طرح نگهداشت و افزایش تولید ۲۷ مخزن

CONSEQUENCE MODELING REPORT

نگهداشت و افزایش تولید میدان نفتی بینک

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IFC: Issued For Comment
IFA: Issued For Approval
AFD: Approved For Design
AFC: Approved For Construction
AFP: Approved For Purchase
AFQ: Approved For Quotation
IFI: Issued For Information
AB-R: As-Built for CLIENT Review
AB-A: As-Built –Approved

پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه
BK	GCS	PEDCO	120	SA	RT	0003	D01

REVISION RECORD SHEET

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CONTENTS

1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also, PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

As a part of the Project, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – Surface Fcilities; New Gas Compressor Station
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of: Hirgan Energy – Design & Inspection (D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

2.0 SCOPE

The analysis considered all the units identified as part of the New Gas Compressor Station (adjacent to existing Binak GCS). In current report consequence of major hazards, such as Fire, explosion and toxic gas dispersion, associated with a process area has been reported and analyzed. Fire Zone, Restricted Area, Impacted Area have been evaluated in different sections of this study.

3.0 NORMATIVE REFERENCES

3.1 INTERNATIONAL CODES AND STANDARDS

- API RP 752 (2009) — Management of Hazard Associated with Location of Process Plant Permanent Buildings
- TOTAL GS-EP- SAF-253 (2012) — Impacted area, restricted area and fire zones
- TOTAL GS-EP-SAF-041 (2011) — Technological Risk Assessment
- TOTAL GS-EP-SAF-221 (2011) — Safety rules for buildings

3.2 THE PROJECT DOCUMENTS

- BK-GNRAL-PEDCO-000-PR-DB-0001 — Process Basis of Design
- BK-GCS-PEDCO-120-PR-DP-0001 — Process & Utility Description
- BK-GCS-PEDCO-120-PR-PH-0002 — Control Philosophy
- BK-GCS-PEDCO-120-PR-PF-0001 — Process Flow Diagram (PFD)
- BK-GCS-PEDCO-120-PI-PY-0001 — Unit Plot Plan Drawing

3.3 ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No. BK-GNRAL-PEDCO-000-PR-DB-0001".

3.4 ABBREVIATIONS

- API — American Petroleum Institute
- ESD — Emergency Shutdown
- ESDV — Emergency Shutdown Valve

- H2S — Hydrogen Sulphide
- HSE — Health, Safety & Environment
- HVAC — Heating, Ventilation and Air Conditioning
- LFL — Lower Flammable Limit
- MW — Molecular Weight
- PFD — Process Flow Diagram
- P&ID — Piping and Instrumentation Diagram
- IDLH — Immediately Dangerous to Life and Health
- TLV — Threshold Limit Value
- VCE — Vapor Cloud Explosion
- PPM — Part Per Million

3.5 PURPOSE

The purpose of this document is “identifying contours of Fire Zone, Impacted and Restricted area”. This approach is aimed at fulfilling a two-fold objective:

- Based upon unit lay-out, nature of equipment and risks (nature and level) associated to equipment, provide means or take dispositions that shall ensure:
  - ✓ Prevention of ignition: Separate, as far as practicable, ignition sources from fuel sources.
  - ✓ Mitigation: Minimize the consequences of fires, explosions and other hazard; prevent escalation of fire to other areas; minimize hydrocarbon inventory in areas where fire initiated (isolation and depressurization); focus active fire-fighting to one single zone and improve the emergency response; contain the risk within the boundaries of the installation and avoid exposure of public to hazards.
  - ✓ Escape, Evacuation and Rescue: Protect personnel from fire and explosion in the escape routes to a safe area.
- Provide tools that will ensure the safety of public that may be present, either permanently or just passing by, in the vicinity of production facilities.

