PROCESS DESCRIPTION
FOR
SAFETY SYSTEMS

CONTRACT NO.:	POGC-801-84/240
PROJECT:	South Pars Gas Field Development Phases 15&16
COMPANY:	Pars Oil and Gas Company
CONSORTIUM:	GHORB,IOEC,ISOICO and SAFF

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1 INTRODUCTION

1.1 GENERAL PROJECT DESCRIPTION

GHORB is developing of the SOUTH PARS Phases 15 & 16 Project for Pars Oil & Gas Company (POGC) in IRAN. This project includes onshore facilities for the processing of reservoir fluid.

Phases 15 & 16 onshore Complex will be located on the Iranian coast of Persian Gulf in ASSALUYEH (approximately 270 km South East of Bandar Bushehr).
The Total capacity of Phases 15 & 16 onshore facilities is 2000 MMSCFD of reservoir fluid.

Phase 15 & 16 onshore Complex will include all processing units, utilities, offsets and infrastructure necessary to produce sales gas, gaseous ethane cut of petrochemical feedstock quality, commercial grade propane and butane for export and stabilized condensate. The complex is fed by the reservoir fluid delivered to the onshore plant (Tie-in) via two multiphase lines:

- receiving facilities for HP separation of raw gas and condensate/water mixture.
- Condensate stabilization producing stabilized condensate for storage and export and light ends recycled in the HP gas system. One condensate flashing unit, normally not operated, is provided as a back-up of the stabilization facilities
- Gas treatment facilities producing sales gas, gaseous ethane and NGL's and consisting of:
    - H2S removal from gas / CO2 partial removal from gas
    - Dehydration unit, using molecular sieves technology
    - Mercury guard
    - Ethane extraction unit producing sales gas, gaseous ethane and NGL's
- NGL fractionation facilities to produce gaseous ethane and sour liquid butane and propane
- Gaseous ethane cut treatment for CO2 removal and drying for further export
- Propane and butane treatment for mercaptan removal and drying for further storage and export
- Export gas compression to export pipeline pressure
- MEG regeneration and injection unit
- Sulphur recovery producing liquid Sulphur for further solidification and export
- Utilities, offsets required for operation.

1.2 PURPOSE OF THIS DOCUMENT

This document covers the process description of the Safety Systems for the South Pars Phases 15 & 16 Onshore Facilities.

2 PRESSURE PROTECTION AND RELIEF

2.1 REQUIREMENTS FOR PRESSURE PROTECTION AND RELIEF

2.1.1 CAUSES OF OVER-PRESSURISATION

The faults listed below can lead to an over-pressurisation; they shall be taken into account for the design of pressure protection and relief systems.

- blocked outlet, blow-by, inadvertent inlet valve opening from a high-pressure source, check-valve malfunction,
- loss of cooling : loss of power, loss of cooling agent, mechanical failure of fans, reflux failure, etc.,
- loss of heat (some particular cases of fractionation systems in series),
- fire, excessive heat input, unsteady process (exothermic reactions, etc.),
- utility failure and / or loss of control (air instrument, power, etc.), uncontrolled re-pressurisation,
- heat exchanger tube failure, transient pressure surges, quick-closing valves,
- severe slugging regime (multiphase flow),

Process facilities shall be designed to minimise the probability of occurrence of these causes. The rules and principles contained in this document are focused on the mitigation devices to minimize the effects of an over-pressurization.

2.1.2 PRESSURE PROTECTION SYSTEMS

Three main approaches are possible for pressure protection systems:

FULL PRESSURE-RATED MECHANICAL DESIGN

The system design pressure exceeds the maximum possible pressure at design temperature, reached in case of process upset, and with due allowance for corrosion being made.

RELIEF SYSTEMS

The system design pressure includes a safety margin above the system maximum operating pressure but, in case of a process upset, the pressure prevailing in the system can exceed the design pressure. It is therefore fitted with devices actuated by the system static pressure and designed to open in case of upset conditions.

The pressure systems in the plant shall normally be protected following the API 520/521 recommendations.

OVER-PRESSURE PROTECTION SYSTEMS (OPPS)

OPPS belong to the HIPS category. They are instrument-based systems of sufficient integrity (involving high reliability redundant and / or diversified instruments) so as to make the risk of exceeding the design pressure acceptable.

As an alternate to the conventional system, it can be envisaged to implement High Integrity pressure Protection System (HIPPS) in order to minimise relief and flaring capacities.

STORAGE TANKS

The atmospheric and low pressure storage tanks shall meet the venting requirements of API ST 2000. This should be achieved through storage vendors.

