



TECHNICAL REQUIREMENTS

GENERAL

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1. SCOPE

- 1.1** Scope of the General Requirements is the definition of the common basis for the design of all the Units involved in ORLEN Lietuva.
- 1.2** As a general consideration the design criteria and philosophy will be aimed at achieving the desired levels of reliability and efficiency.
- 1.3** Attention will be paid for designing a Plant with a high level of safety, maintenance and operational simplicity.
- 1.4** To minimize the cost of spare parts and replacement items as far as possible, standardization of components and materials should be carried out.

2. REFERENCES

When this specification conflicts with local government or state codes, the more stringent document will govern.

Reference standards are included in the OL specifications:

2.1 General Requirements – OL Specifications**2.1.1 General**

OL-TR-GR-001 *General. Noise Level*

OL-TR-GR-002 *General. Firefighting*

2.2 Civil Requirements – OL Specifications**2.2.1 General**

OL-TR-CR-000 *Civil. General*

OL-TR-CR-001 *Civil. Structural Design*

OL-TR-CR-002 *Civil. Heat Insulation*

OL-TR-CR-003 *Civil. Fire-Proofing*

OL-TR-CR-004 *Civil. Concrete Structures*

OL-TR-CR-005 *Civil. Structural Steel*

OL-TR-CR-006 *Civil. Geotechnical Investigation*

OL-TR-CR-007 *Civil. Earthwork and Subgrade Preparation*

OL-TR-CR-008 *Civil. Roads*

OL-TR-CR-009 *Civil. Water and Sewage*

OL-TR-CR-010 *Civil. Underground Gravity Sewers*

2.2.2 Corrosion Protection and Lining

OL-TR-CR-011	<i>Civil. Corrosion Protection and Lining. Painting</i>
OL-TR-CR-012	<i>Civil. Corrosion Protection and Lining. Lining for Pressure Vessels and Piping</i>
OL-TR-CR-013	<i>Civil. Corrosion Protection and Lining. Lining for Heaters</i>
OL-TR-CR-014	<i>Civil. Corrosion Protection and Lining. Cathodic Protection</i>

2.3 Mechanical Requirements – OL Specifications**2.3.1 General**

OL-TR-MR-000	<i>Mechanical. General</i>
OL-TR-MR-001	<i>Mechanical. General Welding, Fabrication and Inspection</i>
OL-TR-MR-002	<i>Mechanical. Positive Material Identification</i>

2.3.2 Piping

OL-TR-MPR-001	<i>Mechanical. Piping</i>
OL-TR-MPR-002	<i>Mechanical. Piping Specifications</i>

2.3.3 Pressure Vessels

OL-TR-MVR-001	<i>Mechanical. Pressure Vessels</i>
OL-TR-MVR-002	<i>Mechanical. Internals for Towers, Drums and Fixed Bed Reactors</i>

2.3.4 Heat Exchangers

OL-TR-MER-001	<i>Mechanical. Shell and Tube Heat Exchangers</i>
OL-TR-MER-002	<i>Mechanical. Double Pipe Heat Exchangers</i>
OL-TR-MER-003	<i>Mechanical. Air Cooled Heat Exchangers</i>

2.3.5 Heaters and Boilers

OL-TR-MHR-001	<i>Mechanical. Fired Heaters</i>
OL-TR-MHR-002	<i>Mechanical. Industrial Boilers</i>

2.3.6 Cooling Towers

OL-TR-MCR-000	<i>Mechanical. Cooling Towers</i>
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2.3.7 Welded Storage Tanks

OL-TR-MTR-000	<i>Mechanical. Welded Storage Tanks</i>
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2.3.8 Machinery

OL-TR-MRR-000	<i>Mechanical. Machinery. General</i>
OL-TR-MRR-011	<i>Mechanical. Machinery. Centrifugal Pumps</i>
OL-TR-MRR-012	<i>Mechanical. Machinery. Sealless Centrifugal Pumps</i>
OL-TR-MRR-013	<i>Mechanical. Machinery. Shaft Sealing Systems for Centrifugal and Rotary Pumps</i>
OL-TR-MRR-021	<i>Mechanical. Machinery. Positive Displacement Pumps – Reciprocating</i>
OL-TR-MRR-022	<i>Mechanical. Machinery. Positive Displacement Pumps – Rotary</i>
OL-TR-MRR-023	<i>Mechanical. Machinery. Positive Displacement Pumps – Controlled Volume</i>
OL-TR-MRR-031	<i>Mechanical. Machinery. Axial, Centrifugal and Expander Compressors</i>
OL-TR-MRR-032	<i>Mechanical. Machinery. Positive Displacement Compressors – Rotary</i>
OL-TR-MRR-033	<i>Mechanical. Machinery. Reciprocating Process Compressors</i>
OL-TR-MRR-041	<i>Mechanical. Machinery. General-Purpose Steam Turbines</i>
OL-TR-MRR-042	<i>Mechanical. Machinery. Special-Purpose Steam Turbines</i>
OL-TR-MRR-051	<i>Mechanical. Machinery. General-Purpose Gear Units</i>
OL-TR-MRR-052	<i>Mechanical. Machinery. Special-Purpose Gear Units</i>
OL-TR-MRR-061	<i>Mechanical. Machinery. General-Purpose Centrifugal Fans</i>
OL-TR-MRR-062	<i>Mechanical. Machinery. Special-Purpose Centrifugal Fans</i>
OL-TR-MRR-063	<i>Mechanical. Machinery. Industrial Fans for General Process Service</i>
OL-TR-MRR-071	<i>Mechanical. Machinery. Protection Systems</i>

2.4 Automation and Instrumentation Requirements – OL Specifications

OL-TR-IR-000	<i>General Requirements</i>
OL-TR-IR-001	<i>Automation and Instrumentation. Flow Instruments</i>
OL-TR-IR-002	<i>Automation and Instrumentation. Pressure Instruments</i>

OL-TR-IR-003	<i>Automation and Instrumentation. Level Instruments</i>
OL-TR-IR-004	<i>Automation and Instrumentation. Temperature Instruments</i>
OL-TR-IR-005	<i>Automation and Instrumentation. Analyzers</i>
OL-TR-IR-006	<i>Automation and Instrumentation. Control Valves</i>
OL-TR-IR-007	<i>Automation and Instrumentation. ON-OFF Valves</i>
OL-TR-IR-008	<i>Automation and Instrumentation. Field Installation</i>
OL-TR-IR-009	<i>Automation and Instrumentation. Control and Auxiliary Rooms</i>
OL-TR-IR-010	<i>Automation and Instrumentation. Power Supply</i>
OL-TR-IR-011	<i>Automation and Instrumentation. Distributed Control System</i>
OL-TR-IR-012	<i>Automation and Instrumentation. ESD, BMS</i>
OL-TR-IR-013	<i>Automation and Instrumentation. Programmable Logic Controller</i>
OL-TR-IR-014	<i>Automation and Instrumentation. Fire and Gas Monitoring Systems</i>
OL-TR-IR-015	<i>Automation and Instrumentation. Plant Material Balance</i>
OL-TR-IR-016	<i>Automation and Instrumentation. Antisurge Systems</i>
OL-TR-IR-017	<i>Automation and Instrumentation. Erection Technical Documentation. Completion of Works</i>
OL-TR-IR-018	<i>Automation and Instrumentation. Scope of Supply</i>
OL-TR-IR-019	<i>Automation and Instrumentation. HMI/SCADA System</i>
OL-TR-IR-020	<i>Automation and Instrumentation. Data Sheets for instruments</i>

2.5 Electrical Requirements – OL Specifications

OL-TR-ER-000	<i>General Requirements</i>
OL-TR-ER-001	<i>Electrical. Electrical Buildings</i>
OL-TR-ER-002	<i>Electrical. Medium Voltage Switchgear Units</i>
OL-TR-ER-004	<i>Electrical. Low Voltage Switchgear Units</i>
OL-TR-ER-005	<i>Electrical. Low Voltage Motor Control Centers</i>

OL-TR-ER-008	<i>Electrical. Motor Control Devices (VFD, Soft Starters)</i>
OL-TR-ER-009	<i>Electrical. Power Control Devices</i>
OL-TR-ER-010	<i>Electrical. Medium Voltage Motors</i>
OL-TR-ER-011	<i>Electrical. Low Voltage Motors</i>
OL-TR-ER-012	<i>Electrical. Capacitors and Reactive Power Compensation Units</i>
OL-TR-ER-013	<i>Electrical. Power Transformers</i>
OL-TR-ER-014	<i>Electrical. Bus Conductors</i>
OL-TR-ER-015	<i>Electrical. Uninterruptible Power Supply</i>
OL-TR-ER-017	<i>Electrical. Illumination</i>
OL-TR-ER-018	<i>Electrical. Maintenance Illumination and Power Supply Connection Points</i>
OL-TR-ER-019	<i>Electrical. High Building Warning Lights</i>
OL-TR-ER-021	<i>Electrical. Grounding</i>
OL-TR-ER-022	<i>Electrical. Protection of Direct and Indirect Lighting Effects</i>
OL-TR-ER-023	<i>Electrical. Cathodic Protection</i>
OL-TR-ER-024	<i>Electrical. Cable Trench</i>
OL-TR-ER-025	<i>Electrical. Cable Trays</i>
OL-TR-ER-026	<i>Electrical. Power and Control Cables</i>
OL-TR-ER-027	<i>Electrical. Electrical Heating for Piping and Equipment</i>
OL-TR-ER-028	<i>Electrical. Electrical Heating for Instruments</i>
OL-TR-ER-029	<i>Electrical. Instrument and BMS Power Supply</i>
OL-TR-ER-030	<i>Electrical. Electric Actuators</i>
OL-TR-ER-031	<i>Electrical. Electric Shock Protection</i>
OL-TR-ER-032	<i>Electrical. Overvoltage Protection</i>
OL-TR-ER-036	<i>Electrical. General Electrical Erection Procedures</i>

2.6 Safety Equipment

See para. 18 of this specification.

