/	/0.671	0.0186/	/0.6416	0.0223/	0.0238/	0.0282/	0.0302/	/0.4467

Stream Number	32	33	34	35	36	38	39	40	41	42	43	44	94	143
	Combustor Offgas feed	Combustor Offgas product	Offgas to Drier Scrubber	Offgas to expander	Expanded Offgas	Offgas to Atmosphere	Offgas Scrubber Base liquid	Scrubber Liquid Recirculation	Offgas Scrubber Effluent	Caustic to Offgas Scrubber	Offgas Scrubber Fresh liquid	Water for Desuperheating	Atmospheric Scrubber vent	Offgas D.Scrub. Liquid effluent
ACETIC ACID	9.9	0.2	0.0	0.2	0.2	1.5	70.9	63.5	7.1	0.0	63.5	8.4	0.0	0.0
WATER	1786.2	2378.5	331.9	2046.6	2046.6	14053.8	182575.0	163562.0	18218.5	6507.4	170069.0	19185.1	94.7	4248.5
OXYGEN	14534.7	12734.8	1776.8	10958.0	10958.0	11289.1	0.2	0.2	0.0	0.0	0.2	0.0	153.4	0.0
NITROGEN	339829.0	339829.0	47415.2	292414.0	292414.0	300399.0	3.0	2.7	0.3	0.0	2.7	0.0	3242.7	0.6
CARBON MONOXIDE	1542.8	7.7	1.1	6.6	6.6	17.1	0.0	0.0	0.0	0.0	0.0	0.0	10.3	0.0
CARBON DIOXIDE	7188.9	10542.1	1470.9	9071.2	9071.2	9100.4	4.1	3.7	0.4	0.0	3.7	0.0	266.1	0.6
HYDROGEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PARAXYLENE	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA SOLIDS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CBA SOLID	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P- TOLUIC ACID	0.0	0.0	0.0	0.0	0.0	0.0	4.8	4.3	0.5	0.0	4.4	0.4	0.0	0.0
BENZOIC ACID	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.4	0.0	0.0	0.0
METHYL ACETATE	234.9	2.3	0.3	2.0	2.0	11.8	1.1	1.0	0.1	0.0	1.0	0.0	9.7	0.0
PROPYL ACETATE	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COBALT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANGANESE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BROMIDE	0.0	22.2	3.1	19.1	19.1	0.0	221.9	198.8	22.1	0.0	198.7	0.0	0.0	3.1
METHYL BROMIDE	27.7	1.4	0.2	1.2	1.2	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
PROPANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METHANOL	367.4	3.7	0.5	3.2	3.2	3.2	4.8	4.3	0.5	0.0	4.3	0.0	0.0	0.4
BYPRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OXALATE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SODIUM	0.0	0.0	0.0	0.0	0.0	0.0	2795.5	2504.4	279.0	192.6	2697.1	0.0	0.0	86.2
CARBONATES	0.0	0.0	0.0	0.0	0.0	0.0	7414.1	6642.0	739.8	0.0	6642.2	0.0	0.0	228.7
TOTAL (kg/hr)	365522.0	365522.0	51000.0	314522.0	314522.0	334877.0	193096.0	172987.0	19268.3	6700.0	179687.0	19193.9	3777.2	4568.3
MEAN MOL. WT. (kg/kmol)	28.3	28.3	28.3	28.3	28.3	27.8	18.6	18.6	18.6	18.1	18.6	18.0	28.5	18.7
TEMPERATURE (°C)	350	420	360	360	107	37	38	38	38	80	40	90	29	40
PRESSURE (bara)	10.84	10.62	10.40	10.40	1.08	1.01	1.09	2.00	1.75	7.00	2.00	6.00	1.01	10.09
DENSITY (kg/m3)	5.9	5.2	5.6	5.6	1.0	1.1	1020.0	1020.0	1020.0	948.2	1017.2	959.3	1.1	1025.5
ENTHALPY (kW)	7454	7454	109	671	-22811	-74108	-812460	-727850	-81072	-28672	-756520	-83179	-1038	-18972
SOLIDS (%w/w)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VISCOSITY (Cp)	0.0301/	0.0323/	04/0.6471	0.0304/0.6471	0212/0.8239	0177/0.7068	/0.7241	/0.7237	/0.7237	/0.3623	/0.7011	/0.3137	0.0175/	/0.7118

Annexure B: Standard Operating Conditions

Tag No	Description	Fluid	State	min.	normal	max.	Range	Units	Remarks	**Consequences of going above max or below min value** (only provided for parameters having impact on safety and equipment integrity)	**Protection provided** (only provided for parameters having impact on safety and equipment integrity)	**Corrective Actions** (only provided for parameters having impact on safety and equipment integrity)
PDI01101	SUCTION FILTER	AIR	GAS			10		mbar				
GI01102	1. ST. COMPR. IGV	AIR	GAS	10		100		%				
PI01104	COMPR. DISCHARGE PRESSURE CONTROL ACTUAL PRESSURE TO DCS	AIR	GAS	16				barg				
PI001104A	5. ST. COMPR. DISCHARGE	AIR	GAS	16				barg				
PI001104B	5. ST. COMPR. DISCHARGE	AIR	GAS	16				barg				
XA01105	EXP. INLET VALVE GUARD ALERT	AIR	GAS									
PI01106	EXP. PROCESS	OFFGAS	GAS	4				barg				
FI01107	COMPR. ANTI SURGE CONTROL	AIR	GAS			450		t/h				
PDI01107A	5. ST. COMPR. DISCHARGE	AIR	GAS									
PDI01107B	5. ST. COMPR. DISCHARGE	AIR	GAS									
TI01108	EXP. EXHAUST	OFFGAS	GAS					C				
TI01108 (XHH,XLL)	EXP. EXHAUST	OFFGAS	GAS					C				
TI01108A	EXP. EXHAUST	OFFGAS	GAS					C				
TI01108B	EXP. EXHAUST	OFFGAS	GAS					C				
TI01108C	EXP. EXHAUST	OFFGAS	GAS					C				

TI01108D	EXP. EXHAUST	OFFGAS	GAS	80/12		160/190		C	80 at L and 12 at XL 160 at H & 190 at XH			
PI01109	EXP. EXHAUST	OFFGAS	GAS			0.3		bar				
TI01115	EXP. INLET	OFFGAS	GAS	150		425		C				
TI01115A	EXP. INLET	OFFGAS	GAS									
TI01115B	EXP. INLET	OFFGAS	GAS									
TI01115C	EXP. INLET	OFFGAS	GAS									
GI01117	EXP. IGV	OFFGAS	GAS									
XY01119	REACTOR TRIP REACTOR TRIP	OFFGAS	GAS	0		100		%				
GI01132	EXP. COOLING GAS FCV	OFFGAS	GAS	0		100		%				
PI01136A	1. ST. COMPR. SUCTION	AIR	GAS	-0.1				barg				
PI01136B	1. ST. COMPR. SUCTION	AIR	GAS	-0.1				barg				
TI01137A	1. ST. COMPR. SUCTION	AIR	GAS									
TI01137B	1. ST. COMPR. SUCTION	AIR	GAS									
TI01139	1. ST. COMPR. DISCHARGE	AIR	GAS			140		C				
PI01140	1. ST. COMPR. DISCHARGE	AIR	GAS									
PDI01141	1. ST. COMPR. COOLER	AIR	GAS			0.15		bar				
TI01143	2. ST. COMPR. SUCTION	AIR	GAS			50		C				
TI01145	2. ST. COMPR. DISCHARGE	AIR	GAS									
PI01146	2. ST. COMPR. DISCHARGE	AIR	GAS	3.4				barg				
PDI01147	2. ST. COMPR. COOLER	AIR	GAS			0.15		bar				
TI01149	3. ST. COMPR. SUCTION	AIR	GAS			50		C				
TI01151	3. ST. COMPR. DISCHARGE	AIR	GAS									
PI01152	3. ST. COMPR. DISCHARGE	AIR	GAS									
PDI01153	3. ST. COMPR. COOLER	AIR	GAS			0.15		bar				
TI01155	5. ST. COMPR. DISCHARGE	AIR	GAS			165		C				
ZI01155	3. ST. COMPR. DISCHARGE TEMP.	AIR	GAS									