2.1.3 CRITERIA FOR INSTALLATION OF RELIEF DEVICES

Any vessel unless protected by HIPPS shall be equipped with a protection device sized for fire or other contingencies. Pressure relief may consist in one or a combination of PSV, TSV, and rupture disc. The criteria for installation of PSV's and TSV's are as follows:

	PSV (Process)	PSV (Fire case)	TSV
PIPING that cannot be isolated (5): - all fluids	No	No	No
PIPING that can be isolated (5) but cannot be exposed to fire: -flammable gas -Liquefied HC -liquid HC	 No (1) No (1) No (1)	 No No No	 No Yes (7) (6) Yes (7) (6)
PIPING that can be isolated (5) and can be exposed to fire (8): -flammable gas -liquefied HC -liquid HC	 No (1) No (1) No (1)	 if > 3 tons, yes if > 2 tons, yes if > 2 tons, yes	 No Yes (6) Yes (2) (6)
VESSELS that cannot be isolated (5) -all fluids	YES (3)	No	No
VESSELS that can be isolated but cannot be exposed to fire (5) - all fluids	YES (3)	No	No
VESSEL that cannot be isolated (5) and can be exposed to fire (8): - all fluids	YES (3)	YES	No

Notes:

1. Assuming piping is protected against the maximum possible pressure under upset conditions (full pressure rated design or PSV installed upstream of it). Otherwise a process PSV is required.
2. The installation of TSV's on piping handling liquid hydrocarbon shall be assessed case by case, based on service criticality and risk assessment.
3. As per ASME SECT VIII.

4. Includes pressurised hydrocarbon at ambient temperature, refrigerated hydrocarbons at atmospheric pressure or partially refrigerated pressurised hydrocarbon.
5. Any type of isolation, automatic or manual valves.
6. A TSV is not required if a PSV (process or fire case) is already installed.
7. A TSV is required if ambient temperature conditions and / or sun radiation may lead to a prevailing pressure exceeding piping design pressure.
8. All piping or vessels shall be considered as being possibly exposed to fire if more than 10% of their external surface can be engulfed in a pool fire likely to last more than 3 minutes.

In case of toxic substances, the threshold criteria for the installation of PSV fire case and / or TSV may be made more stringent. This issue shall be assessed on a case by case basis.

2.2 RELIEF DEVICE SETTING

The setting points and other characteristics of the relief devices shall be as per API RP 520 for process equipment, utilities and pressure vessels for storage of liquefied hydrocarbon. API ST 2000 recommendations shall apply for liquid petroleum product tanks.

2.3 RELIEF SYSTEM SIZING

Failure cases

Individual relief valves shall be sized to relief the pressure resulting from the combination of any single safety system failure (double jeopardy not considered) with any possible process failure including general failure cases such as instrument air or UPS failure.

For the sizing of the relief systems, the following scenario shall be considered (non exhaustive list):

Flow:

- blocked outlet,
- blow by, (control valve and bypass shall be considered as fully opened)
- inadvertent valve opening from high pressure source,
- check valve malfunction,
- heat exchanger tube rupture

Heat:

- fire,
- excessive heat input,
- exothermic reactions,
- Loss of cooling,
- loss of power,
- loss of cooling agent,
- mechanical failure of fans,
- reflux failure,

Loss of heat (particular case of fractionating systems in series)

Utility failure and/or loss of control :

- power,
- air instrument,
- Transient pressure surge,
- quick closing valves,
- two phase slugs

2.4 RELIEF SYSTEM CONFIGURATION

2.4.1 NUMBER OF RELIEF VALVES

The number of relief valves fitted onto an equipment is not driven only by safety related concerns. However, the following rules shall apply on top of other (e.g. process) considerations:

- For process pressure safety valves, if n is the number of PSV (or set of PSV) necessary to ensure 100 % relief capacity, then n + 1 PSV (or set of) shall be installed.
- A single PSV (fire case) is provided for equipment that can be momentarily isolated for maintenance providing the PSV fire case does not comply a process function too.
- Where, for capacity reasons, several pressure relief valves must be provided in parallel, the set pressures should be staggered to avoid chattering during relief. The difference between set points shall be less than 5 % of the design pressure.
- A single TSV shall be provided for pipework thermal relief.

- One PSV shown on PID (with one spare provided and located in warehouse) means that PSV will be designed for fire case only. Two or more PSV's (n + 1spare) shown on PID means that safety valves are designed for other cases than fire.

