PROCESS SIZING CRITERIA

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1. GENERAL

1.1 SCOPE

This procedure outlines the sizing / design criteria to be applied on the "Basic Design Services – 4 WP's", awarded to TECHNIP-COFLEXIP by MOBIN Petrochemical Company, for the Complex Utilities, Interconnectings and Offsites of the Petrochemical Zone at Bandar Assaluyeh in Iran.

The scope of the "Basic Design Services – 4 WP's" involves the following four (4) Work Packages (refer to Contract for details) :

- WP-1 : Waste Water Treatment and Incineration
- WP-2 : Utility Complex General Facilities
- WP-3 : Zone Interconnectings, Offsites and General Facilities
- WP-4 : Petrochemical Port Topsides

The process sizing criteria given in this document are applicable to all lines and equipment except those inside the Waste Water Treatment and Incineration Area.

1.2 PURPOSE

The purpose of this document is to define the requirements and criteria, which have to be followed to perform the Basic Design, in the absence of specific requirements on the subject in the Contract.

When such requirements exist, they have to be followed and the present document shall be modified accordingly.

2. MECHANICAL DESIGN CONDITIONS

2.1 DESIGN TEMPERATURES

2.1.1 DESIGN TEMPERATURES FOR PIPES

The following rules apply for both interconnecting lines inside utility centre and outside in the interconnectings and offsites.

The interconnecting line design temperature shall be the same upstream (producer) and downstream (user) interconnecting line.
When these conditions differ, design temperature should be carefully examined and petrochemical plants informed of the discrepancy. Normally, conditions of the producer will prevail.

If no data from Complexes is available, a design temperature will be estimated.

2.1.2 DESIGN TEMPERATURES FOR EQUIPMENT

This chapter is not developped as no equipment is foreseen at this moment

2.1.3 SPECIAL CASES

2.1.3.1 EMERGENCY DEPRESSURISING

No automatic depressurisation of interconnecting lines are foreseen. The facilities to depressurise manually shall be provided and shall be performed together with Petrochemical Complexes equipments, via Petrochemical Complexes facilities.

Accidental depressurising, due to safety valve failure or operator error for example are not taken into account. Indeed these potential cases can be faced by:

- Closing the block valves associated to the safety valve.
- Clear instruction/procedure within the operating manual to avoid such operator error.

2.1.3.2 VACUUM CONDITIONS

Steam interconnecting lines will be calculated for full vacuum.

2.2 DESIGN PRESSURES

2.2.1 GENERAL

Due to the particular arrangement of Assaluyeh Petrochemical Zone, the industrial plants are not at the same ground level. Thus, design pressure shall take account of hydrostatic height when significant.

2.2.2 DESIGN PRESSURES FOR PIPES

The following rules apply for both interconnecting lines inside utility centre and outside in the interconnectings and offsites.

The interconnecting line design pressure shall be the same upstream (producer) and downstream (user) interconnecting line except if adequate protection is provided (pressure relief safety valve or other).
When these conditions differ, design pressure should be carefully examined and petrochemical plants informed of the discrepancy. Normally, conditions of the producer will prevail.

If no data from Complexes is available, a design pressure will be estimated.

2.2.3 DESIGN PRESSURES FOR EQUIPMENT

This chapter is not developed as no equipment is foreseen at this moment.

2.2.4 DESIGN PRESSURE AT THE DISCHARGE OF A CENTRIFUGAL PUMP

The design pressure for lines and equipment located on the pump discharge shall be defined case by case depending on process and utility requirements.

2.3 MATERIAL SELECTION AND CORROSION ALLOWANCES

2.3.1 MATERIALS AND CORROSION ALLOWANCES FOR PIPING

Normally, the material and the corrosion allowance upstream and downstream an interconnection line should be the same. However, there might be some fluids for which interconnecting lines material and/or corrosion allowances have to be upgraded as no isolation is foreseen and as these lines will be critical services all along the Petrochemical Complex life.

For further details, refer to Piping Class Summary referenced as 6830Z 090 NM 0002 001.

2.3.2 MATERIAL AND CORROSION ALLOWANCES FOR EQUIPMENT

1 A new potable water head tank 67B-TK-101 is implemented. This tank will be made of concrete and internally coated with epoxy.

2.3.3 POSTWELD HEAT TREATMENT

Not applicable.

2.3.4 INSULATION

Thermal insulation for hot or cold services may be required for :

- heat or cold conservation of equipment and piping,
- personnel protection for accessible parts of piping when operating temperature is above 65°C.
- to avoid external water condensation or ice formation
- steam or electrical heat tracing

In all cases, insulation shall be minimised in order to limit CUI (Corrosion Under Insulation).