	CONTROL											
TI01155A	5. ST. COMPR. DISCHARGE	AIR	GAS									
TI01155B	5. ST. COMPR. DISCHARGE	AIR	GAS									
TI01155C	5. ST. COMPR. DISCHARGE	AIR	GAS									
TI01156	3. ST. COMPR. COOLER OUTLET	AIR	GAS			50		C				
TI01160	4. ST. COMPR. SUCTION	AIR	GAS			60		C				
TI01162	4. ST. COMPR. DISCHARGE	AIR	GAS									
PI01163	4. ST. COMPR. DISCHARGE	AIR	GAS									
TI01166A	5. ST. COMPR. DISCHARGE TEMP. SHUTDOWN	AIR	GAS									
TI01166B	5. ST. COMPR. DISCHARGE TEMP. SHUTDOWN	AIR	GAS									
XA01170	EXP. INLET FLOW ALARM	OFFGAS	GAS									
PI01171	EXP. INLET	OFFGAS	GAS	3.5		13		barg				
PI01171A	EXP. INLET	OFFGAS	GAS									
PI01171B	EXP. INLET	OFFGAS	GAS									
PI01171C	EXP. INLET	OFFGAS	GAS									
JI01172	EXP. POWER LIMITATION CONTROL ACTUAL VALUE	OFFGAS	GAS			29000		KW				
LI01172	1. ST. COMPR. COOLER	CONDENSED WATER	GAS			100		mm				
LI01175	2. ST. COMPR. COOLER	CONDENSED WATER	GAS			100		mm				
LI01178	3. ST. COMPR. COOLER	CONDENSED WATER	GAS			100		mm				
TAH01185	EXP. INSTRUMENT AIR	AIR	GAS									
XS01194	TRIP											
XA01196	CONTROL PANEL REACTOR TRIP BY PAC = 1											
JI01210	ST COUPLING LIVE STEAM SIDE	STEAM	VAPOUR			45017		KW				
WI01210	ST COUPLING LIVE STEAM SIDE	STEAM	VAPOUR									

TI01211	ST JOURN. BRG. EXH.-STEAM SIDE	STEAM	VAPOUR					C				
TI01211A	ST JOURN. BRG. EXH.-STEAM SIDE	STEAM	VAPOUR			100		C				
TI01211B	ST JOURN. BRG. EXH.-STEAM SIDE	STEAM	VAPOUR			100		C				
VI01212	ST JOURN. BRG. EXH.-STEAM SIDE	STEAM	VAPOUR					µm				
VI01212X	ST JOURN. BRG. EXH.-STEAM SIDE	STEAM	VAPOUR			75.6		µm				
VI01212Y	ST JOURN. BRG. EXH.-STEAM SIDE	STEAM	VAPOUR			75.6		µm				
TI01213	ST JOURN. BRG. LIVE STEAM SIDE	STEAM	VAPOUR					C				
TI01213A	ST JOURN. BRG. LIVE STEAM SIDE	STEAM	VAPOUR			100		C				
TI01213B	ST JOURN. BRG. LIVE STEAM SIDE	STEAM	VAPOUR			100		C				
TI01214	ACTIVE THRUST BRG.	STEAM	VAPOUR					C				
TI01214A1	ST ACTIVE THRUST BRG.	STEAM	VAPOUR			100		C				
TI01214B1	ST ACTIVE THRUST BRG.	STEAM	VAPOUR			100		C				
TI01214C1	ST ACTIVE THRUST BRG.	STEAM	VAPOUR			100		C				
TI01215	INACTIVE THRUST BRG.	STEAM	VAPOUR					C				
TI01215A1	ST INACTIVE THRUST BRG.	STEAM	VAPOUR			100		C				

TI01215B1	ST INACTIVE THRUST BRG.	STEAM	VAPOUR			100		C				
VSHH01216	ST JOURN. BRG. LIVE STEAM SIDE							µm				
VI01216X	ST JOURN. BRG. LIVE STEAM SIDE					75.6		µm				
VI01216Y	ST JOURN. BRG. LIVE STEAM SIDE					75.6		µm				
ZI01218	ST AXIAL DISPLACEMENT			-0.4(TRIP)		0.4(TRIP)		mm				
ZI01218A	ST AXIAL DISPLACEMENT			-0.3		0.3		mm				
ZI01218B	ST AXIAL DISPLACEMENT			-0.3		0.3		mm				
ZI01218C	ST AXIAL DISPLACEMENT			-0.3		0.3		mm				
VI01220	COMPR. CASING					8		mm/s				
TI01222	COMPR. SHAFT 1 JOURN. BRG. DE							C				
TI01222A	COMPR. SHAFT 1 JOURN. BRG. DE					120		C				
TI01222B	COMPR. SHAFT 1 JOURN. BRG. DE					120		C				
TI01223	COMPR. SHAFT 1 THRUST BRG. OUTBOARD							C				
TI01223A	COMPR. SHAFT 1 THRUST BRG. OUTBOARD					120		C				
TI01223B	COMPR. SHAFT 1 THRUST BRG. OUTBOARD					120		C				
TI01224	COMPR. SHAFT 1 THRUST BRG. INBOARD							C				
TI01224A	COMPR. SHAFT 1 THRUST BRG. INBOARD					120		C				
TI01224B	COMPR. SHAFT 1 THRUST BRG. INBOARD					120		C				
TI01224C	COMPR. SHAFT 1 THRUST BRG. INBOARD					120		C				
VI01225	COMPR. SHAFT 1 JOURN. BRG. DE							µm				
VI01225X	COMPR. SHAFT 1 JOURN. BRG. DE					70		µm				
VI01225Y	COMPR. SHAFT 1 JOURN. BRG. DE					70		µm				
ZI01226	COMPR. SHAFT 1 AXIAL DISPLACEMENT			-0.2(TRIP)		0.2(TRIP)		mm				

ZI01226A	COMPR. SHAFT 1 AXIAL DISPLACEMENT			-0.1		0.1		mm				
ZI01226B	COMPR. SHAFT 1 AXIAL DISPLACEMENT			-0.1		0.1		mm				
ZI01226C	COMPR. SHAFT 1 AXIAL DISPLACEMENT			-0.1		0.1		mm				
TI01228	COMPR. SHAFT 1 JOURN. BRG. NDE							C				
TI01228A	COMPR. SHAFT 1 JOURN. BRG. NDE					120		C				
TI01228B	COMPR. SHAFT 1 JOURN. BRG. NDE					120		C				
VI01229	COMPR. SHAFT 1 JOURN. BRG. NDE							µm				
VI01229X	COMPR. SHAFT 1 JOURN. BRG. NDE					70		µm				
VI01229Y	COMPR. SHAFT 1 JOURN. BRG. NDE					70		µm				
TI01232	COMPR. SHAFT 2 JOURN. BRG. DE							C				
TI01232A	COMPR. SHAFT 2 JOURN. BRG. DE					120		C				
TI01232B	COMPR. SHAFT 2 JOURN. BRG. DE					120		C				
VI01233	COMPR. SHAFT 2 JOURN. BRG. DE							µm				
VI01233X	COMPR. SHAFT 2 JOURN. BRG. DE					60		µm				
VI01233Y	COMPR. SHAFT 2 JOURN. BRG. DE					60		µm				
TI01234	COMPR. SHAFT 2 JOURN. BRG. NDE											
TI01234A	COMPR. SHAFT 2 JOURN. BRG. NDE					120		C				
TI01234B	COMPR. SHAFT 2 JOURN. BRG. NDE					120		C				
VI01235	COMPR. SHAFT 2 JOURN. BRG. DE							µm				
VI01235X	COMPR. SHAFT 2 JOURN. BRG. NDE					60		µm				
VI01235Y	COMPR. SHAFT 2 JOURN. BRG. NDE					60		µm				
TI01237	COMPR. SHAFT 3 JOURN. BRG. DE							C				
TI01237A	COMPR. SHAFT 3 JOURN. BRG. DE					120		C				
TI01237B	COMPR. SHAFT 3 JOURN. BRG. DE					120		C				
VI01238	COMPR. SHAFT 3 JOURN. BRG. DE							µm				
VI01238X	COMPR. SHAFT 3 JOURN. BRG. DE					49		µm				
VI01238Y	COMPR. SHAFT 3 JOURN. BRG. DE					49		µm				