2.7 Other Codes, Standards and Specifications

2.7.1 General Considerations

All equipment must be marked CE sign and meet EU requirements.

All equipment shall also be in accordance with the OL Specifications.

2.7.2 Environmental

LAND 43-2013

The Limitation of Emissions of Certain Pollutants into the Air from Large Combustion Plants (EU directive 2001/80/EB)

Environmental Protection Law of the Republic of Lithuania

Lietuvos Respublikos aplinkos oro apsaugos įstatymas – Air environmental protection law of the Republic of Lithuania

Law on the Evaluation of Environmental Impact of Planned Economic Activity of the Republic of Lithuania

LAND 31-99/M-11

Method for Calculation of Volatile Organic Compounds (VOC) Not Differentiated as per Composition, Emissions Resulting from Petroleum Storage and Distribution

Law on Waste Management of the Republic of Lithuania

Resolution of the Government of the Republic of Lithuania No. 1090 on Provisions of prevention, elimination and investigation of Industrial Emergencies, adopted on 4 August, 1995

Integrated Pollution Prevention and Control (IPPC). Reference Document on Best Available Techniques for Mineral Oil and Gas Refineries, February 2003

2.7.3 Construction

Republic of Lithuania. Law on Construction

Republic of Lithuania. Law on Territorial Planning

STR 1.01.05:2007

Regulatory Technical Documents for Construction

STR 1.11.01:2010

The Procedure for the Acknowledgement of Construction Works as Suitable for Use.

STR 1.01.06:2010

Construction Works of Exceptional Significance

STR 1.05.06:2010

Design of Construction Works

STR 1.05.07:2002

Set of Design Conditions for a Structure

<u>STR 1.06.03:2002</u>	<i>Expert Examination of Construction Works and of Design Documentation of Construction Works</i>
<u>STR 1.07.01:2010</u>	<i>Documents Permitting Construction (Construction Authorizations)</i>
<u>STR 1.09.05:2002</u>	<i>Technical Supervision of Construction of the Structures</i>
<u>STR 2.05.03:2003</u>	<i>Building Structures Basic Design</i>
<u>STR 2.05.04:2003</u>	<i>Effects and Loads</i>
<u>STR 2.07.01:2003</u>	<i>Water Supply and Sewerage. Engineering Systems in the Building. Outside Engineering. Networks</i>
RSN 156-94	<i>Building climatology manual</i>

3. TERMS, DEFINITIONS AND ABBREVIATIONS

For general terms and definitions see separately OL specifications acc. to para. 2 of this Specification.

Basic Engineering Package: The basic engineering Specifications and preliminary operating and laboratory manuals for the Project

Completion Certificate: The certificate to be issued by the Engineer stating that part of the permanent works (as defined in the Contract) specified in the Certificate has been completed.

Contractor: The persons, firm, company or consortium whose tender has been accepted by the 'OL' and includes the Contractor's personnel representative, successors and permitted authorized assignees.

Defects: All items which require replacement or repair but could not have been replaced or repaired before Take Over and in no way hinder or affect the requirements for substantial completion.

Dossier: All inspections and test certificates and all other documents that record the 'System' and/or 'Unit' completion status in accordance with terms of 'Contract'. The Dossier will be prepared individually for each 'System' and/or 'Unit'.

Effective Date of the Contract: The date when all the necessary formalities mutually agreed upon including signing of all the Agreement between the 'OL' and the 'Contractor', take place in accordance with the 'Contract'.

Engineer: The OL's authorized representative appointed by the 'OL' from time to time to supervise execution of the 'Project'.

Engineer's Representative: Any authority or person appointed, in writing by the 'Engineer', from time to time, and to whom part or all of the 'Engineer's' authorities and powers are delegated by the 'Engineer'.

Final Acceptance: The certificate to be issued by 'Engineer' stating that all of the 'Contractor's' guarantees under the 'Contract' have been satisfactorily met or

discharged subject to 'Contractor's' obligations and after completion of 'Works', tests on completion, taking over, and the remedy of defects period.

Performance Test: The test conducted to demonstrate and ratify performance of Unit or Units meeting all process and utilities guarantees as requested and defined in the Contract.

Permanent Works: All Works which will be incorporated in and form part of the project to be handed over to the "OL" by the 'Contractor'.

Progress Report: The reports by the 'Contractor' in writing to the 'OL's' authorized Representative specifying the amount of Progress of the Services and Works, respective values and Project area of concerns.

Project: 'Works' to be performed and rendered by the 'Contractor' in accordance with the terms and conditions of the 'Contract' documents.

Provisional Acceptance: Operability Test' have been satisfactorily completed with the system operating at capacity as defined in the relevant clauses of the 'Contract', for a continuous period as defined in the 'Contract'. Substantial completion shall be evidenced by issuance of a "Provisional Acceptance Certificate" as per the 'Contract'.

Site: The lands and other places, on, under or through which the works are to be executed or carried out, and any other lands or places provided by the 'OL' for the purposes of the 'Contract' together with such other place as may be specially designated in the 'Contract' as forming part of the site.

Specifications: Drawings, Specifications, data sheets and any other technical documents, whatever they may be, issued with the 'contract' documents including any revisions or additions from time to time to the drawings, specifications, data sheets and any other technical documents.

Sub-Contractor: Any person, firm or company (other than Contractor) to whom any part of the Works has been entrusted by Contractor with the consent in writing of OL, and also the legal representative, successors and permitted authorized assignees of such person, firm or company.

System: A part of each 'Unit' which can be well identified with battery limits in the relevant Unit for systematic turnover of that Unit. e.g., instrument air, cooling water, control room, electrical substation, etc.

Temporary Works: All temporary works of every kind required in or about the execution or remedy of defect of the "Works" but does not include Contractor's equipment.

Tests on Completion: Such tests to be made by the 'Contractor' before the 'Works' are taken over by the 'OL' as are provided for in the 'Contract' and such other tests as may be agreed between the 'OL and the 'Contractor'.

Unit or Units: One or all Units and facilities as applicable, to form a complete operable oil or gas refinery, and a petrochemical complex or distribution depot as defined in the Scope of Work of the 'Contract' except those items listed in the Scope of Work as to be designed and constructed by others.

Works: Any and all design and engineering, supply of materials and procurement services, assistance in commissioning and start-up (if required), and remedy of defects

and all other services to be rendered by the 'Contractor' in accordance with the 'Contract'.

CA: Corrosion Allowance.

CS: Carbon Steel.

DCS: Distributed Control System.

DN: Nominal Diameter.

ESD: Emergency Shut-Down.

HE: Heat Exchanger.

ISA: International Society of Automation.

LP: Low Pressure.

LPG: Liquefied Petroleum Gas.

MP: Medium Pressure.

Non-removable internals: welded internals to vessels (support rings, support lugs, etc.).

OL: AB "ORLEN Lietuva".

PFD: Process Flow Diagram.

P&ID: Piping and Instrument Diagram.

PSV: Pressure Safety (Relief) Valve.

Removable internals: non-welded internals to vessels.

SIL: Safety Integrity Level.

SIS: Safety Instrumented System.

SS: Stainless Steel.