This study will cover the following zones:

- Process facilities including:
  - ✓ Compressors
  - ✓ Suction drums

- ✓ KO drums
- ✓ Air coolers
- ✓ Fuel gas KO drum
- ✓ Dehydration Package

- Buildings
- Flare system

The following zones will not be studied:

- Non-flammable systems
  - ✓ Fire Water station (fire water tank and distribution system)
  - ✓ Raw Water System
  - ✓ Nitrogen System
  - ✓ Utility Air System
  - ✓ Instrument Air System
- Other systems
  - ✓ Diesel System (as flash point is higher than ambient temperature)
  - ✓ Non-hazardous Open Drain System (as does not normally contain hydrocarbon)
  - ✓ Closed drain System (as flow rate and pressure are usually low)
  - ✓ Pig launcher (it is not in continuous service and safety checks will be done before operation)

3.6 DEFINITION

3.6.1 MAJOR FAILURE

A conceivable incident that can possibly occur on the facility, selected out of a list of reference incidents based on experience and considering that mitigation measures have been implemented and protection systems have operated as required.

3.6.2 FIRE ZONE

Fire Zones are the areas within the installation where equipment is grouped by nature and/or homogeneous level of risk attached to them.

The partition of an installation into fire zones results in a significant reduction of the level of risk. This implies that consequences of a fire, flammable gas leak or an explosion corresponding to the credible event likely to occur in the concerned fire zone, shall not impact other fire zones to an extent where their integrity could be put at risk.

3.6.3 RESTRICTED AREA

The Restricted Area is the area within the boundaries of the installation and hence under the control of Client. The restricted area is affected:

• Permanently by normal operation of the facility

• Exceptionally by the consequences of an emergency situation caused by a major failure.

Within the restricted area, Client shall have control of all possible sources of ignition, including vehicles. A security fence shall include at least the restricted area.

3.6.4 IMPACTED AREA

The Impacted Area is the area that extends beyond the boundaries of the installation but which is nevertheless affected either permanently by normal operation of the facility (e.g., noise or radiation) or exceptionally by the consequences of an emergency situation caused by a major failure. The impacted area is not under the control of Client but agreement shall be formalized with Local Authorities to minimize presence of public (e.g., to limit construction of buildings, in particular permanent settlements, or operation of transportation means open to public).

Typical layout of Fire Zone, Restricted and Impacted area is shown in 0Figure 1.