2.4.2 PSV INSTALLATION

2.4.2.1 ISOLATION

The following rules shall apply:

- n + 1 sets of pressure relief valves shall be associated with car seal procedures for both upstream and downstream isolation valves. Interlock devices with keys are to be avoided.
- Gate valve to be provided upstream PSV for rating up to 150 # and for diameter lower than or equal to 8" and for non sour service or non toxic.
- Valve located downstream PSV to be gate valve type for non sour service and ball valve type for sour service or toxic.
- If feasible, and assuming this does not create interference with other process systems, the relief discharge lines from a process unit and/or fire zone shall be routed to a common sub-header. In such a case no isolation valve shall be provided on each individual relief discharge line and a single isolation valve shall be fitted on the sub-header, upstream of its connection with the main header.
- Subheader downstream isolation valves cannot be avoided, they shall be locked open in normal operating conditions. A single valve without positive isolation is considered as acceptable even for toxic gas services.
- Full bore ball valve shall be used for service where design temperature <= 200°C.

2.4.2.2 LOCATION

- PSV will be installed directly on vessel. However Company criteria is to minimise nozzle on vessel and therefore PSV relocation on overhead vapour line should be considered if no demister is installed within API constraints.
- A spool piece will be installed upstream PSV. However, advantage of the presence of a spacer at capacity outlet can be considered.

- PSV bypass line to be in 2" whatever the vessel capacity is.

2.4.3 RELIEF SYSTEM PIPING

- Block valves shall be avoided on flare header and sub header. However, ball valves full bore with position indicator are required for maintenance at each battery limit.
- Flare header shall be self draining towards the flare drum.
- All connections shall be done with no low point and on the top of the header. Connection to the header should be done at 45° angle except for small diameters ***up to 4"***.
- Flow orifice or flow meter (except annubar type or equivalent) which can be blocked by foreign matters shall not be installed.
- The fitting of check valves downstream of relief devices is prohibited.
- Adequate systems shall be installed to separate liquids before the vent or flare tip. Where a significant quantity of liquid is expected, a K.O. drum shall be provided with its own liquid evacuation devices. The design of the network and, in particular, of the drain points, shall be such that the ingress of air under vacuum conditions is avoided.
- The relief piping shall be selected from material suitable for the lowest expected discharge temperature. If water may be present, the risk of ice or hydrate formation shall be assessed, and methanol or glycol injection or any other suitable mitigation measure such as headers separated from the flare K.O. drum, should be envisaged to avoid blockage.
- Adequate supports shall be provided upstream and downstream relief devices.

3 EMERGENCY SHUTDOWN

3.1 PURPOSE

The purpose of the ESD system is:

- to limit the loss of containment by isolating hydrocarbons flows and inventory,
- to prevent ignition by shutting-off sources of ignition,
- to line-up the process plant so that the Emergency Depressurisation can be initiated.

3.2 GENERAL CONSIDERATIONS

The design of the ESD system shall not only take into account the needs resulting from normal operation; it must also fulfil the requirements that may arise during other possible (and likely to occur) abnormal or down-graded configurations. It is not the purpose of this general specification to define the methodology that will be used to select relevant operating configurations, nevertheless the following issues shall be adequately addressed when relevant:

- Shutting-down an equipment or unit does not necessarily eliminate all sources of hazards.
- New hazards can appear as a consequence of the loss of essential utilities such as essential power, air, hydraulics, etc. These new hazards shall be identified, mitigated, and the associated risks shall be assessed.
- All operating configurations generated by the ESD system shall be safe and steady-state. All ESD-related transients from one operating configuration to another shall be safe.
- The ESD shall be compatible with the re-start philosophy. All operating configurations of the re-start sequence, from the black-out status to the full production status, shall be safe, stable and reversible. The inevitable inhibitions of the control and safety systems during the re-start sequence shall be identified, limited in number, time and duration.
- In some circumstances, the change of control settings to overcome a fault should be considered as a safer alternative than shutting-down immediately the equipment or unit.
- Shut-down should be understood as a generic wording only. Shut-Down does not mean that all valves close, or all equipment trip. Some ESDV's or SDV's can be diverting valves opening when the main flow is stopped ; BDV's may be required to open ; the load of some systems, such as disposals, is increased ; some equipment start upon "Shut-Down" trigger signal, such as essential generator, fire-fighting facilities etc.

  A particular attention shall be paid to non-routine operating conditions and to the suitability of the ESD and EDP systems to deal with them. The main scenario contemplated shall be:

  - Degraded modes of operation: maintenance of a safety system, short-time deviation from product specification etc.

- Simultaneous operations: maintenance and production, construction and production, etc.

Each operation shall be safe, but a particular attention shall be paid to the safety of the combination resulting from their simultaneity (example: simultaneous maintenance on two systems).