3. LINE SIZING CRITERIA

3.1 MINIMUM PIPING SIZES

The minimum size shall be :

Underground lines:

- 4" for gravity flow lines (short line L<200 meters)
- 6" for gravity flow lines (long line L>=200 meters)
- 2" for pressurised steel line
- 2" for pressurised non metallic piping pipe

Above ground lines:

- 2" for process line on pipe rack
- 2" for utility line on main pipe rack
- 2" for pipe on pipe sleeper

3.2 LINE SIZING CRITERIA

The following criteria are not applicable to safety relief and flare lines for which dedicated chapter has been developed (refer to chapter 4).

3.2.1 LINES INSIDE UTILITY CENTRE

Pressure drop must be compatible with corresponding service.

3.2.1.1 LIQUIDS

Process lines	DP (bar/km)		Max. Velocity. (m/s)			
	Norm.	Max.	to 2"	3" to 6"	8" to 18"	from 20"
Pump discharge - Disch. pres. <= 50 bar g.	2.5	4.5	1.5 to 4.5 m/s			6.0
- Gravity Flow	0.25	0.45	Note 1			

Notes: (1) Normal velocity : 0.6 m/s

Water lines	DP (bar/km)		Max. Velocity. (m/s)			
	Norm.	Max.	to 2"	3" to 6"	8" to 18"	from 20"
-Desalinated, demineralized, potable water , steam condensates	1.0	3.0	1.5 to 4.5 m/s			6.0
- Boiler feed water Pres. <= 50 bar g.	2.5	4.5	1.5 to 4.5 m/s			6.0

3.2.1.2 GAS & VAPOURS

Process Gas lines and utility lines (oxygen, natural gas , nitrogen, air)	ρv^2 max. ($kg.m.s^{-2}$)	Max. Velocity (m/s)	DP (bar/km)	
			Normal	Maxi
	Max 15000		Pressure drop must be compatible with corresponding service	

Vapour and steam lines	ρv^2 max. ($kg.m.s^{-2}$)	Max. Velocity. (m/s)	DP (bar/km)	
			Normal	Maxi
Steam lines				
- P <= 10 bar g. Short line (L <= 200 m)	15 000	Diameter <=2" 10 m/s for saturated steam 15 m/s for superheated steam	0.5	0.1
- 10 < P <= 30 bar g. Short line (L <= 200 m)	15 000	2"<Diameter <=8" 30 m/s for saturated steam 40 m/s for superheated steam	1.2	2.3
- P > 30 bar g. Short line (L <= 200 m)	15 000	Diameter > 8" 40 m/s for saturated steam 60 m/s for superheated steam	1.2	2.3

3.2.1.3 MIXED PHASE

- For steam condensates, criteria to be applied will be:

Normal DP : 0.2 to 0.3 bar/km

Max velocity : 10 to 20 m/s

- For other fluids, criteria to be applied will be:

v_m = 10 to 23 m/s

$\rho_m v_m^2$ = 5 000 to 10 000 Pa (15 000 Pa Max)

where:

ρ_m = density of mixed phase (kg/m3)

As a general, continuous flow patterns should be ensured such as:
- Stratified, annular, bubble, wavy flow patterns, etc. for horizontal lines or slightly sloped.
- Annular or bubble flow, etc…, for the vertical lines,
- For horizontal lines in slug and plug flow regimes and for the vertical line in slug flow regimes, reinforced anchoring shall be specified.

3.2.2 LINES IN INTERCONNECTING AND OFFSITES

Pressure drop must be compatible with corresponding service.

3.2.2.1 LIQUIDS

Process lines	DP (bar/km)		Max. Velocity. (m/s)			
	Norm.	Max.	to 2"	3" to 6"	8" to 18"	from 20"
Pump discharge - Disch. pres. <= 50 bar g.	2.5	4.5	1.5 to 4.5 m/s			6.0
- Gravity Flow	0.25	0.45	Note 1			

Notes: (1) Normal velocity : 0.6 m/s

Water lines	DP (bar/km)		Max. Velocity. (m/s)			
	Norm.	Max.	to 2"	3" to 6"	8" to 18"	from 20"
-Desalinated, demineralized, potable water , steam condensates	1.0	3.0	1.5 to 4.5 m/s			6.0
- Boiler feed water Pres. <= 50 bar g.	2.5	4.5	1.5 to 4.5 m/s			6.0