4. UNITS OF MEASURE

4.1 The following units of measure shall be used as shown in Table 1.

Table 1. Units of Measure

Description	Unit
Temperature	°C
Pressure	
Gauge	bar(g)
Absolute	bar(a), mmHg
Vacuum	mmHg
Weight	kg
Volume	
Liquid	m ³
Gas	Nm ³
Flow of Process fluid	
Liquid	
Mass flow	kg/h, t/h
Volume flow	m ³ /h
Gas	
Mass flow	kg/h
Volume flow	Nm ³ /h
Flow of steam	kg/h, t/h
Density relative, absolute	kg/m ³
Enthalpy	kcal/kg
Heat duty/Power	Gcal/h, kW
Transfer rate	kcal/m ² ·°C·h
Fouling resistance	m ² ·°C·h/kcal
Viscosity	
Kinematic	cSt
Dynamic	cP
Velocity	m/s
Sound pressure, power	dBA
Level	mm, %
Pipe length	m
Pipe diameter	mm (DN)
Equipment, Duct dimensions	mm, m
Vessel nozzle sizes	mm (DN)
Plot Plan dimensions	mm, m

4.2 The normalized conditions for gas and liquid measurement as shown in Table 2.

Table 2. Normalized Conditions for Gas and Liquid Measurement

Description	Value / Unit
Gas	
Standard	760 mmHg, 15 °C (Sm ³ /h)
Normal	760 mmHg, 0 °C (Nm ³ /h)
Liquid	
Standard	760 mmHg, 15 °C (Sm ³ /h)

5. CLIMATIC DATA

See Table 3.

Table 3. Climatic Data (RSN 156-94)

Description	Value / Unit ⁽¹⁾
Maximum temperature	+33 °C
Design maximum ambient temperature	+26.8 °C
Minimum temperature	-36 °C
Winterizing temperature	-23 °C
Design minimum temperature	-36 °C
Relativity humidity	
Average	63 %
Maximum	89 %
Dry bulb temperature	-15 °C
Barometric pressure	
Minimum	
Maximum	
Average	101.3 kPa (760 mmHg)

Notes:

(1) These data are required for reference only to indicate if a need exists for tracing or winterizing.

6. UTILITIES AND FLARE

6.1 Steam and Condensate

See Table 4.

Table 4. Steam and Condensate. Pressure-Temperature Data

Description	Pressure bar(g)	Temperature °C
High pressure		
Minimum (for thermal design)	34.0	340
Normal	37.0	360
Maximum	38.0	380
Mechanical design	39.0	400
Medium pressure		
Minimum (for thermal design)	8.5	190
Normal	9.0	220
Maximum	11.0	250
Mechanical design	13.0	250
Steam from MP Steam	16.0	290
Low pressure		
Minimum (for thermal design)		
Normal		
Maximum		
Mechanical design		
MP Steam condensate	1 - 4	70 - 90
(Give for each level required)		

6.2 Water

See Table 5.

Table 5. Water. Pressure-Temperature Data

Description	Pressure bar(g)	Temperature °C
Cooling water - Supply		
Source		
Minimum	3.0	10
Maximum	5.5	27
Mechanical design	6.5	45
Cooling water - Return		
Minimum pressure required for return	1.8	
Maximum temperature for return		45
Boiler feed water (30-50 ppb O ₂)		
Minimum (for thermal design)		
Normal		
Maximum		
Mechanical design		
Process water (catalyst wash, chemicals)		
Minimum		
Normal		
Maximum		
Mechanical design		
Source: demineralized water		
Quality: provide detailed analysis		
Process water (water wash)		
Minimum	1 - 4	70 - 90
Normal		
Maximum		
Mechanical design		
Source: cond., B.F.W., stripper water		Steam condensate
Quality: deaerated, provide detail analysis		
	Pumps to be foreseen	

6.3 Air

See Table 6.

Table 6. Air. Pressure-Temperature Data

Description	Pressure bar(g)	Temperature °C
Plant Air (oil-free for catalyst regeneration)		
Minimum	3.5	-36
Normal	4.0	Ambient
Mechanical design	8.0	50
Instrument air		
Minimum	3.5	-36
Normal	4.0	Ambient
Mechanical design	8.0	50

6.4 Nitrogen

See Table 7.

Table 7. Nitrogen. Pressure-Temperature Data

Description	Pressure bar(g)	Temperature °C
LP Nitrogen		
Minimum	3.0	-36
Normal		20 - 30
Mechanical design	9.8	50
Availability: yes		
Quality: 99.7 % (+ O ₂ + CO ₂)		
MP Nitrogen		
Minimum	12.0	-36
Normal		20 - 30
Mechanical design	16.0	50
Availability: yes		
Quality: 99.7 % (+ O ₂ + CO ₂)		

6.5 Fuel

See Table 8.

Table 8. Fuel. Pressure-Temperature Data

Description	Pressure bar(g)	Temperature °C
Fuel gas		
Minimum	1.0	10
Normal	2.5	20
Maximum	3.4	30
Mechanical design	4.9	50
Quality: provide typical analysis		
Fuel oil		

6.6 Flare Header

See Table 9.

Table 9. Flare Header. Pressure-Temperature Data

Description	Pressure ⁽¹⁾ bar(g)	Temperature ⁽¹⁾ °C
Flare header		
Normal	0.5	
Mechanical design	3.0	

Notes:

(1) Parameters for separate terminal area (connection point) will be delivery.

6.7 Electricity

See Table 10.

Table 10. Power Supply Networks

Description	Voltage	No. of Phases	Frequency	Neutral
Medium Voltage	6300 V	3	50 Hz	Compensated (resonant grounded) neutral
Low Voltage	230 / 400 V	1, 3	50 Hz	Solidly-grounded neutral, TN-C-S

7. SAFETY AND ENVIRONMENTAL REQUIREMENTS

7.1 SIS Related to Chemistry

The Contractor shall make sure that the type and quality of the instrumentation supplied for the SIS, the redundancies which are possibly necessary for sensors and final elements, the logic system, and the on-site test frequency will be compatible with the SIL level which is specified.

7.2 SIS Not Related to Chemistry

The SIL and the corresponding SIS connected to equipment protection will be the responsibility of the Engineering Contractor and OL (see *OL-TR-IR-000* para. 9.21).

7.3 Shutdown of Pumps by Low Level in Upstream Vessel

For all cases, Engineering Contractor will check with the pump's vendor if automatic shutdown is required. A note shall be notified on the P&ID.

7.4 Electrical Isolation Valves Inlet/Outlet Tanks

OL thinks that electrical valves in inlet/outlet of tanks should be installed. Contractor can have arguments to change these requirements.

7.5 High Level in Tanks

To avoid overfilling, an independent high level alarm (LAH) should be specified.

7.6 Prevention of Back Flow Overpressure

Devices will be considered at the pump discharge by check valve.

7.7 Seals on Pumps

See *OL-TR-MRR-000*.

7.8 Other Requirements

7.8.1 Noise isolation shall be in accordance with *OL-TR-GR-001*.

7.8.2 Fireproofing shall be in accordance with *OL-TR-CR-003*.

8. EQUIPMENT IDENTIFICATION AND NUMBERING

8.1 Equipment Identification

For equipment symbols of identification see Table 11.

Table 11. Equipment Identification

Identification	Equipment	Identification	Equipment
KR	Heater	S	Pump
R	Reactor	DK, IK, SK	Compressor
K	Tower and Column	RZ	Storage Tank
T	Drum	J	Ejector
SP	Separator	M	Miscellaneous
TK	Heat Exchanger	DR	Dryer
AO	Air cooler	VT, VI	Fan (feed, exhaust)
AV	Water cooler	D	Induced draft fan
F	Filter	Esk	Motor operated valve

8.2 Equipment Numbering

See Figure 1.

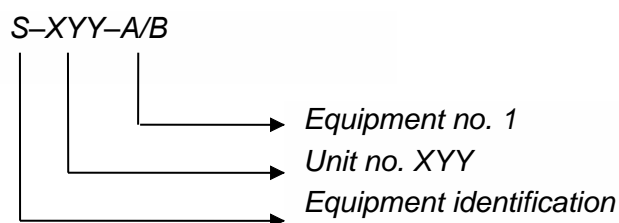


Figure 1. Example of Equipment Numbering

9. LINE NUMBERING AND IDENTIFICATION

9.1 Example

Example of line numbering and identification:

150 – LS – 001 – Af – HC – ST

indicates:

150	Line Size (mm)
LS	Service designation (see Table 12)
001	Line Tag
Af	Piping Material Specification
HC	Insulation
ST	Tracing

Table 12. Service Identification

ID ⁽¹⁾	Description	ID ⁽¹⁾	Description
Heating / Cooling			
LS	Low pressure steam	LC	Low pressure steam condensate
MS	Medium pressure steam	MC	Medium pressure steam condensate
HS	High pressure steam	HC	High pressure steam condensate
LSS	Low pressure superheated steam		
MSS	Medium pressure superheated steam		
HSS	High pressure superheated steam	HO	Heat transfer fluid
CWS	Cooling water supply	CWR	Cooling water return
FR	Refrigerant		
FG	Fuel gas	FO	Fuel oil
Chemicals			
IG	Inert gas	ZS	Caustic soda
NG	Nitrogen	ZA	Ammonia
CA	Catalyst	ZC	Chemicals
Air			
IA	Instrument air	PA	Process air (oil free)
UA	Utility air		
Water			
RW	Raw water	PW	Process water
DW	Demineralized water	TW	Tempered water
BFW	Boiler feed water		
Effluents Disposal			
BD	Blowdown	CS	Chemical sewer
SWS	Sour water sewer	OS	Oily sewer
ATM	Vent to atmosphere	FL	Flare
SL	Slops	CDS	Closed Drain System
Process			
D	Diesel	VR	Vacuum residue
GA	Gasoline	BT	Bitumen
K	Kerosene		
VGO	Vacuum distillate	P	Process

Notes:

(1) Fluid identification not found shall be accepted by OL's Process Engineer.