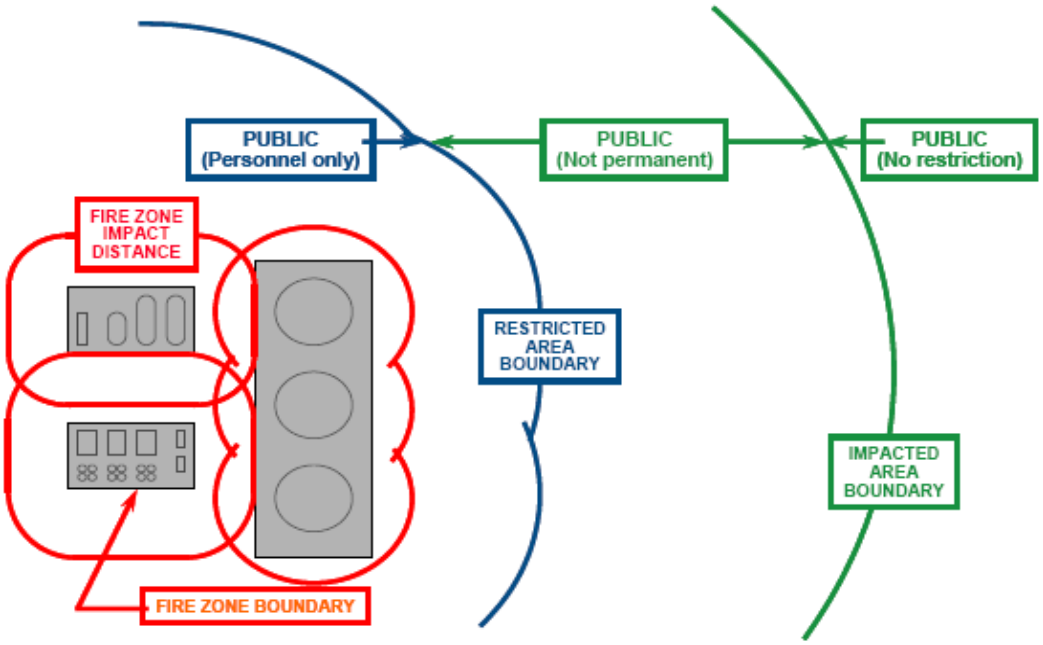


Figure 1- Typical layout - Fire zoning, restricted and impacted areas boundaries

3.6.5 VCE (VAPOR CLOUD EXPLOSION)

One of the physical phenomena that may occur after the accidental release of dangerous goods is a vapor cloud explosion. A vapor cloud can be created by either the release of a gas from

containment or by the evaporation of a liquid that was released from containment.

The explosion resulting from an ignition of a premixed cloud of flammable vapor, gas or spray with air, in which flames accelerate to sufficiently high velocities to produce significant overpressure. This type of explosion can occur in a confined enclosed unit or in a congested open unit.

3.6.6 BLAST

A characteristic feature of explosions is blast. Vapor cloud explosions are characterized by rapid combustion in which high-temperature combustion products expand and affect the surroundings. In this fashion, the heat of combustion of a fuel-air mixture (chemical energy) is partially converted into expansion (mechanical energy). Mechanical energy is transmitted into the surrounding atmosphere in the form of a blast-wave.

3.6.7 JET FIRE

Jet fires are burning jets of gas or atomized liquid whose shape is dominated by the momentum of the release. A jet fire is an intense fire that gives rise to high levels of thermal radiation at a considerable distance. If compressed or liquefied gases are released from storage tanks or pipelines, the materials discharging through the hole will form a gas jet that entrains and mixes with the ambient air. If the material encounters an ignition source while it is in the flammable range, a jet fire may occur.