3.3 ARCHITECTURE OF THE ESD SYSTEM

The instrumentation shall include the following different systems:

- Process Control System (PCS) is not a safety system. It does not fulfil a safety function and shall be separate from other instrument systems having a safety function. It shall be implemented on DCS.
- Process Safety System (PSS) initiates process trips of individual equipment and functional units. The PSS controls all causes/actions pertaining to SD level 3 (SD3), including fire and gas at local level. In this respect, the PSS can include a F&G sub-system (distinct from the main F&G) of enclosed equipment without any risk of outside propagation. SD3 functions shall be implemented on DCS controllers or on package PLC.
- EMERGENCY Shut-Down system (ESD) initiates shut-down actions required by emergency situation and applicable to fire zones or to the whole installation. The ESD system manages all process related inputs and outputs relative to ESD level 1 (ESD1 fire zone) or SD level 2 (SD2 process unit shutdown). The ESD1, SD2 functions shall be performed on dedicated fail safe PLC’s that will be referred to as “ESD systems” and that will work independently from the DCS.
- Fire & Gas system (F&G) provides inputs to the ESD system. The main F&G system deals with fire and gas detection outdoors and in places where they may result in consequences involving more than just one specific equipment. It generates the corresponding ESD1 actions (ESD1F or ESD1G), except those related to the process that are undertaken by the ESD system.
- Ultimate Safety System (USS) : hardware diversified redundancy of ESD actions upon manual activation to avoid common modes of failures with PLCs.

3.4 SHUT-DOWN LEVELS

Three Shut-Down levels, numbered 1 to 3, shall be defined:

Level 1: ESD 1 FIRE ZONE EMERGENCY SHUT DOWN

- Description:
  - emergency shut-down of all systems in the fire zone,
  - if initiated by gas detection (ESD1G), shut-off all ignition sources except emergency and vital electrical systems with their own batteries and suitable for use in zone 1,
  - if initiated by fire detection (ESD1F), activate fire-fighting means; electrical power remains in service ; however all electrical users shall be shut down.
  - escape of personnel from the fire zone.
- Typical causes :
  - voluntary decision considering a probable or actual credible event,
  - loss of control (UPS low voltage, hydraulic, etc.), to be assessed,
  - outdoors gas detection (ESD1G),
  - outdoors fire detection (ESD1F),
- Typical effects :
  - shutdown of fire zone (process + utility) by means of ESDV
  - generates SD2/SD3 directly or using cascade effect depending on system reaction time
  - on gas detection all ignition sources shall be shutdown.
  - on fire detection, fire protection systems (fire fighting means shall be activated automatically) are activated and all electrical motors are tripped ; however electricity is kept.
  - depressurisation of fire zone : no automatic depressurisation is foreseen. ESD1 gives the permissive use of push buttons to depressurise the fire zone. Normally one fire zone after one will be depressurised, exception is common mode failure (number of fire zones that can be depressurised simultaneously is depending on flare load considering the instantaneous flowrate generated by the depressurisation).

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Level 2: SD 2 FUNCTIONAL UNIT SHUT DOWN

- Description :
  - Shut-down of one functional unit.
- Typical causes :
  - ESD1
  - voluntary decision
  - major process upset (including loss of utility)
- Typical effects :
  - shutdown of functional unit by means of SDV .

Level 3: SD 3 EQUIPMENT SHUT DOWN

- Description :
  - shut-down of one individual equipment.
- Typical causes :
  - SD2
  - voluntary decision
  - low low level closing downstream control valve to avoid gas blow by
  - low low level tripping the pump
  - high high level to shutdown the feed
  - high high level to shutdown compressor
  - high high pressure of column to shutdown steam through reboiler
  - compressor section shutdown by : PSLL, PSHH, TSHH
  - pump suction to be isolated to avoid mechanical seal leakage
- Typical effects :
  - Shutdown of equipment directly or by means of SDV (ESDV will be used only for fuel gas trip valve).
  - Isolation of equipment
  - Isolation of stand by equipment in operation.