9.2 Pipe Material

See Table 13 (1 digit - letter)

Table 13. Pipes and Forgings Material Identification

Type	Material	ASTM Specifications	
		For Pipes	For Forgings
A	CS (MDMT ⁽¹⁾ ≥ - 5°C)	A106 – GrB	A105
B	CS (– 45°C ≤ MDMT ⁽¹⁾ < – 5°C)	A333 – Gr6	A350 Gr LF 2
C	C - 1/2 Mo	A335 – P1	A182 – F1
D	1Cr - 1/2 Mo	A335 – P12	A182 – F12
E	1 1/4Cr - 1/2 Mo	A335 – P11	A182 – F11
F	2 1/4Cr - 1 Mo	A335 – P22	A182 – F22
G	3Cr - 1 Mo	A335 – P21	A182 – F21
H	5Cr - 1/2 Mo	A335 – P5	A182 – F5
I	9Cr - 1 Mo	A335 – P9	A182 – F9
J	SS - TP316	A312 – TP316	A182 – F316
K	SS - TP316L	A312 – TP316L	A182 – F316L
L	SS - TP304	A312 – TP304	A182 – F304
M	SS - TP304L	A312 – TP304L	A182 – F304L
N	SS - TP321	A312 – TP321	A182 – F321
O	SS - TP317L	A312 – TP317L	A182 – F317L
P	SS - TP347	A312 – TP347	A182 – F347
R	Alloy 800 (INCOLLOY 800™)	B407 – N08800	B564 – GrN08800
S₁	Alloy 400 (MONEL 400™) D ≤ 5"	B165 – N04400	B564 – GrN04400 Annealed
S₂	Alloy 400 (MONEL 400™) D > 5"	B165 – N04400	B564 – GrN04400 Annealed
U	Duplex S31803 (URANUS 45 N™)	A789 – S31803	A182 – Gr F51

Notes:

(1) MDMT: Minimum Design Metal Temperature.

9.3 Corrosion Allowance

See Table 14 (1 digit - number).

Table 14. Corrosion Allowance Identification

ID	Allowance (mm)	ID	Allowance (mm)	ID	Allowance (mm)
0	0.25	2	1.50		
1	1.00	3	3.00	6	6.00

9.4 Special Requirement

See Table 15 (1 digit - letter).

Table 15. Special Requirements Identification

ID	Description	ID	Description
S	Killed CS (KCS) wet H ₂ S resistant ⁽¹⁾		
R	Internal lining		

Notes:

(1) Seamless pipe sulfide stress corrosion cracking resistant as per NACE MR-01-75 std. (last edition).

9.5 Flange Rating

See Table 16 (1 or 2 digits - number).

Table 16. Flange Rating Identification

ID	Rating	ID	Rating	ID	Rating
1	150#	6	600#	15	1500#
3	300#	9	900#	25	2500#

9.6 Flange Facing

See Table 17 (2 digits - letter).

Table 17. Flange Facing Identification

ID	Description	ID	Description
FF	Flat Face		
RF	Raised Face		
RJ	Ring Joint		
LJ	Lap Joint		

9.7 Insulation

See Table 18 (1 or 2 digits - letter).

Table 18. Insulation Identification

ID	Description	ID	Description
HC	Heat Conservation	AS	Anti-Sweat
FP	Freeze Protection		
PP	Personal Protection		
C	Refrigeration Conservation		

9.8 Tracing

See Table 19 (1 or 2 digits - letter).

Table 19. Tracing Identification

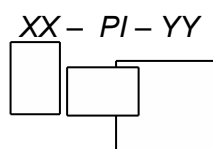
ID	Description	ID	Description
ST	Steam Tracing	J	Jacketing
WT	Hot Water Tracing		
ET	Electric Tracing		

10. INSTRUMENT NUMBERING AND IDENTIFICATION

According to ISA code as per General Symbols.

10.1 Instrument

See Figure 2.



P&ID number (last two digits)
Symbol
Sequential number

Figure 2. Instrument Numbering and Identification

10.2 Pressure Relief Valve

Example of PSV numbering and identification:

PSV – XX

11. EQUIPMENT DESIGN BASIS

11.1 Design Pressure

11.1.1 Design Pressure for Individual Equipment Items

11.1.1.1 Design pressure does not include the liquid static as this will be added by the vessel design group based on the high level. Pressure drop across or vessel internals should be included if it is significant.

11.1.1.2 Whichever is greater: 3.5bar(g).

11.1.1.3 Flare design pressure if the vessel is connected to flare.

11.1.1.4 For maximum operating pressures less than 15bar(g), use the maximum operating gage pressure +1.5 bar.

11.1.1.5 For maximum operating pressures between 15bar(g) and 100bar(g), use 110% of the maximum operating gage pressure.

11.1.1.6 Equipment normally operated under vacuum or subject to start-up or shut down evacuation is designed for full vacuum and for the highest pressure the equipment can experience in case of vacuum system failure.

11.1.1.7 Full vacuum will be specified for isolable equipment containing fluid having a vapor pressure lower than atmospheric pressure at ambient temperature.

11.1.1.8 Full vacuum is not specified for transient operations as steam purging where opening of vent is always considered. For equipment equipped with steam out the following sentence will be specified on the data sheet: “*Subject to steam out conditions*” with the pressure and temperature of the steam.

11.1.2 Design Pressure for Complete Systems

When several pieces of equipment are protected by the same relief valve, each piece of equipment will be designed, at least, for the pressure imposed by the discharge conditions of the relief valve in case of emergency.

11.2 Design Temperature

15°C above the maximum operating temperature or specified by Contactor.

11.3 Purging Equipment with Steam

For equipment submitted to steam purging at start-up or shutdown,

11.4 Corrosion Allowance**11.4.1 Equipment Design Life**

Design life may be applied to the design of the unit as a standard base shown in Table 20.

Table 20. Equipment Design Life

Equipment	Life (years)	Equipment	Life (years)
Columns, vessels	20	Piping	10
HE shell and similar services	20	CS / low alloy HE tube bundles	10
High alloy exchanger tube bundles	10		

12. CORROSION ALLOWANCE**12.1 Pressure Retaining Equipment**

12.1.1 The calculated corrosion allowance shall be based on the designed number of years in service.

12.1.2 For carbon steel, OL considers a minimum corrosion allowance (CA) of 3mm (1/8") in general for non-corrosive environment as regular hydrocarbon.

12.1.3 For other materials, minimum CA is 3mm (1/8") for low-alloyed steels (up to 2.1/4%Cr included), 3mm (1/8") for low-alloyed steels (up to 9%Cr included) and 0.75mm (1/32") for stainless steel.

12.1.4 The corrosion allowance of 3mm for low-alloyed steels (up to 9%Cr) and for critical equipment.

12.1.5 For tubular heat exchangers, CA defined for tubes and shell sides, applied to pressure retaining elements. Tubesheet is concerned by CA on each side. Tubes are not concerned by CA, whichever the side.

12.1.6 If equipment is clad or overlayed, undiluted thickness of clad or overlay is considered as CA allowance.

12.2 Internals

12.2.1 Removable parts of carbon steel and low-alloyed steels (up to 9%Cr) internals shall have a minimum CA of one half of total vessel shell CA on each side in contact with the operating fluid.

12.2.2 Fixed internals carbon steel and low alloyed steel (up to 9%Cr) made shall have the full corrosion allowance on each face (in total 2 times the designed CA of shell).

12.2.3 In general, no corrosion allowance will be given for removable internals made of stainless steel (13%Cr and above) as also for those made of non-ferrous high alloyed. However, a corrosion allowance shall be specified for some internals exposed to severe conditions such as non-removable internals of reactor, catalyst bed support

beams of reactor. These internals shall therefore have the CA, based on the reactor design life specified in paragraph “Equipment Design Life”, on each exposed surface.

12.2.4 Removable and non-removable internals of tubular heat exchangers are not concerned by CA, whichever the side.

12.2.5 No corrosion is considered for internals made with V wire screen or wire mesh.

13. VESSELS

13.1 For shop fabrication or shipping indicate any known limitation (diameter, length, weight).

13.2 Connections will be flanged.

13.3 Vessels should be provided with vent and drain nozzles.

13.4 Vent and drain sizes will not be indicated, unless required for process reasons.

13.5 Separate steam-out connections should be specified (if required).

13.6 Indicate size/weight limitation for transportation/erection, if any.

14. PUMPS

14.1 10% oversizing should normally be specified.