4.0 PROCESS CONSEQUENCE MODELING

4.1 BASIC OF THE CALCULATION

4.1.1 APPLIED DOCUMENTS AND USED SOFTWARE

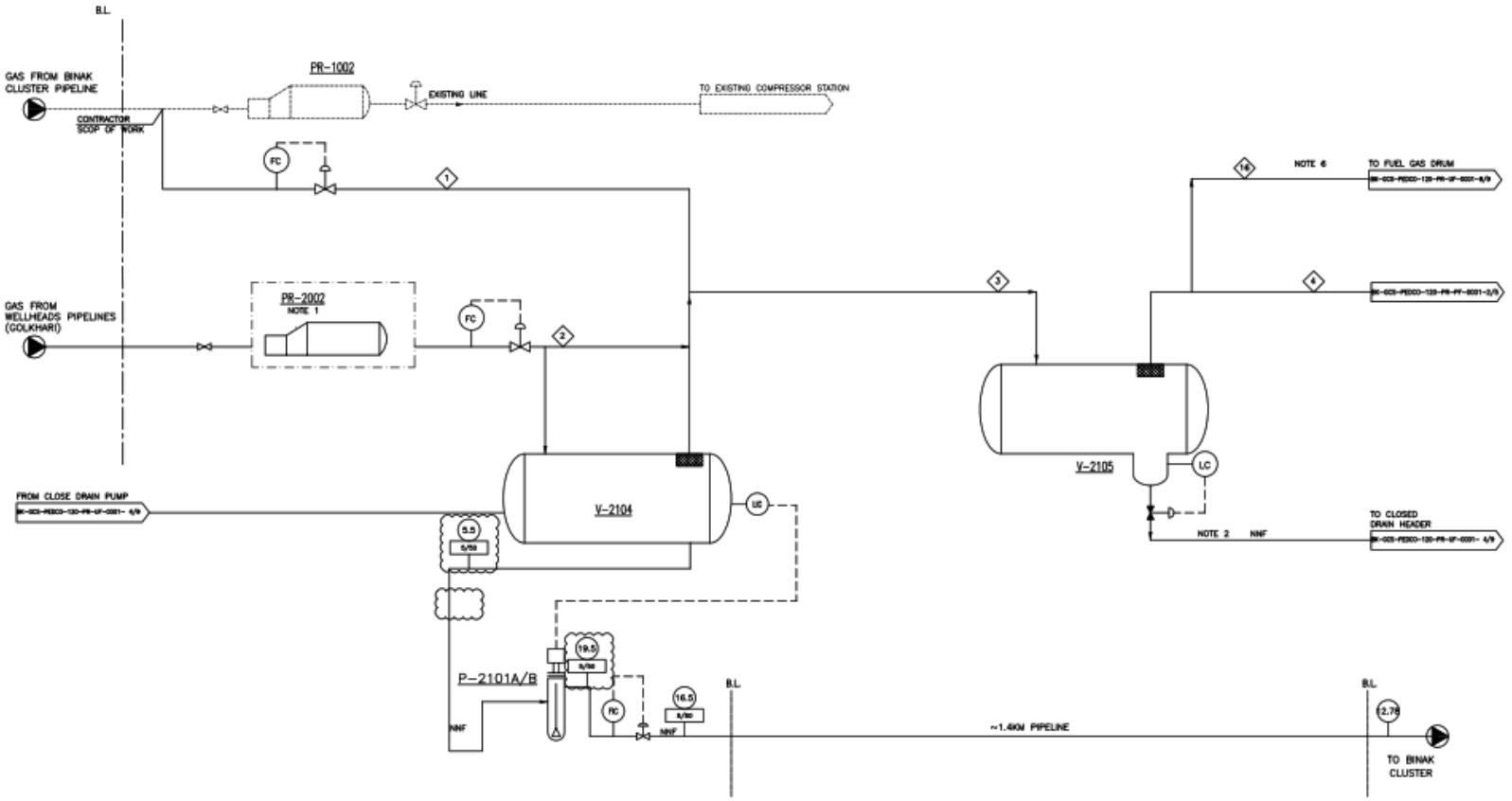
The calculations for the consequences analysis are made according to the Total Exploration Production document TOTAL-GS-SF-253 General Specification Safety of Impacted Area, Restricted Area and Fire Zones. The software used for the consequence analysis has been PHAST 8 (DNV).

4.1.2 PROCESS DATA

The data used is the design data available at detail stage of the project, such as noted in PFD's, Process Heat and Material Balances, P&ID and in some cases equipment data sheets. For each case, the most conservative process data are taken into consideration to perform the simulation.

There is only one process fire zone including three compressor trains with all related accessories.