3.5 SHUTDOWN DEVICES

For Level 3 :(implemented on PSS or package PLC):

- Sensor: will be done by an independent transmitter. Redundancy signal and /or voting system is not required. For dirty and critical services three transmitters (2 out of 3) may be used.
- action :
  - On control valve equipped with solenoid is allowed in case of small inventory : less than 5 m3 of liquid hydrocarbon or PV< 100 bar.m3 for gas. In that case, control valve will be designed taking into account the following specifications :
    - TSO / FC
    - manifold control valve by pass : CSC
    - auto reset giving authorisation of remote opening
  - on SDV
    - bypass authorised
    - TSO
    - FC
    - no fire proof requirement
    - auto reset giving authorisation of remote opening, no local reset except for process reasons
    - no air back-up except if double acting

For Level 2 (implemented on ESD PLC)

- Sensor: will be done by one independent transmitter. Redundancy signal by voting system may be required (2 on 3) for critical system generating a phase shutdown.
- action :
  - on control valve equipped with solenoid is allowed in case of small inventory: less than 5 m^3 of liquid hydrocarbon or PV< 100 bar.m^3 for gas. In that case, control valve will be designed taking into account the following specifications :
    - TSO
    - FC
    - by pass CSC

- remote reset
- on SDV
  - bypass authorized
  - TSO
  - FC
  - no fire proof requirement
  - remote reset.
  - no local reset except for process reasons
  - no air back-up except if double acting

For Level 1 (implemented on ESD PLC):

- device : ESD1 will be generated by operator through two ways
  - Push button hardwired
  - Push button through PLC system
- action :
  - on control valve not permitted
  - on ESDV
    - – bypass not authorised
    - – TSO
    - – FC
    - – Fire proof
    - – Local reset
    - – no air back-up except if double acting

3.6 ISOLATION OF FIRE ZONE

3.6.1 NUMBER OF ISOLATIONS

The number of ESDV's for each stream incoming/outgoing a fire zone shall be such that the reliability is adequate.

This requirements implies the installation of two ESDV's.

In practice, however, other factors such as battery limit versus fire zone interconnection, permanently manned or not, shall be taken into account and may lead to exceptions as follows:

- import/export lines
  2 ESDV's
- interconnecting
  2 ESDV's
  1 ESDV+1SDV (note 1)
  1 ESDV+1block valve (note 2)

note 1: where SDV are used for this service, they cannot be control valves.

note 2: block valve can be used if operation using the considered line is permanently manned and attended. The services concerned by this consideration are :

- propane make-up
- drain to burn pit

SDV's and ESDV's have to be installed considering the independence of gas train or phase or unit.

Distance between ESDV and hazardous equipment in the fire zone should conform to the results of the consequence analysis. If impact of these results cannot be implemented, the ESDV shall be located at 15 m mini from the fire zone with adequate protection for valving and piping.

3.6.2 ACTIONS OF ESD (PLC) AND USS SYSTEMS

Fire zone isolation will be performed by acting ESD-1 through PLC. As ultimate safety system, hardware diversified redundancy of ESD actions is also provided. The aim of this system is to shutdown the main equipment of the unit in order to keep the unit in safe manner.

- Action of ESD-1 (PLC) are as follows :
  - ESDV's, SDV's, Control valves shutdown
  - pumps, compressors, air cooler shutdown
  - permissive to start depressurisation

These actions will be done through shutdown level 2 or 3 using cascade effect. However, exception is made for SDV's used

- to isolate one fire zone,
- to isolate part of process to avoid contamination
- to isolate part of process to be depressurised from those which are not depressurised

In these cases, SDV will be shutdown directly from ESD-1 without the cascade effect. This may imply to provide two solenoids one for shutdown 3 and the other for shutdown 1 or 2.

- Action of ESD-1 (hardwired) are as follows :
  - Essential ESDV's or BDV's
  - Shutdown of essential electrical user at sub-station.

4 EMERGENCY DEPRESSURISATION

4.1 GENERAL CONSIDERATION

4.1.1 PURPOSE

The purpose of the Emergency Depressurisation (EDP) is

- to unstress an equipment under fire by releasing pressure
- to limit the quantity released through a leak
- to minimise hydrocarbon inventory.

4.1.2 LIQUID BLOWDOWN

In case of a large liquefied hydrocarbon inventory, a liquid emergency blowdown will not be provided to achieve the required reduction of pressure in the allowable period of time.

In order to limit the wall temperature and therefore possible damage of the capacities exposed to fire, liquid will be kept inside vessel.

4.1.3 EDP LEVELS

Two levels of depressurisation are provided:

- Level 1 (implemented on ESD PLC)

EDP1 is initiated by operator through push buttons under the permissive given by ESD1 of the considered fire zone.

- Level 3 (implemented on DCS or PLC package)

EDP3 concerns mainly individual equipment such as compressor which in case of major upset, will be depressurised automatically through the package PLC.

4.2 BLOWDOWN VALVE LOCATION

4.2.1 ISOLATION DEFINITION

An emergency depressurisation (EDP) system is defined as a system of several pieces of equipment and piping elements that can be both exposed and isolated to or from fire simultaneously. These systems are isolated by Control Valves which are Fail Closed (FC) and/or by Shut Down Valves (SDV, ESDV).