14.2 Pumps on P&ID's are shown with temporary strainers at suction, unless permanent strainers are indicated.

15. INSTRUMENT AND CONTROL VALVES

15.1 The symbols to be used will be in accordance with ISA.

15.2 Specify the type of architecture instrumentation to be used (DCS).

16. ALARM AND SHUTDOWN DEVICES

16.1 Alarms and shutdown devices should be specified where required for process, safety or equipment protection considerations.

16.2 All safety devices are connected to one specific system (ESD type).

17. PRESSURE RELIEF VALVES

17.1 Pressure relief valves are normally installed on the equipment.

17.2 Pressure relief valves should be equipped with a by-pass.

17.3 Inlet and outlet isolation block valves should be specified for maintenance. The client practice is to isolate safety valve for maintenance and have operator seated nearby local PI and bypass valve. If required, operator opens bypass valve (see Figure 3).



FLARE

PI



Figure 3. PSV Installation Scheme

NOTES:

(1) Valves before and after PSV, shall be locked in open position (LO).

(2) Depending on process specification, If risk is significant, PSV shall be doubled.

17.4 Pressure relief valves in hydrocarbon vapor service will normally discharge to a flare system.

17.5 Indicate if Customer policy and environmental regulations permit discharging non-toxic vapors to the atmosphere and under which conditions.

17.6 Indicate flare header normal and design pressures.

18. SAFETY EQUIPMENT

18.1 Scope

18.2 This Para. covers requirements for emergency showers and eye-washers and safety shields for piping and equipment.

18.3 This specification is supplemental to OL design drawings, standard details and instructions in the Requisition. In the case of conflict between any of the documents, the vendor must get written clarification from OL before proceeding.

18.4 References

All codes, standards and specifications (local and national) referred to herein are the latest edition and include the latest addenda issued prior to the purchase order date, unless otherwise specified in the Requisition documents.

ISEA Z358.1 *Emergency Eyewash and Shower Equipment*

Equipment shall comply also with European Directives includes all needed/requested CE nameplates, marking, declaration of conformity, operating instruction manuals etc.

18.5 Terms and Definitions

Dangerous materials, as used herein, include only the following:

Acutely toxic materials: such as phenol.

Highly corrosive materials: such as acid and caustic.

18.6 Emergency Showers and Eye-Washers**18.6.1 Design****18.6.1.1** *Water Supply*

Only potable water supplies are permitted for use with safety showers and eyewash facilities. The supply water to the facilities shall be constant. All block valves in the system shall be car sealed open.

18.6.1.2 *Temperature Control*

18.6.1.2.1 The design shall be suitable for the climate zone specified (see OL-TR-GR-000). Where the effect of solar radiation is a consideration, exposed piping shall be insulated. Anti-scalding devices should be used where required to prevent personnel exposure to hot water (due to solar radiation on the piping) when activating the safety shower/eye wash.

18.6.1.2.2 The water temperature at the shower and eyewash shall be maintained at between 15°C and 35°C (60°F and 95°F) based on 15 minutes continuous operation of the shower.

18.6.1.2.3 If a hot water heater tank is used, it shall have an electric immersion type heating element and thermostatic control. The minimum capacity of the tank shall be 570 L (150 gal).

18.6.2 Materials and Equipment**18.6.2.1** *General*

18.6.2.1.1 All materials of construction shall be corrosion resistant to prevent rust or scaling. Piping shall be brass, copper, stainless, or galvanized steel. The use of aluminum or plastic (CPVC) shall be approved by the OL's Engineer.

18.6.2.1.2 Enclosures for electrical equipment shall be suitable for the specified electrical area classification and environmental exposure.

18.6.2.2 *Shower and Eyewash Equipment*

Equipment shall be the combination eyewash and shower type conforming to ISEA Z358.1 and the following:

- a) Either a walk-on treadle valve or pull rod shall operate the emergency shower. Either a foot treadle or push lever shall operate the eyewash, as specified by the OL's Engineer;
- b) The operating valves shall remain open until intentionally shut off. The operating valves shall be self-draining for outdoor locations;
- c) When specified, actuation of the shower or eyewash shall trigger an alarm light in a manned control house;
- d) Hand drench hoses shall be provided only if specified;
- e) Identification and signage shall be per site standard.

18.6.2.3 *Enclosures*

Where enclosed facilities for shower and devices are required, the enclosures shall be designed as follows:

- a) The minimum unobstructed area inside the enclosure shall be 1200 mm (48") in diameter;
- b) The enclosure shall be constructed of materials which do not support combustion, such as masonry or insulated metal panels;
- c) Electric heat shall be provided to maintain a minimum temperature above freezing in the enclosure;
- d) A 750 mm x 2000 mm (30" x 80") double swing door with a 300 mm x 300 mm (12" x 12") safety glass panel shall be provided. The door shall have a friction catch.

18.6.3 Installation

Installation procedure shall be per ISEA Z358.1 and the additional requirements specified herein.

18.6.3.1 Location

18.6.3.1.1 Emergency shower and eyewash shall be provided in areas where dangerous materials are handled and personnel exposure may result in skin burns or eye injury. Sources of exposure normally involve pumps, sample points, areas where frequent maintenance activity is expected, tank truck/tank car loading/unloading connections, open hatch loading positions, outside battery rooms, and other locations handling dangerous materials, including elevated locations.

18.6.3.1.2 The shower and eyewash shall be in an accessible location which requires not more than ten seconds to reach and a travel distance of not more than 15 m (50 ft) from the source(s) of exposure and shall be in an area which is free of the contaminant. This shall be outside the toe wall (if one exists) which surrounds the source(s) of exposure. There shall be an unobstructed path from the source(s) of exposure to the shower and eyewash. Stairs or ladders shall not be used to reach the facilities. The shower and eyewash should be located no closer to the potential release point than necessary to assure that personnel are far enough away from the hazardous material release. This distance may vary depending upon the application (e.g., 7600 mm for pumps, 3050 mm for battery rooms). Barriers may be installed between the potential leak source and the safety shower/eyewash stations in lieu of using distance. The final locations of the shower and eyewash shall be approved by the OL's Engineer.

18.6.3.2 Grade Level Installations

18.6.3.2.1 The area beneath unenclosed shower and eyewash facilities installed at grade level shall be paved with concrete and sloped toward a catch basin so that water does not collect and become a freezing or housekeeping problem. Enclosed shower and eyewash facilities shall be installed on a concrete paving with a drain and trap connected to a sewer.

18.6.3.2.2 For an outdoor showers, when possible, the location shall be next to a building wall with the valves operable from the outside but installed inside to prevent freezing. If this is impractical, the operating valves and exposed water lines to the shower and eyewash shall be made self-draining.

18.6.3.3 Elevated Locations

Shower and eyewash facilities installed at elevated locations on open type structures shall rest on steel platforms with an opening in the floor for drainage. For facilities installed at elevated locations in enclosed structures, a floor drain shall be provided with piping to a sewer.

18.6.3.4 *Piping*

Piping to shower and eyewash installations shall not be run in the same trench with steam lines or other high temperature lines.

18.6.3.5 *Testing Requirements*

18.6.3.5.1 Eyewash and safety shower systems must be capable of being tested periodically by flowing (flushing) the system. The minimum recommended frequency is monthly.

18.6.3.5.2 The system shall be designed such that flushing action will be capable of inhibiting biological growth in stagnant potable water piping.

18.6.3.5.3 Provision shall be made on each self-contained portable eyewash/safety shower system to facilitate the addition of approved water additives to prevent biological growth.

18.6.3.6 *Lighting*

54 lx minimum lighting shall be provided at all shower and eyewash facilities including inside enclosures.

18.6.3.7 *Identification*

The shower/eyewash and/or its background shall be marked to be highly visible. The color and pattern of the marks shall be consistent with existing equipment. When an existing color is not established, high visibility green and white stripes shall be used, unless otherwise specified. Signs shall also be provided.

18.7 **Shield for Piping and Equipment****18.7.1** **Application**

18.7.1.1 Safety shields shall be installed at the following locations where personnel may be inadvertently subjected to a spray of dangerous material:

- a) Mechanical seals of mechanical equipment such as pumps and agitators in dangerous material service;
- b) Packing glands of valves handling dangerous materials where designated by the OL's Engineer;
- c) Piping flanges and at piping connections to equipment in dangerous service where designated by OL's Engineer.

18.7.1.2 Safety shields are not required:

- a) In areas where personnel are required to wear fluid contact protection for entrance into an area;
- b) If dual mechanical seals are provided on rotating equipment, or if valves and piping flanges are provided with intrinsic protection or located such that a failure will not contact individuals at frequented locations.

18.7.1.3 Safety shields shall be removable while the equipment is in service. Equipment with removable safety shields shall be provided with a permanent indication denoting the purpose of the shield and the potential hazard(s).

18.7.1.4 A safety shield shall be designed, fabricated, and installed to withstand and deflect a liquid release from failed equipment.