For composition of streams to be referred to appendixes.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PR-2002
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NOTE 6
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NOTE 2
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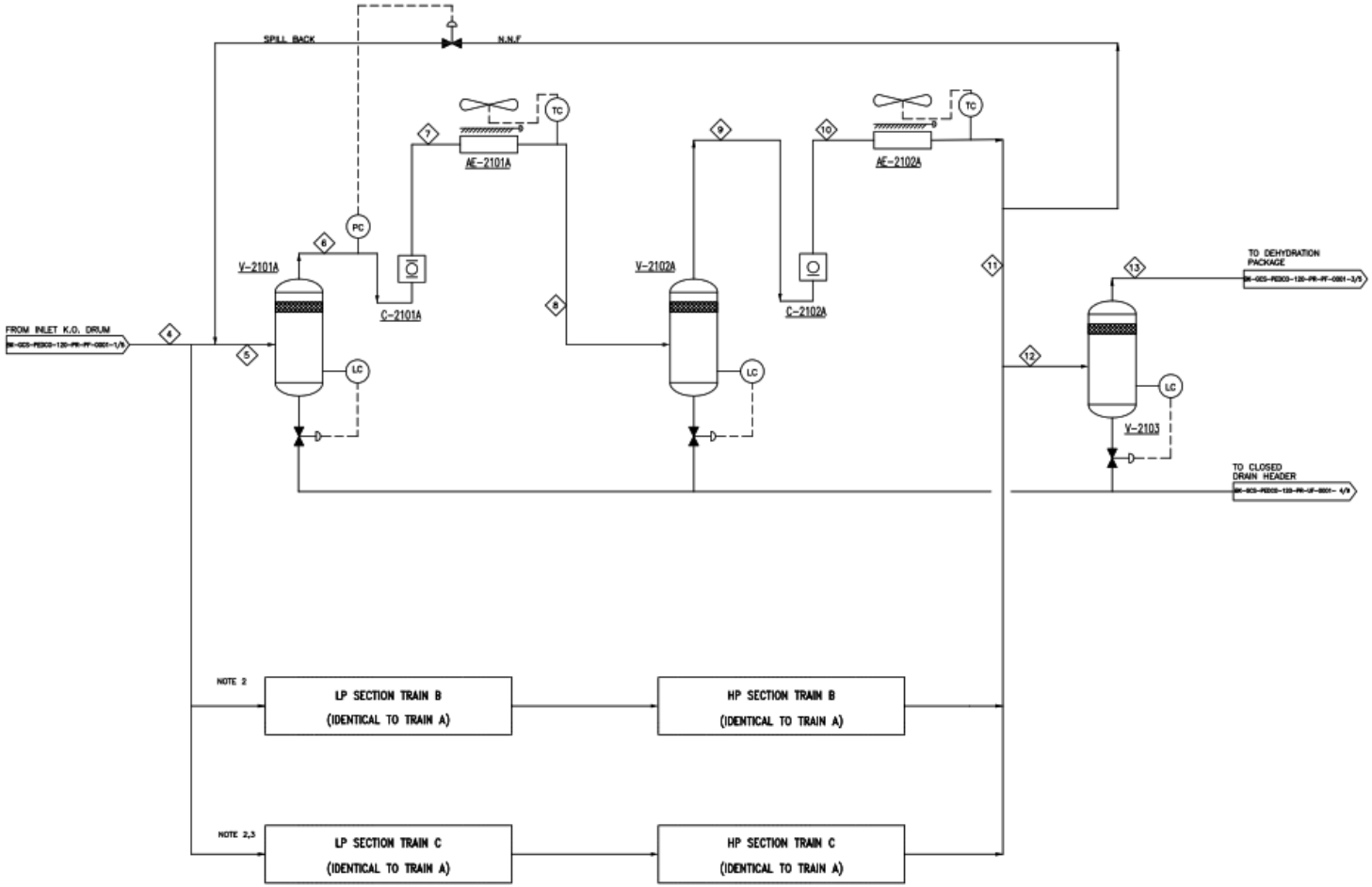