TI01239	COMPR. SHAFT 3 JOURN. BRG. NDE							C				
TI01239A	COMPR. SHAFT 3 JOURN. BRG. NDE					120		C				
TI01239B	COMPR. SHAFT 3 JOURN. BRG. NDE					120		C				
VI01240	COMPR. SHAFT 3 JOURN. BRG. NDE							µm				
VI01240X	COMPR. SHAFT 3 JOURN. BRG. NDE					49		µm				
VI01240Y	COMPR. SHAFT 3 JOURN. BRG. NDE					49		µm				
TI01242	COMPR. SHAFT 4 JOURN. BRG. DE							C				
TI01242A	COMPR. SHAFT 4 JOURN. BRG. DE					120		C				
TI01242B	COMPR. SHAFT 4 JOURN. BRG. DE					120		C				
VI01243	COMPR. SHAFT 4 JOURN. BRG. DE							µm				
VI01243X	COMPR. SHAFT 4 JOURN. BRG. DE					88		µm				
VI01243Y	COMPR. SHAFT 4 JOURN. BRG. DE					88		µm				
TI01245	COMPR. SHAFT 4 THRUST BRG. OUTBOARD							C				
TI01245A	COMPR. SHAFT 4 THRUST BRG. OUTBOARD					120		C				
TI01245B	COMPR. SHAFT 4 THRUST BRG. OUTBOARD					120		C				
TI01245C	COMPR. SHAFT 4 THRUST BRG. OUTBOARD					120		C				
TI01246	COMPR. SHAFT 4 JOURN. BRG. NDE							C				
TI01246A	COMPR. SHAFT 4 JOURN. BRG. NDE					120		C				
TI01246B	COMPR. SHAFT 4 JOURN. BRG. NDE					120		C				
TSI01247	COMPR. SHAFT 4 THRUST BRG. INBOARD							C				
TI01247A	COMPR. SHAFT 4 THRUST BRG. INBOARD					120		C				
TI01247B	COMPR. SHAFT 4 THRUST BRG. INBOARD					120		C				
VI01248	COMPR. SHAFT 4 JOURN. BRG. NDE							µm				
VI01248X	COMPR. SHAFT 4 JOURN. BRG. NDE					88		µm				
VI01248Y	COMPR. SHAFT 4 JOURN. BRG. NDE					88		µm				

ZI01249	COMPR. SHAFT 4 AXIAL DISPL.			-0.2(TRIP)		0.2(TRIP)		mm				
ZI01249A	COMPR. SHAFT 4 AXIAL DISPL.			-0.1		0.1		mm				
ZI01249B	COMPR. SHAFT 4 AXIAL DISPL.			-0.1		0.1		mm				
ZI01249C	COMPR. SHAFT 4 AXIAL DISPL.			-0.1		0.1		mm				
TI01252	COMPR. BULL GEAR JOURN. BRG. DE							C				
TI01252A	COMPR. BULL GEAR JOURN. BRG. DE					110		C				
TI01252B	COMPR. BULL GEAR JOURN. BRG. DE					110		C				
VI01253	COMPR. BULL GEAR JOURN. BRG. DE							C				
VI01253X	COMPR. BULL GEAR JOURN. BRG. DE					152		µm				
VI01253Y	COMPR. BULL GEAR JOURN. BRG. DE					152		µm				
TI01255	COMPR. BULL GEAR JOURN. BRG. NDE							C				
TI01255A	COMPR. BULL GEAR JOURN. BRG. NDE					110		C				
TI01255B	COMPR. BULL GEAR JOURN. BRG. NDE					110		C				
TI01256	COMPR. BULL GEAR THRUST BRG. OUTBOARD							C				
TI01256A	COMPR. BULL GEAR THRUST BRG. OUTBOARD					120		C				
TI01256B	COMPR. BULL GEAR THRUST BRG. OUTBOARD					120		C				
TI01257	COMPR. BULL GEAR THRUST BRG. INBOARD							C				
TI01257A	COMPR. BULL GEAR THRUST BRG. INBOARD					120		C				
TI01257B	COMPR. BULL GEAR THRUST BRG. INBOARD					120		C				
TI01257C	COMPR. BULL GEAR THRUST BRG. INBOARD					120		C				
VI01258	COMPR. BULL GEAR JOURN. BRG. NDE							C				
VI01258X	COMPR. BULL GEAR JOURN. BRG. NDE					152		µm				
VI01258Y	COMPR. BULL GEAR JOURN. BRG. NDE					152		µm				
ZI01259	COMPR. BULL GEAR AXIAL DISPL.			-0.2(TRIP)		0.2(TRIP)		mm				

ZI01259A	COMPR. BULL GEAR AXIAL DISPL.			-0.1		0.1		mm				
ZI01259B	COMPR. BULL GEAR AXIAL DISPL.			-0.1		0.1		mm				
ZI01259C	COMPR. BULL GEAR AXIAL DISPL.			-0.1		0.1		mm				
VI01260	GEAR CASING					8		mm/s				
TI01261	GEAR SHAFT 2 JOURN. BRG. DE							C				
TI01261A	GEAR SHAFT 2 JOURN. BRG. DE					120		C				
TI01261B	GEAR SHAFT 2 JOURN. BRG. DE					120		C				
VI01262	GEAR SHAFT 2 JOURN. BRG. DE							µm				
VI01262X	GEAR SHAFT 2 JOURN. BRG. DE					88		µm				
VI01262Y	GEAR SHAFT 2 JOURN. BRG. DE					88		µm				
TI01265	GEAR SHAFT 2 JOURN. BRG. NDE											
TI01265A	GEAR SHAFT 2 JOURN. BRG. NDE					120		C				
TI01265B	GEAR SHAFT 2 JOURN. BRG. NDE					120		C				
TI01266	GEAR SHAFT 2 THRUST BRG. INBOARD							C				
TI01266A	GEAR SHAFT 2 THRUST BRG. INBOARD					120		C				
TI01266B	GEAR SHAFT 2 THRUST BRG. INBOARD					120		C				
TI01267	GEAR SHAFT 2 THRUST BRG. OUTBOARD							C				
TI01267A	GEAR SHAFT 2 THRUST BRG. OUTBOARD					120		C				
TI01267B	GEAR SHAFT 2 THRUST BRG. OUTBOARD					120		C				
TI01267C	GEAR SHAFT 2 THRUST BRG. OUTBOARD					120		C				
VI01268	GEAR SHAFT 2 JOURN. BRG. NDE							C				
VI01268X	GEAR SHAFT 2 JOURN. BRG. NDE					88		µm				
VI01268Y	GEAR SHAFT 2 JOURN. BRG. NDE					88		µm				
ZI01269	GEAR SHAFT 2 AXIAL DISPLACEMENT			-0.2(TRIP)		0.2(TRIP)		mm				
ZI01269A	GEAR SHAFT 2 AXIAL DISPLACEMENT			-0.1		0.1		mm				
ZI01269B	GEAR SHAFT 2 AXIAL DISPLACEMENT			-0.1		0.1		mm				

ZI01269C	GEAR SHAFT 2 AXIAL DISPLACEMENT			-0.1		0.1		mm				
TSHH01271	GEAR SHAFT 1 JOURN. BRG. NDE							C				
TI01271A	GEAR SHAFT 1 JOURN. BRG. NDE					120		C				
TI01271B	GEAR SHAFT 1 JOURN. BRG. NDE					120		C				
VSHH01272	GEAR SHAFT 1 JOURN. BRG. NDE							µm				
VI01272X	GEAR SHAFT 1 JOURN. BRG. NDE					68		µm				
VI01272Y	GEAR SHAFT 1 JOURN. BRG. NDE					68		µm				
TSHH01274	GEAR SHAFT 1 JOURN. BRG. DE							C				
TI01274A	GEAR SHAFT 1 JOURN. BRG. DE					120		C				
TI01274B	GEAR SHAFT 1 JOURN. BRG. DE					120		C				
VSHH01275	GEAR SHAFT 1 JOURN. BRG. DE							µm				
VI01275X	GEAR SHAFT 1 JOURN. BRG. DE					68		µm				
VI01275Y	GEAR SHAFT 1 JOURN. BRG. DE					68		µm				
ZI01277A	ST EARTH BRUSH											
ZI01277B	ST EARTH BRUSH											
GA01278	GEAR TURNING GEAR COVER											
XS01278	GEAR TURNING GEAR COVER											
TDI01280	EXP. DIFF FLANGE			-35		75		K				
TI01280A	EXP. FLANGE INSIDE			150				C				
TI01280B	EXP. FLANGE OUTSIDE							C				
TSHH01281	EXP. JOURN. BRG. OUTLET SIDE					120		C				
TI01281A	EXP. JOURN. BRG. OUTLET SIDE					100		C				
TI01281B	EXP. JOURN. BRG. OUTLET SIDE					100		C				
VSHH01282	EXP. JOURN. BRG. OUTLET SIDE							µm				
VI01282X	EXP. JOURN. BRG. OUTLET SIDE					59		µm				
VI01282Y	EXP. JOURN. BRG. OUTLET SIDE					59		µm				
TSHH01283	EXP. JOURN. BRG. INLET SIDE											