19. DETAILED DESIGN AND ENGINEERING

19.1 Work Sequence and Procedures

The Contractor shall develop project procedures to cover all aspects of the design and procurement phases of the project. These procedures shall be based on the OL's Standard procedures, modified as necessary to suit the project requirements. In case of lack of the OL's Standard procedures, Contractor can utilize either his own or other international procedures upon approval of the OL. These procedures should include but not be limited to the following:

- a) Filing System.
- b) Document Distribution.
- c) Standards & Codes (Data Base).
- d) Engineering Symbols, Scales and Units.
- e) Numbering Procedures.
- f) Drafting Procedures.
- g) Specification for Handling of the Technical Documents.
- h) Specification Preparation.
- i) Progress Measurement Procedure for Engineering and Procurement
- j) Services.
- k) Design Interface Control.
- l) Safety and Operability Review.
- m) Control of Engineering Budget and Schedule.
- n) Document Control Center.
- o) Engineering Document Checks and Reviews.
- p) Requisitions.
- q) Testing and inspection.
- r) Quality assurance plan.

19.2 Work Methods

The Contractor shall:

- a) Monitor the progress in all areas against the Project schedule to detect early deviations to schedule and to arrange for corrective action, e.g. additional staff, computing facilities or other measures. A biweekly progress meeting may be held to outline the progress achieved, problems encountered, and solutions intended.
- b) Monitor, identify and resolve any non-conformity with the Contract requirements and potential problems.
- c) Be responsible for any and all specifications prepared by vendors/subcontractors. In this connection the Contractor shall review and check and approve the said Specifications compliance with the Contract requirements.

NOTE: Be responsible for the quality and completeness of Work and shall review and sign all drawings, data sheets, Specifications and acquisitions.

- d) Establish format of all data sheet forms.
- e) Confirm that works are all in accordance with Contract requirements and design guides, and shall act to identify and resolve problems. The Contractor shall also monitor any possible trends involving design changes and shall alert the OL of these potential changes.

19.3 Process, Utilities and Safety Engineering

19.3.1 Process and Utilities Engineering

- 19.3.1.1** Based upon the Basic Design Process P & IDs, Contractor shall develop and prepare detail design P & IDs to be approving for design and then follow through to approve for construction incorporating vendors' information.
- 19.3.1.2** The P&IDs shall show the interfaces with other drawings included but not limited to those supplied parts by vendor.
- 19.3.1.3** In case any P&ID prepared by vendors, the said P&IDs should comply with the above mentioned requirements.
- 19.3.1.4** The Contractor shall perform the following main activities as minimum requirement relevant to Process, and Utilities:
- a) Develop complete (inclusive auxiliary system) P&IDs for each Unit to be approved for design based upon the Basic Engineering P&IDs and then follow through and complete the said P&IDs to be approved for construction incorporating vendors information.
 - b) Develop definitive Plant General Plot Plan considering plant safety aspects, operability and maintenance.
 - c) Develop definitive detailed plot plan drawings for the Units taking into account safety, easy operation and maintenance of individual equipment and accessories and parts included in the plant.
 - d) Complete where necessary as a basis for detailed design and issue process data sheets.
 - e) Develop process engineering specifications and drawings for each individual equipment.
 - f) Review and develop basic requirements for plant drainage and disposal systems.
 - g) Provide equipment list/index and schedule for all equipment including driver where applicable.
 - h) Prepare utility data including-effluent data and utility balances diagrams.
 - i) Develop safety data related to P&ID and review process design safety and conduct P&I Diagrams safety review.
 - j) Review equipment arrangement drawings.
 - k) Prepare and develop procedures for preservation of equipment during short/long time of non-operation.
 - l) Review flares and relieving philosophy (in conjunction with different emergency cases) and finalize size of the flares headers and approve flares load data.
 - m) Check and verify all tower capabilities in design, normal and turn down throughputs based on the tower load calculations performed by the tray or packing supplier.
 - n) Prepare line schedules for all piping, including line numbers, unit number, fluid symbol, origin and termination, size, material specification, operating and design conditions field test pressure, insulation type and thickness, special requirements (e.g., stress relieving) and tracing design conditions.
 - o) Prepare piping lists for hydraulic review of piping engineering.
 - p) Prepare hazardous area drawings.
 - q) Prepare piping classification data.
 - r) Develop instrument control system and develop safety safeguarding system basic requirements.
 - s) Complete utility summary tables. The summaries shall be provided all required utilities such as but not limited to for the following utilities:
 - Electrical Load.
 - Steam (All types).
 - Condensate (All types).
 - Boiler Feed Water (BFW).
 - Cooling Water (all types), Demineralized Water, Fire Water, Desalinated Water, Plant Water and Potable Water.

- Instrument and Plant Air.
- Nitrogen.
- Fuels (Gas and Oil).
- t) Prepare Utility Distribution P&I Diagrams for each Unit showing distribution of the all utility services as mentioned above. All headers, branches to the users and all miscellaneous items such as utility stations, safety showers and eye washes and etc. with full details shall also be shown.
- u) Provide system hydraulic design calculations. Contractor shall perform a complete hydraulic design at rated (design) capacity and at the defined turndowns (i.e., Lower Operating Levels) for each part of the Units within the Units Battery Limits. Hydraulic Design shall be based on the procedure established by the Contractor and approved by the OL and shall include, but not be limited to the following:
 - Calculation of line sizes.
 - Control valve process design specifications (e.g., differential pressure across the control valve, etc.).
 - Pump suction and discharge pressure and NPSH.
 - Equipment elevations.
 - Compressor inlet/discharge pressure.
 - Equipment and piping design pressures.
 - Liquid flows in towers and vessels to ensure satisfactory hydraulic flows.
 - Relief systems including relief valve specifications.
 - Equipment to be purchased, to ensure that such equipment will perform satisfactorily within the system for which it is specified.
- v) Prepare for the Company's review, the pressure profiles for all systems comprising the Unit based on the hydraulic design calculations.
- w) Develop emergency shutdown philosophy and review P&I Diagrams for Advanced Process Optimization start-up, shut-down and emergency operations of each Unit and catalyst regeneration (where applicable) to ensure that all necessary processing, utility, and blow down piping and facilities are included for safe operation.
- x) Review alternative operations of the Units when associated Units may be shutdown to ensure continuous operation of each Unit.
- y) Prepare each Unit battery limit conditions (operating and design) for any and all lines inclusive of operating and design flow rates, temperature, pressure and destination/sources.
- z) Complete process information on all equipment data sheets including instruments, vessels, heat exchangers, heaters, electrical motors, fans and blowers and all other miscellaneous equipment.
- aa) Define the philosophy and the functionality for Advanced Process Control system for fired heaters and multi products column.
- bb) Develop process duty specifications for the packaged units.
- cc) Prepare catalyst and chemicals summary.
- dd) Prepare effluent summary for each UNIT separately.
- ee) Prepare chemical hazard report.
- ff) Prepare start-up, shut down, catalyst regeneration (if applicable) and normal operation procedures.
- gg) Prepare normal and emergency shutdown procedures.
- hh) Supply of all other services required to do process and utilities works.
- ii) Supply all other services as may be required to complete the above.

19.3.2 Safety Engineering

19.3.2.1 General

Contractor shall:

- a) Make sure that applicable safety and loss prevention codes as well as the Company's special requirements as expressed in the Safety Rules as mentioned in the Contract are applied in a systematic and effective manner by safety audits during the engineering design phase.
- b) Provide necessary documentation to support safety case and certification submissions as required by the applicable legislation.
- c) Prepare and/or complete the overall safety philosophy and based on the this philosophy, the Contractor shall prepare separate detailed safety documents for each section of the Project.

NOTE: The said documents among other necessary information and Specifications shall include hazards and loss prevention data including plant layouts and arrangements, hazard sources and evaluation, area classifications, detection and alarm systems for specific events e.g., fire, gas release, shutdown, ESD (Emergency Shut Down) systems, toxic gas release, fire protection systems both active and passive, firefighting equipment, means of escape, lifesaving appliances, drainage systems, ventilation, communication systems, navigational aids, regulations for effluent discharge, emergency power supply, sick bay and first aid requirements.

- d) Foresee the following main sequences of safety and Loss prevention work:
 - Preparation of logic diagram, Cause and Effect Charts; preparation of safety documentation.
 - Preparation of layouts of fire and gas detection systems as well as fixed firefighting equipment; collection of up-to-date vendor information; preparation of inquiry packages for loss prevention systems; review and approval of Vendor drawings and documentation.
 - Provide all other services as may be required to complete the above.

19.3.2.2 HAZOP Study

In support of safety and safe operation obligations, full HAZOP studies which allow a systematic approach to identifying hazards and potential operating problems, is required to be conducted at the detail engineering design early stage.

HAZOP will be undertaken at the start of detail design and another following the approved for construction issue of engineering implemented in according with HAZOP procedure.