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V-2103
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TO CLOSED DRAIN HEADER
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(IDENTICAL TO TRAIN A)
HP SECTION TRAIN B
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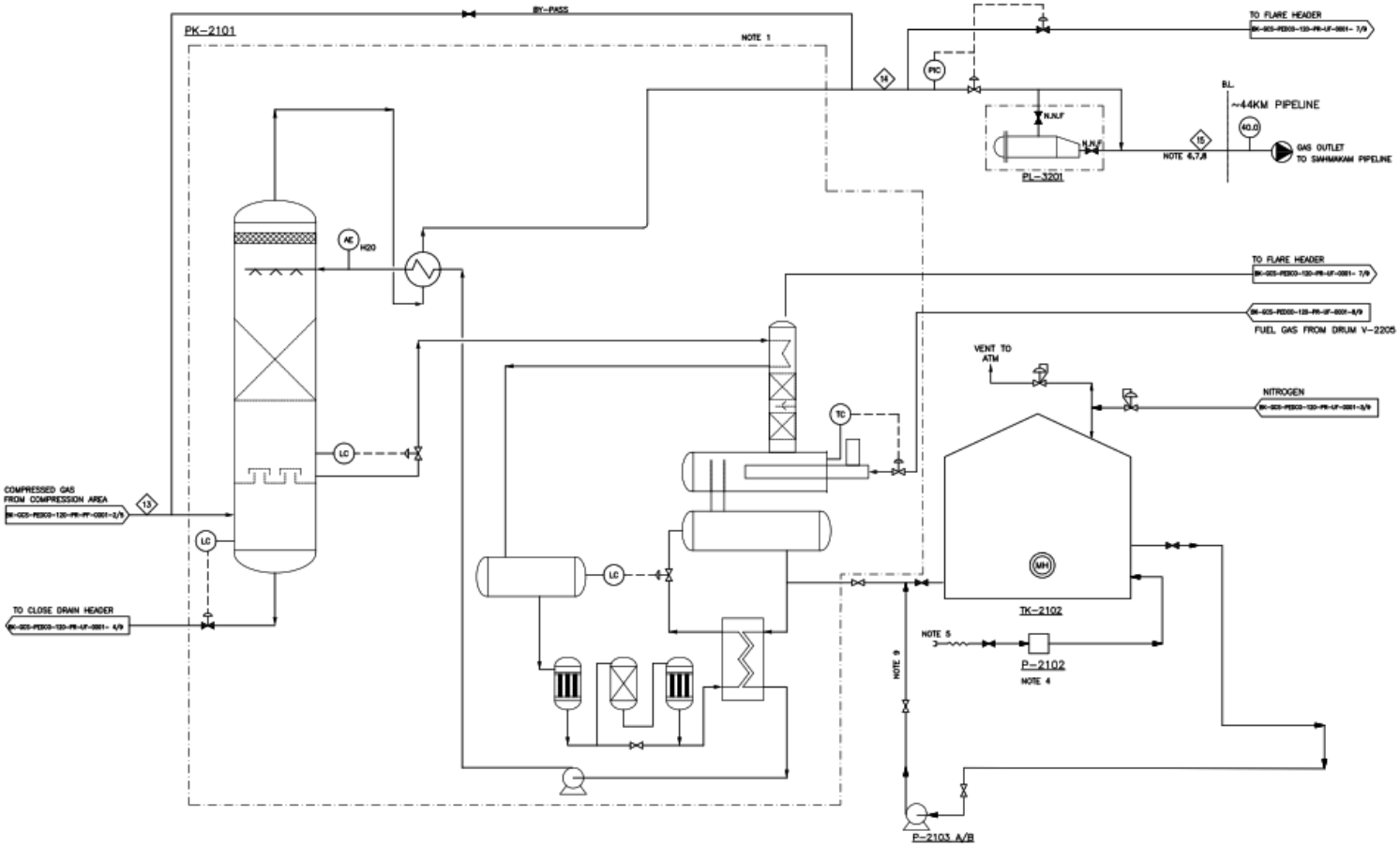