TI01283A	EXP. JOURN. BRG. INLET SIDE					100		C				
TI01283B	EXP. JOURN. BRG. INLET SIDE					100		C				
TSHH01284	EXP. THRUST BRG. INBOARD							C				
TI01284A	EXP. THRUST BRG. INBOARD					110		C				
TI01284B	EXP. THRUST BRG. INBOARD					110		C				
TSHH01285	EXP. THRUST BRG. OUTBOARD							C				
TI01285A	EXP. THRUST BRG. OUTBOARD					110		C				
TI01285B	EXP. THRUST BRG. OUTBOARD					110		C				
TI01285C	EXP. THRUST BRG. OUTBOARD					110		C				
VSHH01287	EXPANDER JOURN. BRG. INLET SIDE							µm				
VI01287X	EXPANDER JOURN. BRG. INLET SIDE					59		µm				
VI01287Y	EXPANDER JOURN. BRG. INLET SIDE					59		µm				
ZSHH01289	EXP. SHAFT AXIAL DISPLACEMENT			-0.4(TRIP)		0.4(TRIP)		mm				
ZI01289A	EXP. SHAFT AXIAL DISPLACEMENT			-0.3		0.3		mm				
ZI01289B	EXP. SHAFT AXIAL DISPLACEMENT			-0.3		0.3		mm				
ZI01289C	EXP. SHAFT AXIAL DISPLACEMENT			-0.3		0.3		mm				
SSL01295	EXP. SPEED (OVS)											
SY01290A	EXP. SPEED (OVS)											
SY01290B	EXP. SPEED (OVS)											
SY01290C	ST ZERO SPEED DETECTION DISCREPANCY											
UAHH01298	ST BRAUN OVERSPEED SYSTEM DISCREPANCY											
PI01332	OIL RESERVOIR	OIL	LIQUID	-5		-3		mbarg				
TI01335	OIL RESERVOIR	OIL	LIQUID	35		80		C				
LI01339	OIL RESERVOIR	OIL	LIQUID	1820		530		mm				
GA01351 A	OIL COOLER TEMP. CONTROL BYPASS	OIL	LIQUID									
ZI01351 A	OIL COOLER TEMP. CONTROL BYPASS	OIL	LIQUID									

TI01351A	OIL FILTER UPSTREAM	OIL	LIQUID	35		50		C				
PDI01352	OIL FILTER	OIL	LIQUID			1		bar				
PI01357A	OIL SIMULATION LINE	OIL	LIQUID	6.5				barg				
PI01363	JACKING OIL HEADER	OIL	LIQUID	135				barg				
LI01369	OVERHEAD RESERVOIR	OIL	LIQUID	400		300		mm				
PI01370	ST LUBE OIL HEADER	OIL	LIQUID	2.3				barg				
PI01370A	ST LUBE OIL HEADER	OIL	LIQUID									
PI01370B	ST LUBE OIL HEADER	OIL	LIQUID									
PI01370C	ST LUBE OIL HEADER	OIL	LIQUID									
LI01401	ST COND HOTWELL	CONDENSATE	LIQUID	115		1025		mm				
FI01402	ST MAIN COND. UPSTREAM EJECT COND.	CONDENSATE	LIQUID	250		580		m3/h				
PI01404	ST EXHAUST CASING					0.235		bara				
PSHHH01404	ST EXHAUST CASING					0.9		bara				
PI01404A	ST EXHAUST CASING											
PI01404B	ST EXHAUST CASING											
PI01404C	ST EXHAUST CASING											
TI01405	ST EXHAUST CASING					125		C				
TI01405A	ST EXHAUST CASING											
TI01405B	ST EXHAUST CASING											
TI01405C	ST EXHAUST CASING											
LI01414	ST LIVE ST. WATER SEPARATOR	CONDENSATE	LIQUID			250		mm				
LI01414A	ST LIVE ST. WATER SEPARATOR	CONDENSATE	LIQUID									
LI01414B	ST LIVE ST. WATER SEPARATOR	CONDENSATE	LIQUID									
LI01414C	ST LIVE ST. WATER SEPARATOR	CONDENSATE	LIQUID									
SI01415	ST SPEED (CONTROL)			2990	3021	3051		1/min				
TI01417	ST VLP-STAGE STEAM BYPASS STATION DOWNSTR. FLAP	STEAM	VAPOUR	60		110		C				

LA01418	ST ELP-STAGE ADMISSION WATER SEPARATOR	CONDENSATE	LIQUID			250		mm				
LA01424	ST VLP-STAGE ADMISSION WATER SEPARATOR	CONDENSATE	LIQUID			250		mm				
TI01430	ST SEAL STEAM UPSTREAM MP/LP CV	STEAM	VAPOUR									
PI01431	ST LIVE ST. UPSTREAM CONTROL FLAP	STEAM	VAPOUR	1.9		4.3		barg				
TI01432	ST LIVE ST. UPSTREAM CONTROL FLAP	STEAM	VAPOUR			160		C				
GI01435	ST LIVE ST. START UP CONTROL VLV					5		%				
TI01436	ST DOWNSTR LS-TRIP FLAP	STEAM	VAPOUR			154		C				
PI01437	ST CASING					5.3		bar a				
UI01437	ST CASING			5.55				kg/s				
PI01437A	ST CASING											
PI01437B	ST CASING											
PI01437C	ST CASING											
TI01442	ST ELP-STAGE ADMISSION UPSTREAM CONTROL FLAP	STEAM	VAPOUR	128				C				
PI01443	ST ELP-STAGE ADMISSION UPSTREAM CONTROL FLAP	STEAM	VAPOUR	1.5				barg				
TI01444	ST ELP-STAGE ADMISSION UPSTREAM TRIP FLAP	STEAM	VAPOUR									
TI01446	ST ELP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR	120				C				
PI01447	ST ELP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR			3.15						
UI01447	ST ELP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR	5.55				kg/s				
PI01447A	ST ELP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR									
PI01447B	ST ELP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR									
PI01447C	ST ELP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR									
PI01450	ST VLP-STAGE ADMISSION UPSTREAM CONTROL FLAP	STEAM	VAPOUR	0.98		1.4		bar a				
TI01451	ST VLP-STAGE ADMISSION UPSTREAM CONTROL FLAP	STEAM	VAPOUR	100		115		C				

TI01452	ST VLP-STAGE ADMISSION UPSTREAM TRIP FLAP	STEAM	VAPOUR									
TI01454	ST VLP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR	100				C				
PI01455	ST VLP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR	0.6		1.29		bar a				
UI01455	ST VLP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR	5.55				kg/s				
PI01455A	ST VLP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR									
PI01455B	ST VLP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR									
PI01455C	ST VLP-STAGE ADMISSION DWNSTREAM TRIP FLAP	STEAM	VAPOUR									
PI01458	ST SEAL STEAM UPSTREAM MP/LP CV	STEAM	VAPOUR	3.05		4.3		bar g				
GI01459	ST SEAL STEAM UPSTREAM MP/LP CV	STEAM	VAPOUR									
TI01460	ST SEAL STEAM SUPPLY DOWNSTREAM CV	STEAM	VAPOUR	120				C				
PI01461	ST SEAL STEAM SUPPLY DOWNSTREAM CV	STEAM	VAPOUR	30		100		mbar g				
LI01479	ST RESERVOIR COND LIFTER	CONDENSATE	LIQUID			250		mm				
LI01479A	ST RESERVOIR COND LIFTER	CONDENSATE	LIQUID									
LI01479B	ST RESERVOIR COND LIFTER	CONDENSATE	LIQUID									
LI01479C	ST RESERVOIR COND LIFTER	CONDENSATE	LIQUID									
LI01501	COMPR. WASHING WATER RESERVOIR	WATER	LIQUID	800				mm				
VI01558	ST CONDENSATE PUMP 1	CONDENSATE	LIQUID									
TI01559	ST CONDENSATE PUMP 1 BEARING TEMP	CONDENSATE	LIQUID									
TI01560	ST CONDENSATE PUMP 1 BEARING TEMP	CONDENSATE	LIQUID									
TI01561A	ST CONDENSATE PUMP 1	CONDENSATE	LIQUID									
TI01562A	ST CONDENSATE PUMP 1	CONDENSATE	LIQUID									
TI01563A	ST CONDENSATE PUMP 1	CONDENSATE	LIQUID									
VI01564	ST CONDENSATE PUMP 2	CONDENSATE	LIQUID									
TI01565	ST CONDENSATE PUMP 2 BEARING TEMP	CONDENSATE	LIQUID									