Contractor shall prepare HAZOP study procedure for OL's review and approval.

Contractor shall be responsible for organizing the HAZOP and following up all actions outstanding as well as provision of any and all facilities for the Works, to insure that all the process, utility, offsite, miscellaneous and other units and equipment to be operated and maintained safely without endangering personnel and equipment at all time.

19.3.2.3 HAZOP Outputs

The information provided by Contractor shall include but not limited to:

- a) **Hazard identification report:** Defining objectives, methods and scope of hazards and operability.
- b) **Hazard Assessment:** The hazard identification studies shall identify areas for hazard assessment and appropriate actions for elimination of the hazard.
- c) Supply all other services required to do HAZOP study and review.

NOTE: The following major hazards are to be considered as minimum requirements:

- *Fire,*
- *Explosions,*
- *Hazardous substances release and their environmental impact,*
- *Events causing escalation of incident, including process emergency systems,*
- *Power supply failure,*
- *Human error,*
- *Others, specific to a Unit or equipment.*

19.4 Civil and Structure Engineering

Contractor shall:

- a) Review the Site survey provided by the OL and perform Site survey if additional data is required as per Contract requirements. In case, no Site survey data is provided by OL, Contractor is responsible to perform Site survey to complete required data for implementation of the Project.
- b) Prepare site preparation information including drawings and data which are necessary for construction activities.
- c) Establish engineering and construction specific job specifications.
- d) Establish specific job requirement for civil work including structure and fireproofing.
- e) Design and prepare detailed drawings for all foundations, elevated concrete, floors, roads, sewer system, basins, sumps, cable trenches, underground piping, etc., including arrangement and detailing of reinforcing and piling (if required), complete with relevant specifications and re-bar bending schedule for equipment foundations.
- f) Design and Prepare general arrangement drawings, specific details and design computations for all reinforced concrete piperacks, steel structures such as equipment structures and platforms, steel building, etc. in sufficient detail.
- g) Develop and design special equipment, which may be necessary for handling of Materials.
- h) Design and Prepare general arrangement plans, elevations and specific details for concrete structures including concrete buildings.
- i) Perform checks for equipment and structural drawings, which are bolted to foundations.
- j) Prepare key plan showing location and orientation of the Units, buildings, shelters, structures and etc.
- k) Design and Prepare arrangement of reinforcing for concrete structures and the necessary details.
- l) Prepare foundation location plan.
- m) Design special pipe supports and assist in preparation of pipe support drawings.
- n) Coordinate foundation and structural steel drawings.
- o) Prepare bills of material.
- p) Prepare drawings for ladder and platform of vessels.
- q) Prepare drawings covering specific details for fire-proofing.
- r) Provide fire alarm and firefighting systems for buildings.
- s) Provide loading diagram and calculations results for structure.
- t) Provide loading diagram and calculations results for foundations.
- u) Design and prepare detail drawings for industrial buildings as per project requirements.
- v) Coordinate with job Site.
- w) Incorporate vendor information on drawings.
- x) Review, comment and approve vendor documents.
- y) Design buildings and all aspects of the building including:
 - Architectural layouts,
 - HVAC,

- Building services,
- Structural engineering.
- z) Design and prepare drawings and specific details for boundary and fencing, retaining walls, lift stations, evaporation ponds, etc.
- aa) Carry out surveying, engineering and design of temporary access roads diversion channel (if required) and other facilities to the plant, required for Materials handling as well as construction activities.
- bb) Design and prepare detail drawings for area paving, sumps and drainage drawing complete with bills of material and specifications with due consideration to Contract requirements.
- cc) Prepare any other drawing and detailed specification as required.
- dd) All civil & structure drawings should be Approved for Construction (AFC).
- ee) Supply all other services required to do civil and structure works.
- ff) Supply all other services as may be required to complete the above.

19.5 Vessels, Towers, Reactors and Storage Tanks

Contractor shall:

- a) Establish specific job specifications for towers, pressure vessels and storage tanks.
- b) Design each vessel (reactors, towers, storage tanks and etc.) and prepare detail drawings showing wall thickness, heads, shells, nozzles, supports, internals including number and locations of caps/valves, risers, baffles, weir supports, downflow section, platforms clips, insulation clips and angles, etc. in sufficient details to permit vendors to prepare shop details.
- c) Check vendor's drawings for conformance with Specifications.
- d) Compile vendor information on the drawings, data sheets and specifications.
- e) Finalize vessel drawings with orientation and lugs.
- f) Check all drawings including vendor's drawings to be virtually complete and issue for Approved for Construction (AFC).
- g) Perform checks for:
 - Vessel foundation drawings.
 - Drawings for steel work and platform supporting vessels.
 - Nozzle sizes and location / orientation.
- h) Supply all other services required for vessel, tower, reactor and storage
- i) tank works.
- j) Supply all other services as may be required to complete the above.

19.6 Heat Transfer Equipment

(including heaters, heat exchangers, water and air coolers, condensers, reboilers, coils, etc.)

Contractor shall:

- a) Establish specific job specifications for heat transfer equipments.
- b) Prepare and complete data sheets.
- c) Perform thermal and mechanical optimization.
- d) Supply thermal and mechanical design.
- e) Supply bills of materials.
- f) Supply setting plans.
- g) Prepare detailed drawings to enable vendors to prepare shop detail drawings.
- h) Review vendors' drawings, data sheet and setting plants for conformance with Specifications, orientation of nozzles and location of supports.
- i) Compile vendor information on the drawings, Specifications, data sheets and other Project documents.
- j) Assist in preparation of plant technical and Equipment manuals.
- k) Supply all other services required to do heat transfer equipment works.

- l) Supply all other services as may be required to complete the above.

19.7 Machinery

(pumps, compressors, blowers, etc & their drivers)

The Contractor shall:

- a) Establish specific job specifications for machineries.
- b) Provide and complete data sheets and make NPSH and machinery discharge systems hydraulic calculations.
- c) Review vendors' data sheets and drawings for conformance with Specifications and Project requirements.
- d) Compile vendor information on the drawings, Specifications and other Project documents.
- e) Perform checks for:
 - Machinery foundation drawings.
 - Nozzle sizes and location / orientation.
- f) Supply all other services required to do machinery works
- g) Supply all other services as may be required to complete the above.

19.8 Piping

Contractor shall:

- a) Establish specific job specifications for piping.
- b) Prepare general and unit plot plans.
- c) Prepare piping layout and general arrangement drawings.
- d) Establish mechanical and material specification for each section of piping, including specifications and data sheets for expansion joints, spring support, shock arrestors and other special items.
- e) Prepare line numbering schedule.
- f) Prepare and complete line list.
- g) Review and check technically all packaged units' inquiries and purchase order requisitions where piping is to be furnished by a vendor as part of the packaged unit with conformity with contract requirements.
- h) Check vendor drawings and specifications for piping and piping components for compliance with Contract requirements.
- i) Design all piping system including special piping items (steam jacketing included) and prepare all necessary arrangement and detail drawings including tie-in points.
- j) Where steam tracing is required, design the steam tracing system and provide details and specifications of steam tracing and traps materials and details plus isometric drawing.
- k) Design underground piping systems and prepare all necessary arrangement and detail drawings.
- l) Design utility piping and prepare drawings showing arrangement of utilities distribution system.
- m) Prepare isometric drawings and spool drawings inclusive of complete bill of materials suitable for fabrication of small and large bore piping, except for underground pressurized lines of below 2" and for skids to the extent they are shop assembled.
- n) Prepare P&ID for pressure testing giving required information for testing.
- o) Prepare bill of material sheets for each isometric in the same drawing.
- p) Prepare stress analysis calculations and pipe support details.
- q) Finalize layout arrangement drawings.
- r) Check and coordinate equipment nozzle orientation.

- s) Prepare plant three dimensional computer models for the new Units. For the Units which are duplicated one computer model may be prepared and in this case the interconnecting piping between the identical units shall also be shown.
- t) Perform checks for:
 - Drawings of equipment and terminal point of package units to which piping is connected.
 - Layout drawings of foundations.
 - Layout and elevations on structural steel drawing.
- u) Assist in preparation of plant technical and Equipment manuals.
- v) Supply all other services required to do piping works
- w) Supply all other services as may be required to complete the above.