SDV's used for the fire zone isolation shall be located at the battery limit of the process unit. However, exception shall be considered if a BDV is required to depressurise the part of pipe comprised between the SDV and ESDV. In that case, the SDV will be located as close as possible to the ESDV to avoid BDV installation.

4.2.2 CRITERIA USED FOR BDV INSTALLATION

The criteria that shall be used to decide whether a Blowdown Valve (BDV) is required are summarised in the following table

		BDV required
	that cannot be isolated	No
	that can be isolated but are not exposed to fire	No (1)

PIPING	that can be isolated and are exposed to fire (5): - flammable gas - liquefied HC (4) - liquid HC - two-phase - toxic gases	 - P > 7 bar g and $P.V_{gas}$ > 100 $bar.m^3$ (6) - M_{gas} or M_{liq} > 2 tons of C_4 and more volatile(6) - No(3) - P > 7 bar g and $P.V_{gas}$ > 100 $bar.m^3$ (6) - As required for protection of personnel
VESSELS	that cannot be isolated	No
	that can be isolated but are not exposed to fire	No(2)
	that can be isolated and are exposed to fire (5): - flammable gas - liquefied HC (4) - liquid HC - two-phase - toxic gases	 - P > 7 bar g and $P.V_{gas}$ > 100 $bar.m^3$ (6) - M_{gas} or M_{liq} > 2 tons of C_4 and more volatile(6) - No(3) - P > 7 bar g and $P.V_{gas}$ > 100 $bar.m^3$ - As required for protection of personnel

Notes:

1. Except piping interconnecting equipment subject to EDP within one process unit, regardless of pressure and volume.
2. Except vessels between other vessels or piping within the same process unit and subject to EDP.
3. TSV or PSV fire cases are regarded as sufficient protections.
4. Both refrigerated or under pressure.
5. Piping or vessels shall be considered as being possibly exposed to fire if their external surface (more than 10%) can be engulfed in a pool fire likely to last more than 3 minutes.
6. The presence of pressurised fluid “trapped” in the network after EDP shall be avoided. The position of check valves and/or control valves failing to close shall be carefully contemplated in this respect.
7. BDV protecting an equipment with mesh will be installed upstream the mesh
8. Depressurisation to be avoided through plate and frame exchanger.

Legend:

P : Maximum operating pressure (PSHH)

V :	Internal vessels (or piping or vessel + piping) volume
V_{gas} :	Gas phase volume
V_{liq} / V_{gas} :	Maximum liquid/gas volume inside vessel or piping or both (LAHH/LALL)
M_{liq} / M_{gas} Maximum:	Mass of liquefied hydrocarbon liquid phase/gaseous phase inside vessel (or piping or both)

4.3 BLOWDOWN VALVE SPECIFICATION

- TSO, Full Bore
- FO, de-energised to open (except for slug catcher : XV energised to open)
- equipped with bottle and with two solenoid if ESD1 and SD3 act on same BDV
- no fire proof requirement
- local reset
- the greater value between 3 strokes mini or 30 min. of bottle capacity
- mini diameter higher or equal to 2”.

4.4 SYSTEM VOLUME TO BE DEPRESSURISED

4.4.1 SYSTEM VOLUME DETERMINATION

Volume of the system to be depressurised shall be determined by the isolation block valves considered here above which are ESDV, SDV and control valve FC. The volume will not take into account the possibility of non closing of the SDV or control valve.

4.4.2 PURGE AND DRAIN LINES

Purge and drain lines are neglected in the total volume.

4.5 INDIVIDUAL BLOWDOWN CALCULATIONS

Blowdown valve sizing is based on the practices recommended in the Relief and Blowdown sizing philosophy DB ***1516*** 999 P312 210.

Three different depressurisation procedures are considered:

- Depressurisation in case of external pool fire ("Hot fluid depressurisation")
- Depressurisation after prolonged shutdown ("Cold fluid depressurisation")
- Spurious Depressurisation

4.5.1 DEPRESSURISATION IN CASE OF EXTERNAL POOL FIRE

The flow is assumed to be critical through the Restriction Orifice and designed according to the followed considerations:

a) Initial conditions :

Pressure	=	Maximum operating pressure or PSHH
Temperature	=	Maximum operating (it is assumed that heat exchanges are stopped)
Liquid Level	=	NLL for vessel with auto level control
		LSH for vessel with ON/OFF control
		Liquid Level corresponding to piping hold up for piping
		LSH for relief K.O. drum or flare vessel