3.2.2.2 GAS & VAPOURS

Process Gas lines and utility lines (oxygen, natural gas , nitrogen, air)	ρv^2 max. ($kg.m.s^{-2}$)	Max. Velocity (m/s)	DP (bar/km)	
			Normal	Maxi
	Max 15000		Pressure drop must be compatible with corresponding service	

Vapour and steam lines	ρv^2 max. ($kg.m.s^{-2}$)	Max. Velocity. (m/s)	DP (bar/km)	
			Normal	Maxi
Steam lines				
- P <= 10 bar g. Long line (L > 200 m)	15 000	Diameter <=2" 10 m/s for saturated steam 15 m/s for superheated steam	0.15	0.25
- 10 < P <= 30 bar g. Long line (L > 200 m)	15 000	2"<Diameter <=8" 30 m/s for saturated steam 40 m/s for superheated steam	0.25	1.0
- P > 30 bar g. Long line (L > 200 m)	15 000	Diameter > 8" 40 m/s for saturated steam 60 m/s for superheated steam	0.35	1.0

3.2.2.3 MIXED PHASE

Refer to paragraph 3.2.1.3.

4. FLARE AND COLD VENT SYSTEMS

4.1 TYPE OF FLARE TIP

For flares and cold vents, the tip can be normally conventional or sonic depending on the required and allowed back pressure at Petrochemical Complexes and noise limitation.

The tips types are fixed by Petrochemical Complexes Operating Companies and Contractors.

4.2 FOR RADIATION LEVELS CRITERIA

The radiation levels criteria shall follow the Basic Engineering Design Data referenced as 6830Z 90 CN 0007 001 . The minimum relative humidity stated on the basis of design shall be applied.

The flare system design shall be such that the maximum acceptable heat radiation (excluding solar radiation : 0.98 kW/m^2) in case of flaring shall not exceed the values listed in the following table :

MAXIMUM ACCEPTABLE HEAT RADIATION IN CASE OF FLARING

Location	Radiation levels (kW/m^2)
At fences of the remote flare area	4.73
At Complex Offsites Buildings	1.58

4.3 EMISSIVITY COEFFICIENT

Flare calculations are normally performed by Complexes who are supplying their flares. For any internal check, recommended emissivity coefficient are:

For pipe flare :

- natural gas molecular weight of 18 : 0.21
- natural gas molecular weight of 21 : 0.23
- ethane : 0.25
- propane : 0.30
- see also API RP 521.

For sonic flare :

The emissivity coefficient = 0.13 for all gasses without liquid carry over, and 0.15 with liquid carry over not exceeding 5% weight.

4.4 FLARE LINES

Flares headers diameters have been estimated by Petrochemical Complexes.

Flare headers sizes will be checked in terms of:

- back pressures that have to be compatible with the protected equipments (set at their Battery limit by each Petrochemical Complex).

- velocities and ρV^2 :
  - MONOPHASIC (GAS) :
  - intermittent flow :
    - headers: 0.7 Mach maximum and $\rho V^2 < 150\ 000$ kg/m/s²
    - For a $\rho V^2 > 100\ 000$ kg/m/s², vibration and line support studies are required. Dedicated note will be added on PID.
  - continuous flow :
    - velocity < 0.35 Mach and $\rho V^2 \leq 50\ 000$ kg/m/s². Velocity shall be lower than 50 m/s.
  - MULTIPHASE (2 phase flow at the inlet of relieving device) :
    - velocity ≤ 0.25 Mach and $\rho V^2 \leq 50\ 000$ kg/m/s².

4.5 PURGE GAS LINES

The purge gas is provided to avoid :

- air ingress into the flare or cold vent stack in order to avoid to form an explosive mixture in the stack or header.
- for a flare, the risk of burn back which induces a quickest deterioration of the tip.

The main purge of the flare network is considered to be done inside and by the Petrochemical Complexes.

Purge of the flare tip will also be defined when necessary.

5. PRESSURE SAFETY VALVES

Safety valves shall be generally balanced for discharge into closed systems and not-balanced for discharge to the atmosphere.

Lines filled with liquid which may be blocked-in between two isolation devices shall be protected by safety valves for liquid expansion.

Safety valves shall be sized according to API-ASME standards and/or local regulation/codes.

6. SOFTWARE

The following softwares are recommended by Technip for process related calculations and verification:

- HYSYS : Plant thermodynamic simulations (heat and power balance)
- FLARESIM : Flare radiation levels (performed by flare Vendors)