TI01566	ST CONDENSATE PUMP 2 BEARING TEMP	CONDENSATE	LIQUID									
TI01567A	ST CONDENSATE PUMP 2	CONDENSATE	LIQUID									
TI01568A	ST CONDENSATE PUMP 2	CONDENSATE	LIQUID									
TI01569A	ST CONDENSATE PUMP 2	CONDENSATE	LIQUID									
TI01578	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01581	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01581A	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01581B	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01581C	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01582	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01582A	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01582B	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01582C	ST COND HOTWELL	CONDENSATE	LIQUID									
PI01584	ST MAIN CONDENSER	CONDENSATE	LIQUID	7.5				bar g				
AI01585A	ST MAIN CONDENSER	CONDENSATE	LIQUID			9.8		pH				
AI01585B	ST MAIN CONDENSER	CONDENSATE	LIQUID			0.1		µS /cm				
YI01588	ST CONDENSATE PUMP 1	CONDENSATE	LIQUID									
YI01589	ST CONDENSATE PUMP 2	CONDENSATE	LIQUID									
FI01597	ST STEAM EJECTOR GROUP MOTIVE STEAM	STEAM	VAPOUR	600		2400		kg/h				
GSSO01604	COMPR. PROCESS DOWNSTREAM					100		%				
TSHH01821	MOTOR JOURN. BRG. NDE					100		C				
TI01821A	MOTOR JOURN. BRG. NDE					90		C				
TI01821B	MOTOR JOURN. BRG. NDE					91		C				
VSHH01822	MOTOR JOURN. BRG. NDE					101.6		µm				
VI01822X	MOTOR JOURN. BRG. NDE					50.8		µm				
VI01822Y	MOTOR JOURN. BRG. NDE					50.8		µm				
TSHH01824	MOTOR JOURN. BRG. DE					100		C				

TI01824A	MOTOR JOURN. BRG. DE					90		C				
TI01824B	MOTOR JOURN. BRG. DE					90		C				
VSHH01825	MOTOR JOURN. BRG. DE					101.6		µm				
VI01825X	MOTOR JOURN. BRG. DE					50.8		µm				
VI01825Y	MOTOR JOURN. BRG. DE					50.8		µm				
TI01831A1	MOTOR WINDINGS U 1					120		C				
TI01831A2	MOTOR WINDINGS U 1					120		C				
TI01831B1	MOTOR WINDINGS U 2					120		C				
TI01831B2	MOTOR WINDINGS U 2					120		C				
TI01832A1	MOTOR WINDINGS V 1					120		C				
TI01832A2	MOTOR WINDINGS V 1					120		C				
TI01832B1	MOTOR WINDINGS V 2					120		C				
TI01832B2	MOTOR WINDINGS V 2					120		C				
TI01833A1	MOTOR WINDINGS W 1					120		C				
TI01833A2	MOTOR WINDINGS W 1					120		C				
TI01833B1	MOTOR WINDINGS W 2					120		C				
TI01833B2	MOTOR WINDINGS W 2					120		C				
TI01835	MOTOR COOLING AIR COLD					45		C				
TI01836	MOTOR COOLING AIR COLD					45		C				
TI01837	MOTOR COOLING AIR HOT					75		C				
TI01838	MOTOR COOLING EXCITATION					75		C				
SI01862	MOTOR SPEED											
GI022119A	ST LIVE ST. CONTROL FLAP											
GI022202A	ST ELP-STAGE ADMISSION CONTROL FLAP											
GI022204A	ST VLP-STAGE ADMISSION CONTROL FLAP											
GI022204B	ST VLP-STAGE STEAM BYPASS STATION CONTROL FLAP											

Annexure C: Alarm and Trip Schedule

Tag No.	Title	Low Alarm	High Alarm	Low Trip	High Trip	Units	Remarks
PAHH 01437	ST CASING				5.5	bar(a)	
ZSHH 01218	ST AXIAL DISPLACEMENT				0.4	mm	001,MMS INTERNAL TRIP
ZSHH 01226	COMPR. SHAFT 1 AXIAL DISPLACEMENT				0.2	mm	001,MMS INTERNAL TRIP
ZSHH 01249	COMPR. SHAFT 4 AXIAL DISPL.				0.2	mm	001,MMS INTERNAL TRIP
ZSHH 01259	COMPR. BULL GEAR AXIAL DISPL.				-0.2	mm	001,MMS INTERNAL TRIP
ZSHH 01269	GEAR SHAFT 2 AXIAL DISPLACEMENT				0.2	mm	001,MMS INTERNAL TRIP
ZSHH 01289	EXP. SHAFT AXIAL DISPLACEMENT				0.4	mm	001,MMS INTERNAL TRIP
ZSLL 01218	AXIAL DISPLACEMENT			-0.4		mm	001,MMS INTERNAL TRIP
ZSLL 01226	COMPR. SHAFT 1 AXIAL DISPLACEMENT			-0.2		mm	001,MMS INTERNAL TRIP
ZSLL 01249	COMPR. SHAFT 4 AXIAL DISPL.			-0.2		mm	001,MMS INTERNAL TRIP
ZSLL 01259	COMPR. BULL GEAR AXIAL DISPL.			0.2		mm	001,MMS INTERNAL TRIP
ZSLL 01269	GEAR SHAFT 2 AXIAL DISPLACEMENT			-0.2		mm	001,MMS INTERNAL TRIP
ZSLL 01289	EXP. SHAFT AXIAL DISPLACEMENT			-0.4		mm	001,MMS INTERNAL TRIP
PAHH 01404	ST EXHAUST CASING				0.25	bar(a)	001,254- VLP BYPASS STATION SHUT OFF
LAHH 01414	ST LIVE ST. WATER SEPARATOR				400	mm	
LAHH 01479	ST RESERVOIR COND LIFTER				400	mm	
PAHH 01171	EXP. INLET				13.5	bar(g)	
PALL 01171	EXP. INLET			3		bar(g)	
SSLL 01415 A	ST SPEED (CONTROL)			2950		1/min	
TAHH 01108	EXP. EXHAUST				170	°C	
TAHH 01155	5. ST. COMPR. DISCHARGE				175	°C	
TAHH 01405	ST EXHAUST CASING				160	°C	
TAHHH 01115	EXP. INLET				450	°C	002, High high high trip
TAL 01115	EXP. INLET DURING HOT RESTART			270		°C	
TAXHH 01108	EXP. EXHAUST				200	°C	
TAXLL 01108	EXP. EXHAUST			8		°C	
TSHH 01211	ST JOURN. BRG. EXH.-STEAM SIDE				120	°C	002, MMS INTERNAL TRIP
TSHH 01213	ST JOURN. BRG. LIVE STEAM SIDE				120	°C	002, MMS INTERNAL TRIP
TSHH 01214	ACTIVE THRUST BRG.				120	°C	002, MMS INTERNAL TRIP
TSHH 01215	INACTIVE THRUST BRG.				120	°C	002, MMS INTERNAL TRIP
TSHH 01222	COMPR. SHAFT 1 JOURN. BRG. DE				125	°C	002, MMS INTERNAL TRIP
TSHH 01223	COMPR. SHAFT 1 THRUST BRG. OUTBOARD				125	°C	002, MMS INTERNAL TRIP
TSHH 01224	COMPR. SHAFT 1 THRUST BRG. INBOARD				125	°C	002, MMS INTERNAL TRIP