19.9 Instrumentation and Control System

Contractor shall:

- a) Establish specific job specifications for field instruments and analytical instruments.
- b) Prepare detail specifications for Process Control System (PCS), Emergency Shut-down Systems (ESD), Safe Guarding System (SGS) and Fire and Gas (F&G) Detection systems.
- c) Prepare detail specification for advanced process control system.
- d) Prepare detail specifications for Maintenance Management system.
- e) Prepare detail specification for Management Information System.
- f) Prepare detail specifications for Asset Management system.
- g) Provide detail specification for tank gauging system.
- h) Provide computer system and application software for the above mentioned systems.
- i) Develop process P & ID's and utility distribution diagrams including instruments numbering symbols and identification.
- j) Provide computerized data base inclusive of data and information for any and all equipment and other items to be utilized for the said application software.
- k) Minimum two dedicated consoles shall be provided for start-up and shutdown in main control system. Allocation of the various Units to each console shall be proposed by Contractor and approved by OL.
- l) Prepare instrument lists, comprising all loop components, instrument tag numbers and relevant drawing cross-references.
- m) Prepare data sheets for all instrumentation components.
- n) Size control valves
- o) Size safety and relief valves
- p) Size orifice plates and other flow elements.
- q) Size UPS, battery and chargers.
- r) Size PD meters, turbine meters and meter provers.
- s) Prepare cable schedule
- t) Prepare layouts for instrument panels, etc
- u) Review and check technically all packaged units' inquiries and purchase order requisitions where instrumentation is to be furnished by a vendor as part of the packaged unit with conformity with Contract requirement.
- v) Prepare drawings showing location of instruments, cable route and utilities distribution systems.
- w) Layout and develop electrical systems, for instrumentation.
- x) Check instrumentation vendor prints / drawings and Specifications for compliance with Contract requirement.
- y) Perform checks on vessel drawings for instrumentation.
- z) Prepare panel layout drawings to scale with overall dimensions and show the locations of instruments, push buttons, lights, annunciators, alarms, etc.
- aa) Prepare instrument location drawings, using piping drawings as background.

- bb) Prepare logic diagrams for interlock and alarm systems.
- cc) Prepare logic diagrams for sequence and program control.
- dd) Prepare cause & effect tables showing all causes with their consequences.
- ee) Establish SIL (Safety Integrity Level) requirements.
- ff) Prepare SIL assessment report.
- gg) Prepare all other data sheets drawings and diagrams required for installation maintenance and operation of instrument and control items.
- hh) Prepare instrument cable/tubing schedules.
- ii) Prepare junction box locations.
- jj) Prepare instrument hook-up drawings with bill of material.
- kk) Prepare instrument transmission loop details.
- ll) Prepare bulk items specifications.
- mm) Prepare all analyzer specifications.
- nn) Prepare detail test procedures for PCS/SGS/F&G systems.
- oo) Prepare detail test procedure of the interlocks and sequential Loops.
- pp) Prepare basic logic scheme and function description for start-up, shutdown, emergency shutdown procedure, anti-surge control and etc.
- qq) Prepare comprehensive drawings and Specifications index sorted by document number as well as document title.
- rr) Prepare list of all set point values for alarm and shutdown system.
- ss) Prepare full instrument instruction manuals including operation, installation, calibration, trouble-shooting and maintenance.
- tt) Prepare instrument inspection report.
- uu) Prepare instrument summaries for checking, cross-checking and reference.
- vv) Provide comprehensive calculation sheets and selection philosophy, bounded separately for each category of control valves, flow elements, safety valves, pressure control valves, PD meters, turbine meters, UPS and batteries & charges including method of calculations.
- ww) Prepare Schematic wiring diagram of alarms and inter-locks showing functional sequence of start and stop buttons, relays, alarms, solenoid and shutdown switches.
- xx) Prepare initial and final material Take-off for all instruments and instrument material.
- yy) Supply all other services required to do instrument and control system works.
- zz) Supply all other services as may be required to complete the above.

19.10 Electrical

Contractor shall:

- a) Establish specific job specifications for all electrical system (inclusive of electrical tracing system and cathodic protection system).
- b) Prepare single line diagrams for the whole electrical generation and distribution systems, and also for each area substations.
- c) Design electrical distribution system.
- d) Design electrical tracing where required.
- e) Prepare lighting systems and prepare drawing showing arrangement of lighting panels, lighting requirement at grade, on platforms and structures and electrical trays with specific details as required.
- f) Prepare data sheets for electrical equipment (including motors).
- g) Prepare layout drawings of power cables and specific requirements for switchgear and motor control center.
- h) Prepare grounding drawings and details.
- i) Layout and prepare electrical power supply systems for instrumentation.
- j) Prepare area classification drawings.
- k) Perform checks for underground drawings of piping and civil where underground electrical cables are to be laid.

- l) Prepare electrical load list including motors and other consumers.
- m) Prepare relay setting schedule.
- n) Prepare electrical system design report including voltage profile, reacceleration, and fault studies.
- o) Prepare electrical system study and short circuit calculations.
- p) Prepare electrical cable schedules and routing.
- q) Prepare schematic wiring diagrams for all circuit breakers and electrical items having internal wiring or relays.
- r) Prepare layout of switch rooms showing the location of major equipment, battery charger room and classification of hazardous locations.
- s) Prepare list of all starters and switchgears with capacity requirements and specifications for each.
- t) Prepare all earthing, control station and other miscellaneous fixing and mounting details.
- u) Prepare material Take-off for all electrical material.
- v) Prepare power control house building (substation) layout.
- w) Prepare substation and switchgear drawings.
- x) Prepare system shutdown connection diagrams.
- y) Prepare electrical instrument drawings.
- z) Prepare electrical heat tracing drawings.
- aa) Prepare cathodic protection system with detailed specifications and drawings.
- bb) Supply load flow calculations in start-up and steady state operation of the electrical system.
- cc) Design emergency supply including uninterrupted power supply system.
- dd) Prepare initial and final material take-off for all electrical equipment, accessories and materials.
- ee) Prepare material requisitions for all electrical accessories, equipment and materials including heat tracing material, if any.
- ff) Prepare block diagrams, connection diagrams, design philosophy and instruction manuals for interlocking systems, alarm system and other complicated power and control systems.
- gg) Prepare physical location of electrical equipment and wiring installed and installation details.
- hh) Prepare physical location of grounding electrodes, equipment to be grounded and wiring layouts as well as their installation details.
- ii) Prepare engineering, manufacturing, inspection requirements, construction/erection, precommissioning and commissioning specifications and procedures for all electrical components, equipment, accessories and materials.
- jj) Prepare cable cutting schedule.
- kk) Prepare cable orientation on trays and /or trenches
- ll) Prepare cable room tray orientation.
- mm) Prepare PDCS system installation.
- nn) Prepare PDCS I/O list (including serial links).
- oo) Prepare logic sequence diagram for PDCS system.
- pp) Prepare PDCS software details.
- qq) Prepare operation and maintenance manual for PDCS completed with illustrated spare list.
- rr) Check vendor's drawings and data for conformance with Contract requirements.
- ss) Supply all other services to do the electrical works.
- tt) Supply all other services as may be required to complete the above.

19.11 Telecommunication

Contractor shall:

- a) Establish specifics job specifications for the telecommunication systems.
- b) Prepare detailed drawings and specifications for the telecommunication systems.

- c) Perform checks for underground drawings of piping and civil where underground telecommunication cables are to be laid.
- d) Check vendor's drawings and data for conformance with Contract requirement.
- e) Supply all other services required to do telecommunication works.
- f) Supply all other services as may be required to complete the above.

19.12 Miscellaneous and/or Special Equipment

Contractor shall:

- a) Establish specific job specifications for miscellaneous and/or special equipment.
- b) Prepare detailed specifications, data sheets, duty specifications (where applicable) for each item.
- c) Review vendor's drawings and technical documents for conformance with Contract requirements.
- d) Supply all other services to do miscellaneous/special equipment.
- e) Supply all other services as may be required to complete the above.

19.13 Insulation and Painting

Contractor shall:

- a) Establish specific job specifications for all insulation and painting items.
- b) Prepare insulation schedules for equipment and piping showing operating temperature, insulation, service, type and thickness of insulation and reference to the applicable specifications.
- c) Prepare painting schedule and paint/painting application specifications
- d) Prepare insulation and painting bill of material.
- e) Prepare methods and procedures of surface preparation in detail.
- f) Prepare methods and procedures of painting of equipment and material in the manufacturer workshop and at Site in detail.
- g) Supply all other services required to do insulation and painting works.
- h) Supply all other services as may be required to complete the above.

19.14 Fireproofing

Contractor shall:

- a) Prepare fireproofing specifications for steel structure and vessel skirt or supports.
- b) Establish specific job specifications for fireproofing.
- c) Prepare drawings covering specific details for fireproofing.
- d) Prepare fireproofing material specification and bill of quantities.
- e) Supply all other services required to do fire proofing work.
- f) Supply all other services as may be required to complete the above.

19.15 Firefighting

Contractor shall:

- a) Establish specific job specifications for firefighting system.
- b) Prepare detail specification, data sheet and detail drawings for firefighting system.
- c) Perform checks for underground drawings of piping and civil where underground firefighting system is to be laid.
- d) Check vendor's drawings and data for conformance with Specifications.
- e) Prepare overall design basis and specification of fixed fire and gas systems and firefighting equipment.
- f) Supply all other services required to do firefighting system works.
- g) Supply all other services as may be required to complete the above.