Final Conditions:

7 bar g or 50 % of PSHH (or design pressure) whichever is lower.

b) Depressurisation time

- As a general rule, for vessels whose smallest wall thickness is equal to or greater than 25 mm, time to achieve the final pressure level after an EDP has been initiated shall be, by default :
  - within 15 minutes or less for piping and vessels containing hydrocarbon, both gas or liquid
  - within 8 minutes or less for storage vessels containing LPG's or light condensate to avoid the risk of BLEVE
- For wall thickness smaller than 25 mm, the following rule shall be applied :
  - Wall thickness < 25 mm: 15 minutes minus 3 minutes for each 5 mm decrease in thickness

c) Heat input

- Pool Fire

This shall be considered only in the fire zone corresponding to a cylindrical volume of about 18 m diameter / 8 m height. In the case of equipment and/or piping elevated at 8 meters or higher, heat input will only be considered if a retention structure appears.

The heat input will be specified as per API:

$q = 21000\ F\ A^{-0.18}$

$Q = 21000\ F\ A^{0.82}$

Where:

q = average unit heat absorption, in BTU/h.ft² of wetted surface

Q = total heat absorption (input) to the wetted surface, in BTU/h

F = environment factor to be taken equal to 1 for EDP - insulation shall be considered as non fire resistant

A = total wetted surface, in ft² (The expression $A^{-0.18}$ is the area exposure factor or ratio. This ratio recognises the fact that large vessels are less likely than small ones to be completely exposed to the flame of an open fire)

- Heat exchanges by natural convention with the ambient shall be based on :
  - ambient temperature : 30 °C
  - heat transfer coefficient : 5 W/m2°C
- For restriction orifice, atmospheric conditions shall be considered downstream the orifice.

4.5.2 DEPRESSURISATION AFTER PROLONGED SHUTDOWN

In the cold depressurisation procedure, the target is to check the final temperature after the system has reached the final network pressure (around 0 barg), in order to assure the material resistance at the lowest temperature reached in the system. Besides, this calculation allows calculating the time necessary to reach this pressure: in fact, the restriction orifice will be sized for the depressurisation in case of pool fire, which usually gives the highest peak flow.

The same initial pressure for the fire case is assumed as starting point for the depressurisation, while the initial temperature is the operating temperature or 21°C, whichever the lowest.

The following actions concern the preparation of the PRO/II input file.
The system must be brought to the depressurisation initial conditions by feeding the same streams, as in the depressurisation for fire, to a FLASH (ISO) with PRES equal to the system design pressure and T=21 (or lower operating).

The final temperature calculation shall be carried out using DEPRESSURING (DEPRE) mode, imputing:

- Total volume of the circuit to be depressurised (same as calculated for depressurisation for fire)
- Total initial liquid inventory updated by PRO/II during calculation (same as calculated for depressurisation for fire)
- Total time and time step for calculation
- Valve model (SUPERSONIC), with a constant which must be the same as the one calculated in case of fire

On the output file, the time step at which the final pressure is reached can be read, as well as the corresponding temperature.

In case of conflict between this calculated minimum temperature and the material resistance low limit temperature, specific calculations will be performed. In particular, the maximum operating pressure, instead of the design pressure, will be selected as starting point and the calculation procedure will also consider the effect of metal weight on heat capacity.

- Heat exchanges by natural convention with the ambient shall be based on :
  - ambient temperature : 17°C
  - heat transfer coefficient : 5 W/m2°C

4.5.3 SPURIOUS BLOWDOWN

Spurious blowdown will be applied for all systems and defined as follows :

a) Initial conditions :

Pressure	=	Maximum operating pressure or PSHH.
Temperature	=	Minimum operating (it is assumed that heat exchanges are stopped)
Liquid Level	=	NLL for vessel with auto level control
		LSH for vessel with ON/OFF control
		Liquid Level corresponding to piping hold up for piping
		LSL for relief K.O. drum or flare vessel

Final Conditions :

The calculation shall be carried up to ATM pressure to find the minimum achieved temperature.

b) Depressurisation time

No time is taken into account here because the blowdown rate depends on the orifice sized on fire case blowdown basis.

c) Heat input

None in this case. However, insulation, if any, will be considered.

- Heat exchanges by natural convention with the ambient shall be based on :
  - ambient temperature : 17°C
  - heat transfer coefficient : 5 W/m2°C

4.6 FIRE ZONE DEPRESSURISATION

- Inside one fire zone, the system exposed to fire will be defined within a cylindrical volume (dimensions: about 18 m diameter x 8 m height). This zone will be determined as the area generating the largest blowdown flow (in general this area presents the largest liquid inventory).
- Therefore, the flowrate generated by the blowdown of one fire zone will be calculated by adding :
  - ➢ The flowrate determined as § 4.4.1 through BDV's and included in the cylindrical volume exposed to fire.