TSHH 01228	COMPR. SHAFT 1 JOURN. BRG. NDE				125	°C	002, MMS INTERNAL TRIP
TSHH 01232	COMPR. SHAFT 2 JOURN. BRG. DE				125	°C	002, MMS INTERNAL TRIP
TSHH 01234	COMPR. SHAFT 2 JOURN. BRG. NDE				125	°C	002, MMS INTERNAL TRIP
TSHH 01237	COMPR. SHAFT 3 JOURN. BRG. DE				125	°C	002, MMS INTERNAL TRIP
TSHH 01239	COMPR. SHAFT 3 JOURN. BRG. NDE				125	°C	002, MMS INTERNAL TRIP
TSHH 01242	COMPR. SHAFT 4 JOURN. BRG. DE				125	°C	002, MMS INTERNAL TRIP
TSHH 01245	COMPR. SHAFT 4 THRUST BRG. OUTBOARD				125	°C	002, MMS INTERNAL TRIP
TSHH 01246	COMPR. SHAFT 4 JOURN. BRG. NDE				125	°C	002, MMS INTERNAL TRIP
TSHH 01247	COMPR. SHAFT 4 THRUST BRG. INBOARD				125	°C	002, MMS INTERNAL TRIP
TSHH 01252	COMPR. BULL GEAR JOURN. BRG. DE				115	°C	002, MMS INTERNAL TRIP
TSHH 01255	COMPR. BULL GEAR JOURN. BRG. NDE				115	°C	002, MMS INTERNAL TRIP
TSHH 01256	COMPR. BULL GEAR THRUST BRG. OUTBOARD				125	°C	002, MMS INTERNAL TRIP
TSHH 01257	COMPR. BULL GEAR THRUST BRG. INBOARD				125	°C	002, MMS INTERNAL TRIP
TSHH 01261	GEAR SHAFT 2 JOURN. BRG. DE				125	°C	002, MMS INTERNAL TRIP
TSHH 01265	GEAR SHAFT 2 JOURN. BRG. NDE				125	°C	002, MMS INTERNAL TRIP
TSHH 01266	GEAR SHAFT 2 THRUST BRG. INBOARD				125	°C	002, MMS INTERNAL TRIP
TSHH 01267	GEAR SHAFT 2 THRUST BRG. OUTBOARD				125	°C	002, MMS INTERNAL TRIP
TSHH 01271	GEAR SHAFT 1 JOURN. BRG. NDE				125	°C	002, MMS INTERNAL TRIP
TSHH 01274	GEAR SHAFT 1 JOURN. BRG. DE				125	°C	002, MMS INTERNAL TRIP
TSHH 01281	EXP. JOURN. BRG. OUTLET SIDE				120	°C	002, MMS INTERNAL TRIP
TSHH 01283	EXP. JOURN. BRG. INLET SIDE				120	°C	002, MMS INTERNAL TRIP
TSHH 01284	EXP. THRUST BRG. INBOARD				120	°C	002, MMS INTERNAL TRIP
TSHH 01285	EXP. THRUST BRG. OUTBOARD				120	°C	002, MMS INTERNAL TRIP
TSHH 01821	MOTOR JOURN. BRG. NDE				100	°C	002, MMS INTERNAL TRIP
TSHH 01824	MOTOR JOURN. BRG. DE				100	°C	002, MMS INTERNAL TRIP
UALL 01437	ST CASING			5		kg/s	
UALL 01447	ST ELP-STAGE ADMISSION DWNSTREAM TRIP FLAP			5		kg/s	
UALL 01455	ST VLP-STAGE ADMISSION DWNSTREAM TRIP FLAP			5		kg/s	
VSHH 01212	ST JOURN. BRG. EXH.-STEAM SIDE				100.7	µm	002, MMS INTERNAL TRIP
VSHH 01216	ST JOURN. BRG. LIVE STEAM SIDE				100.7	-	002, MMS INTERNAL TRIP
VSHH 01225	COMPR. SHAFT 1 JOURN. BRG. DE				131	µm	002, MMS INTERNAL TRIP
VSHH 01229	COMPR. SHAFT 1 JOURN. BRG. NDE				131	µm	002, MMS INTERNAL TRIP
VSHH 01233	COMPR. SHAFT 2 JOURN. BRG. DE				111	µm	002, MMS INTERNAL TRIP
VSHH 01235	COMPR. SHAFT 2 JOURN. BRG. NDE				111	µm	002, MMS INTERNAL TRIP
VSHH 01238	COMPR. SHAFT 3 JOURN. BRG. DE				91	µm	002, MMS INTERNAL TRIP
VSHH 01240	COMPR. SHAFT 3 JOURN. BRG. NDE				91	µm	002, MMS INTERNAL TRIP
VSHH 01243	COMPR. SHAFT 4 JOURN. BRG. DE				163	µm	002, MMS INTERNAL TRIP

VSHH 01248	COMPR. SHAFT 4 JOURN. BRG. NDE				163	µm	002, MMS INTERNAL TRIP
VSHH 01253	COMPR. BULL GEAR JOURN. BRG. DE				284	µm	002, MMS INTERNAL TRIP
VSHH 01258	COMPR. BULL GEAR JOURN. BRG. NDE				284	µm	002, MMS INTERNAL TRIP
VSHH 01262	GEAR SHAFT 2 JOURN. BRG. DE				164	µm	002, MMS INTERNAL TRIP
VSHH 01268	GEAR SHAFT 2 JOURN. BRG. NDE				164	µm	002, MMS INTERNAL TRIP
VSHH 01272	GEAR SHAFT 1 JOURN. BRG. NDE				126	µm	002, MMS INTERNAL TRIP
VSHH 01275	GEAR SHAFT 1 JOURN. BRG. DE				126	µm	002, MMS INTERNAL TRIP
VSHH 01282	EXP. JOURN. BRG. OUTLET SIDE				78	µm	002, MMS INTERNAL TRIP
VSHH 01287	EXPANDER JOURN. BRG. INLET SIDE				78	µm	002, MMS INTERNAL TRIP
VSHH 01822	MOTOR JOURN. BRG. NDE				101.6	µm	002, MMS INTERNAL TRIP
VSHH 01825	MOTOR JOURN. BRG. DE				101.6	µm	002, MMS INTERNAL TRIP
ZAHH 01435	ST LIVE ST. START UP CONTROL VLV				10	%	002, MMS INTERNAL TRIP
PALL 01370	ST LUBE OIL HEADER			2		bar(g)	002, MMS INTERNAL TRIP
LAHHH 01401	ST COND HOTWELL				1100	mm	002, MMS INTERNAL TRIP
TALL 01108	EXP. EXHAUST			70		°C	008, MMS INTERNAL TRIP
LAL 01339	OIL RESERVOIR	1820				mm	010, STARTUP INTERLOCK
LAH 01339	OIL RESERVOIR		580			mm	
PAHH 01431	ST LIVE ST. UPSTREAM CONTROL FLAP		4.5			bar(g)	010, STARTUP INTERLOCK
TAL 01351 A	OIL FILTER UPSTREAM	35				°C	010, STARTUP INTERLOCK
PAH 01332	OIL RESERVOIR		-5			mbar(g)	102, OIL MIST FAN
TAL 01280 A	EXP. FLANGE INSIDE	150				°C	LUBE OIL PUMP/TURNING GEAR/PURGING AIR VALVE
LAL 01501	COMPR. WASHING WATER RESERVOIR	800				mm	105, COMPRESSOR WASH WATER PUMP
PAL 01146	2. ST. COMPR. DISCHARGE	3.4				bar(g)	704, SEAL AIR
HS 01194 A1	CONTROL PANEL ESD BUTTON						001 (1oo2)
HS 01194 A2	CONTROL PANEL ESD BUTTON						001(1oo2)
HS 01194 B 1	EXPANDER SKID ESD BUTTON						001(1oo2)
HS 01194 B 2	EXPANDER SKID ESD BUTTON						001(1oo2)
HS 01194 C 1	TURBINE SKID ESD BUTTON						001(1oo2)
HS 01194 C 2	TURBINE SKID ESD BUTTON						001(1oo2)
HS 01194 D 1	SFC CONTROL PANEL ESD BUTTON						001(1oo2)
HS 01194 D 2	SFC CONTROL PANEL ESD BUTTON						001(1oo2)
HS 01194 E 1	ESD REACTOR TRIP PANEL						001(1oo2)
HS 01194 E 2	ESD REACTOR TRIP PANEL						001(1oo2)
HS 01194 F 1	FIELD ESD BUTTON						001(1oo2)
HS 01194 F 2	FIELD ESD BUTTON						001(1oo2)
US 01294 A	EXP. TRIP						
US 01294 B	EXP. TRIP						

US 01294 C	EXP. TRIP						
US 01299 A	ST TRIP						
US 01299 B	ST TRIP						
US 01299 C	ST TRIP						
USHH 01293 A	EXP. SPEED (OVS)						
USHH 01293 B	EXP. SPEED (OVS)						
USHH 01293 C	EXP. SPEED (OVS)						
USHH 01298 A	ST SPEED (OVS)						
USHH 01298 B	ST SPEED (OVS)						
USHH 01298 C	ST SPEED (OVS)						
XA01846	CONTROL PANEL IBC PROTECTION TRIP						
ZSHH 01201	MACHINE MONITORING SYSTEM COMMON MMS TRIP RELAY						
XA01844	CONTROL PANEL FREQUENCYCONVERTER TRIP						
SALLL 01415 A	ST SPEED (CONTROL)						
TSHH 01203	MACHINE MONITORING SYSTEM COMMAN TRIP JOURNAL BEARING TEMP						002, MMS RELAY CONTACT TO PLC
TSHH 01204	MACHINE MONITORING SYSTEM COMMAN TRIP THRUST BEARING TEMP						002, MMS RELAY CONTACT TO PLC
TSHH 01831 A	MOTOR WINDINGS U 1						002, SFC INTERNAL TRIP
TSHH 01831 B	MOTOR WINDINGS U 2						002, SFC INTERNAL TRIP
TSHH 01832 A	MOTOR WINDINGS V1						002, SFC INTERNAL TRIP
TSHH 01832 B	MOTOR WINDINGS V2						002, SFC INTERNAL TRIP
TSHH 01833 A	MOTOR WINDINGS W1						002, SFC INTERNAL TRIP
TSHH 01833 B	MOTOR WINDINGS W2						002, SFC INTERNAL TRIP
UAHH 01298	ST BRAUN OVERSPEED SYSTEM DISCREPANCY						
USHH 01456	ST LAST BLADE PROTECTION						
UZ 01415	STEAM TURBINE SPEED NOT VALID						
VSHH 01202	MACHINE MONITORING SYSTEM COMMAN MMS TRIP RELAY						002, MMS RELAY CONTACT TO PLC
XSV01107 C	COMPRESSOR ANTISURGE CONTROL VALVE ECXESSIVE SURGE						
XS 01119 A	REACTOR TRIP						
XS 01119 B	REACTOR TRIP						
XY01119	REACTOR TRIP REACTOR TRIP						
XL 01852	MOTOR SFC REMOTE OPERATION						
XSA01127	PLANT ELP STEAM TRIP						
XSA01128	PLANT VLP STEAM TRIP						
PDAH01101	SUCTION FILTER						
PI01104	COMPR. ANTI SURGE CONTROL	16/15				barg	
PAL001104A	EXP. EXHAUST	16				barg	

PAL001104B	EXP. EXHAUST	16				barg	
XA01105	EXP. INLET DURING HOT RESTART						
PAL01106	1. ST. COMPR. DISCHARGE	4				barg	
FAH01107	2. ST. COMPR. DISCHARGE						
FAHH01107	3. ST. COMPR. SUCTION						
TAHH01108	EXP. POWER LIMITATION CONTROL				170	C	
TALL01108	1. ST. COMPR. COOLER					C	
TAXHH01108	2. ST. COMPR. COOLER				200	C	
TAXLL01108	3. ST. COMPR. COOLER			8		C	
TAH01108D	ST JOURN. BRG. EXH.-STEAM SIDE					C	
TAL01108D	ST JOURN. BRG. EXH.-STEAM SIDE					C	
TAXH01108D	ST JOURN. BRG. EXH.-STEAM SIDE					C	
TAXL01108D	ST JOURN. BRG. EXH.-STEAM SIDE					C	
PAH01109	ST JOURN. BRG. EXH.-STEAM SIDE					barg	
PAHH01109	ST JOURN. BRG. EXH.-STEAM SIDE					barg	
TAH01115	ST JOURN. BRG. EXH.-STEAM SIDE					C	
TAHH01115	ST JOURN. BRG. EXH.-STEAM SIDE		430			C	
TAHHH01115	ST JOURN. BRG. EXH.-STEAM SIDE				450	C	
TAL01115	ST JOURN. BRG. EXH.-STEAM SIDE			270		C	
TALL01115	ST JOURN. BRG. LIVE STEAM SIDE	150				C	
XY01119	ST ACTIVE THRUST BRG.						
PAL01136A	ST INACTIVE THRUST BRG.	ALM				barg	
PAL01136B	ST INACTIVE THRUST BRG.	1.9				barg	
TAH01139	ST JOURN. BRG. LIVE STEAM SIDE		140			C	
PDAH01141	ST AXIAL DISPLACEMENT		0.15			barg	
TAH01143	ST AXIAL DISPLACEMENT		50			C	
PAL01146	ST AXIAL DISPLACEMENT	3.4				barg	
PDAH01147	ST AXIAL DISPLACEMENT		0.15			bar	
TAH01149	ST AXIAL DISPLACEMENT		50			C	
PDAH01153	ST AXIAL DISPLACEMENT		0.15			bar	
TI01155	COMPR. SHAFT 1 JOURN. BRG. DE		165		175	C	
TAH01156	COMPR. SHAFT 1 THRUST BRG. INBOARD		50			C	
TAH01160	COMPR. SHAFT 1 JOURN. BRG. DE		60			C	
XA01170	COMPR. SHAFT 1 AXIAL DISPLACEMENT						
PI01171	COMPR. SHAFT 1 AXIAL DISPLACEMENT	3.5	13	3	13.5	barg	
JAH01172	COMPR. SHAFT 1 JOURN. BRG. NDE						
JAHH01172	COMPR. SHAFT 1 JOURN. BRG. NDE					KW	
LAH01172	COMPR. SHAFT 2 JOURN. BRG. DE		100			mm	
LAH01175	COMPR. SHAFT 2 JOURN. BRG. DE		100			mm	

LAH01178	COMPR. SHAFT 2 JOURN. BRG. DE		100			mm	
GAO01180	EXP. INSTRUMENT AIR 1 DURING OPERATION						
TAH01185	EXP. INSTRUMENT AIR					C	
XA01196	CONTROL PANEL REACTOR TRIP BY PAC = 1						
TSHH01211	ST JOURN. BRG. EXH.-STEAM SIDE				120	C	
TAH01211A	ST JOURN. BRG. EXH.-STEAM SIDE					C	
TAHH01211A	ST JOURN. BRG. EXH.-STEAM SIDE					C	
TAH01211B	ST JOURN. BRG. EXH.-STEAM SIDE					C	
TAHH01211B	ST JOURN. BRG. EXH.-STEAM SIDE					C	
VSHH01212	ST JOURN. BRG. EXH.-STEAM SIDE				100.7	µm	
VAH01212X	ST JOURN. BRG. EXH.-STEAM SIDE					µm	
VAHH01212X	ST JOURN. BRG. EXH.-STEAM SIDE					µm	
VAH01212Y	ST JOURN. BRG. EXH.-STEAM SIDE					µm	
VAHH01212Y	ST JOURN. BRG. EXH.-STEAM SIDE					µm	
TSHH01213	ST JOURN. BRG. LIVE STEAM SIDE				120	C	
TAH01213A	ST JOURN. BRG. LIVE STEAM SIDE					C	
TAHH01213A	ST JOURN. BRG. LIVE STEAM SIDE					C	
TAH01213B	ST JOURN. BRG. LIVE STEAM SIDE					C	
TAHH01213B	ST JOURN. BRG. LIVE STEAM SIDE					C	
TSHH01214	ACTIVE THRUST BRG.				120	C	
TAH01214A1	ST ACTIVE THRUST BRG.					C	
TAHH01214A1	ST ACTIVE THRUST BRG.					C	
TSHH01215	INACTIVE THRUST BRG.				120	C	
TI01215A1	ST INACTIVE THRUST BRG.					C	
TI01215B1	ST INACTIVE THRUST BRG.					C	
VSHH01216	ST JOURN. BRG. LIVE STEAM SIDE				100.7	µm	
VI01216X	ST JOURN. BRG. LIVE STEAM SIDE					µm	
VI01216Y	ST JOURN. BRG. LIVE STEAM SIDE					µm	
ZA01218	ST AXIAL DISPLACEMENT	-0.3	0.3	-0.4	0.4	mm	
ZI01218A	ST AXIAL DISPLACEMENT	-0.3	0.3	-0.4	0.4	mm	
ZI01218B	ST AXIAL DISPLACEMENT	-0.3	0.3	-0.4	0.4	mm	
ZI01218C	ST AXIAL DISPLACEMENT	-0.3	0.3	-0.4	0.4	mm	
VI01220	COMPR. CASING					mm/s	
TSHH01222	COMPR. SHAFT 1 JOURN. BRG. DE				125	C	
TI01222A	COMPR. SHAFT 1 JOURN. BRG. DE						
TI01222B	COMPR. SHAFT 1 JOURN. BRG. DE						
TSHH01223	COMPR. SHAFT 1 THRUST BRG. OUTBOARD				125	C	
TI01223A	COMPR. SHAFT 1 THRUST BRG. OUTBOARD						