- With the flowrate calculated on the basis of a spurious blowdown as per § 4.5.3 for other BDV's.

- Phased EDP system within one fire zone will be foreseen if instantaneous flowrate generated by the depressurisation is higher than the design flowrate of the flare.

4.7 PARTICULAR CASE: SLUG CATCHER DEPRESSURISATION

- Finger type slug catcher located at a sufficient distance from the process units are not considered as equipment but as pipeline, the relevant code being ASME B31-8. As a consequence they shall not be equipped with an EDP system matching the requirements developed here above.
- However, a remote opening valve with flow orifice will be provided to vent the slug catcher. This system shall be sized not to exceed the maximum load of the HP flare or to limit temperature in the slug catcher at -29°C min. Therefore, the installed device will allow a slug catcher depressurisation over a period of time longer than what is imposed by the functional requirement exposed here above.
- Additional facilities will be installed for controlled sealine depressurisation using variable orifice for constant flow and minimisation of time to depressurise. During the depressurisation phase of the sealine, the temperature of the sealine shall not be lower than -10°C and the flowrate generated by this venting shall not exceed the HP flare load.

4.8 IMPACT ON MATERIAL SELECTION

The purpose of this paragraph is to summarise the impact of a blowdown on material selection.

4.8.1 PIPING MATERIAL SELECTION

The piping material will be selected taking into account the temperatures occurring during depressurisation; piping re-pressurisation shall be considered as to be performed with the minimum depressurisation temperature.

4.8.2 VESSEL MATERIAL SELECTION

As a base case, the above consideration shall be applied also for vessels: the minimum temperature due to blowdown conditions shall be associated with design pressure.

5 HIPPS

5.1 GENERAL CONSIDERATION

- HIPPS shall be selected, as an alternate of conventional system against overpressure, when full pressure rated design and relief systems prove to be impractical because of :
  - environmental considerations (to avoid relief to atmosphere if possible)
  - layout constraints (size of relief headers and associated downstream systems : vents, flares , etc ...)
- HIPPS and all related equipment must be designed, tested, installed and operated with the greatest care. Special operating procedure shall be applied.
- The HIPPS is based on instrumentation system which requires sufficient integrity (involving high reliability redundant instruments) so as to make the risk of exceeding the design pressure acceptable.

5.2 PLANT PROTECTION

- As the sealine and slug catcher are designed for 139 barg, the main gas line has to be protected against overpressure from the offshore facilities since the inlet design pressure of the plant is set at 82 barg.
- In order to define the protection system of the whole plant, two cases are considered :
  - HP separators blocked outlet
  - PV (at pressure reducing station) fully open

5.2.1 HP SEPARATORS BLOCKED OUTLET

One blocked outlet downstream the HP separators shall be considered due to a mechanical problem or misoperation on the Motor Operating Valve (MOV) located at gas heater (100-

E-101) level. MOV is located on the common header of two gas trains (trains 1&2 or trains 3&4).

If the pressure build up delay is tight, a HIPPS reaction cannot be effective to protect the system against overpressure. Protection using a conventional mode of protection (PSV) is also required.

5.2.2 PV UPSTREAM HP SEPARATORS FULLY OPEN

For protection of the whole plant against the pressure reducing station failure, a HIPPS shall be installed.

5.3 HIPPS SPECIFICATIONS

The objectives of the HIPPS shall be to:

- define the acceptable closing time for ESDV/SDV,
- to check that the instrumentation provided allow to reach sufficient reliability.

5.3.1 HIPPS SAFETY INTEGRITY REQUIREMENT

The HIPPS architecture follows the API 14C recommendations which consist in two safety barriers:

- the first barrier is composed of one PSHH acting on SDV
- the second barrier consists of one independent loop comprising three pressure transmitters, valves and actuator. The three signals enter in logic “two out of three”. Two ESDVs and one SDVs are provided acting on signal from the voting system.

5.3.2 HIPPS REACTION TIME

- The reaction time for the HIPPS shall be as a maximum half of the time necessary to increase the pressure to 82 barg. The reaction time is defined as the time from detection until complete closure of valves.
- The design of the HIPPS shall be such that the increase of pressure downstream the pressure reducing station in case on PVs fully open shall not exceed 82 barg.

6 DESIGN BASIS FOR FLARE SYSTEMS

- See DB 1516 140 P 312 101