TI01223B	COMPR. SHAFT 1 THRUST BRG. OUTBOARD						
TSHH01224	COMPR. SHAFT 1 THRUST BRG. INBOARD				120	C	
TI01224A	COMPR. SHAFT 1 THRUST BRG. INBOARD						
TI01224B	COMPR. SHAFT 1 THRUST BRG. INBOARD						
TI01224C	COMPR. SHAFT 1 THRUST BRG. INBOARD						
VSHH01225	COMPR. SHAFT 1 JOURN. BRG. DE				131	C	
VI01225X	COMPR. SHAFT 1 JOURN. BRG. DE						
VI01225Y	COMPR. SHAFT 1 JOURN. BRG. DE						
ZI01226	COMPR. SHAFT 1 AXIAL DISPLACEMENT			-0.2	0.2	mm	
XA01844	CONTROL PANEL FREQUENCY CONVERTER TRIP						
XL01845	MOTOR SFC OPERATION READY TO LOAD						
XA01846	CONTROL PANEL IBC PROTECTION TRIP						
USHH01456	ST LAST BLADE PROTECTION						
UAH01456B	ST LBP EXHAUST PRESSURE TOO HIGH						
UAH01456C1	ST LBP 1ST ALARM IN AREA C						
UAH01456C2	ST LBP 2ST ALARM IN AREA C						
UAH01456E	ST LBP PRESSURE LAST CARRIER TO HIGH						
SI01415A	ST SPEED (CONTROL)					1/min	
SI01415B	ST SPEED (CONTROL) JACKING OIL ON	800				1/min	
SI01415C	ST SPEED (CONTROL)					1/min	
SC01415E	ST SPEED (CONTROL)						
GI01402	ST COND CONDENSATE CIRC VALVE						
YA01333A	OIL RESERVOIR HEATER 1 FAULT						
SSL01295A	ST SPEED (OVS)						
SSL01295B	ST SPEED (OVS)						
SSL01295C	ST SPEED (OVS)						

Annexure D: Material Safety Data Sheets

a) TA Offgas

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION

TA Offgas

Alternative Names: Treated TA oxidation reactor off-gas

PRODUCT DESCRIPTION

87.8% weight nitrogen

6.0% weight water vapour

3.5% weight carbon dioxide

2.7% weight oxygen

Trace amounts of other gases including paraxylene, methyl bromide and bromine.

2. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT(S) % weight CAS No.

Sodium Hydroxide 3.5 000124-38-9

R35 causes severe burns

3. HAZARDS IDENTIFICATION

A simple asphyxiant.

Unlikely to cause harmful effects under normal conditions of handling and use.

4. FIRST-AID MEASURES

Inhalation : Remove patient from exposure. NB Rescuer should wear breathing apparatus. Apply artificial respiration if breathing has ceased or shows signs of failing. Obtain immediate medical attention.

Skin Contact : Not applicable.

Eye Contact : Not applicable.

Ingestion : Not applicable.

Further Medical Treatment

Symptomatic treatment and supportive therapy as indicated. Administer oxygen if necessary.

5. FIRE-FIGHTING MEASURES

Non-combustible.

6. ACCIDENTAL RELEASE MEASURES

Ventilate area.

In case of insufficient ventilation, wear suitable respiratory equipment.

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7. HANDLING AND STORAGE

7.1 HANDLING

No special requirements

7.2 STORAGE

Not Applicable

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Wear suitable respiratory protective equipment if exposure to levels above the occupational exposure limit is likely.

Occupational Exposure Limits

LTEL 8hr TWA STEL Notes

HAZARDOUS INGREDIENT(S) ppm mg/m³ ppm mg/m³

Carbon Dioxide 5000 9000 15000 27000 - OES

A simple asphyxiant. The oxygen content of air in the workplace should never be allowed to fall below 19% (v/v).

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9. PHYSICAL AND CHEMICAL PROPERTIES

This stream is essentially nitrogen gas.

Form : gas

Colour : colourless

Odour : odourless

Boiling Point (Deg C) : -196 approx

Vapour Density (Air= 1) : 0.97 approx

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10. STABILITY AND REACTIVITY

Hazardous Reactions: None known

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11. TOXICOLOGICAL INFORMATION

Inhalation : Highly unlikely under normal industrial use. High atmospheric concentrations may lead to asphyxiation.

Skin Contact : Not applicable.

b) Inert Gas

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1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION

Name: Inert Gas

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2. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT(S)	Classification	% weight	CAS No.	EC-No.
Carbon Monoxide	R61-23-48/23	0.01-0.5	630-08-0	211-128-3

INGREDIENT(S)	% weight	CAS No.	EC-No.
Nitrogen	93-94	7727-37-9	231-783-9
Oxygen	2.5-4	7782-44-7	231-956-9
Carbon dioxide	2-4	124-38-9	204-696-9

Trace amounts of: Methyl Acetate, p-xylene, Methyl bromide, acetic acid (<50 ppm).

R61 – May cause harm to the unborn child

R23 – Toxic by inhalation

R48/23 – Toxic; danger of serious damage to health by prolonged exposure to inhalation

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3. HAZARDS IDENTIFICATION

Most important hazards: May cause harm to the unborn child. Harmful by inhalation. Harmful; danger of serious damage to health by prolonged exposure through inhalation.

Specific Hazards: A simple asphyxiant.

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4. FIRST-AID MEASURES

Inhalation : Remove patient from exposure. Apply artificial respiration if breathing has ceased or shows signs of failing. Obtain immediate medical attention.

Skin Contact : Not applicable

Eye Contact : Not applicable

Ingestion : Not applicable

Further Medical Treatment: Symptomatic treatment and supportive therapy as indicated. Administer oxygen if necessary

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5. FIRE-FIGHTING MEASURES

Extinguishing Media : Not combustible, choose extinguishing media for the material in immediate surroundings.

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6. ACCIDENTAL RELEASE MEASURES

Ensure the area is well ventilated.

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7. HANDLING AND STORAGE

No special precautions required

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

In case of insufficient ventilation, wear suitable respiratory equipment.

Occupational Exposure Limits:

OES (EH40/2000	LTEL 8hr TWA		STEL 15 min.		Notes
	ppm	mg/m³	ppm	mg/m³	
Nitrogen		asphyxiant			
Carbon monoxide	30	35	200	232	Bmgv
Carbon dioxide	5000	9150	15000	27400	ILV

BEI Determinant	Sampling Time	BEI	Notation
Carboxyhaemoglobin in blood	End of shift	3.5% of Hb	B, Ns
Carbon monoxide in end-exhaled air	End of shift	20 ppm	B, Ns

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9. PHYSICAL AND CHEMICAL PROPERTIES

Form : gas

Colour : colourless

Odour : slight aromatic

No other information available

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10. STABILITY AND REACTIVITY

Hazardous Reactions: None known

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11. TOXICOLOGICAL INFORMATION

Inhalation : A simple asphyxiant. High atmospheric concentrations may lead to headache, drowsiness and in extreme cases unconsciousness and death.

Long Term Exposure : The presence of carbon monoxide, classified as repr. Toxin, in excess of 0.2% makes the whole waste stream a toxic waste as described in point no. 15

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12. ECOLOGICAL INFORMATION

Environmental Fate and Distribution: Inert gas

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13. DISPOSAL CONSIDERATIONS

Disposal should be in accordance with local, state or national legislation.

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14. TRANSPORT INFORMATION

This material is not transported.

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15. REGULATORY INFORMATION

EC Classification :

Hazard Symbol: T – Toxic

Content: Carbon monoxide

Risk phrases: R61 – May cause harm to the unborn child

R20 – Harmful by inhalation

R48/20 – Harmful: Danger of serious damage to health by prolonged exposure through inhalation

Safety phrases: S53 – Avoid exposure – obtain special instructions before use

S45 – In case of accident or if you feel unwell, seek medical advice immediately.