Figure 2; PFD of BINAK GCS

4.1.3 WEATHER CONDITION

The meteorological conditions envisaged for the simulations are the following:

Ambient temperature:

- Min. average ambient temperature (°C): 18.75 °C
- Max. Average ambient temperature (°C): 33.03 °C

Relative humidity:

- Maximum Range: 60.52%
- Average Relative Humidity 54.7%
- Minimum Relative Humidity: 34.94%

Solar radiation:

Solar radiation (maximum): 1010 W /m2

Wind condition:

- Max. wind velocity: 28.33 m/s
- Normal Wind Velocity 5.96 m/s
- Prevailing wind direction: NW to SE
- Prevailing wind Velocity: > 7 m/s

For all scenarios, the simulations are made with 4 wind speeds: 2 m/s, 5 m/s, 15 m/s and 28 m/s considering a neutral atmosphere by Pasquil class respectively F and D.

Finally, four different classes are selected as illustrated in table 1:

Table 1 :Overview of weather condition

Weather Condition	F2	D5	D15	D28
Pasquil Class	F	D	D	D
Wind Speed (m/s)	2	5	10	20
Average Temperature °C	18.75	33	33	33
Solar Radiation. kW/m²	0	1	1	1

4.1.4 SCENARIO SELECTION

The term “scenario” is used as an accident initiator, which is usually represented by a variety of leakage/ full bore ruptures with different sizes in pressurized equipment, piping and fittings (due to process upset, incorrect materials of construction, design error, over pressure, corrosion, equipment malfunction, operational error, and abnormal operation).

Each scenario is characterized by the following specifications:

- Source (single equipment or a group of equipment which feed the leak)
- Source process condition (normal process condition just behind the leak including, material composition, phase, pressure and temperature)
- Inventory (the amount of potential material which is discharge through leak)
- Leak size (representative hole diameter)
- Leak elevation

Based on Total GS-EP-SAF-253; the table below gives the definition of the main typical scenario outcomes applicable to oil and gas production and processing installations. Some of these scenarios will not be studied due to not availability of required specific conditions. For more detail to be referred to the below table:

Table 2 : typical scenarios and chance of occurrence

Scenario outcome	Definition	Specific conditions
Un-ignited gas/spray cloud (flammable gas cloud or flammable atmosphere)	Mixture of flammable gas or vapor in air which will burn when ignited (ISO).	It could be happened on all hydrocarbon vessel/compressors.
Un-ignited gas/spray cloud (toxic gas cloud)	Mixture of toxic gas or vapor in air (Client).	Due to not existence of toxic gas in process streams, there will not be chance of toxic gas dispersion on the site.
Vapor Cloud Explosion in unit (VCE)	The explosion resulting from an ignition of a premixed cloud of flammable vapor, gas or spray with air, in which flames accelerate to sufficiently high velocities to produce significant overpressure (Yellow Book, TNO, 1997). This type of explosion can occur in a confined enclosed unit or in a congested open unit (Client).	It could be happened in compressor shelter area.
Pool fire	Combustion of flammable or combustible liquid spilled and retained on a surface (ISO). Combustion of material evaporating from a layer of liquid at the base of the fire (UKOOA).	As there is no any dike wall, retention basin, this scenario will not be studied.
Jet fire	The combustion of material emerging from an orifice with a significant momentum (UKOOA). Ignited release of pressurized flammable fluids (ISO).	It could be happened.
Boiling Liquid Expanding Vapor Explosion (BLEVE) & boil over	BLEVE: sudden rupture due to fire impingement of a vessel and/or system containing liquefied flammable gas under pressure; the pressure burst and the flashing of the liquid to vapor creates a blast wave and potential missile damage, and immediate ignition of the expanding fuel-air mixture leads to intense combustion creating a fireball (UKOOA). Boil over: expulsion of crude oil (or certain other liquids) from a burning tank. The light fractions of the crude oil burn off producing a heat wave in the residue, which on reaching a water stratum may result in the expulsion of a portion of the contents of the tank in the form of froth (OSHA).	As there is no any liquefied flammable gas under pressure this scenario will not be studied. NFPA defines boil-over as: An event in the burning of certain oils in an open-top tank when, after a long period of quiescent burning, there is a sudden increase in fire intensity associated with expulsion of burning oil from the tank. As there is no any open-top tank, this scenario will not be studied.

Scenario outcome	Definition	Specific conditions
Blowout	When well pressure exceeds the ability of the wellhead valves to control it. Oil and gas “blow wild” at the surface (UKOOA).	Wellhead study is not in scope of this project. So this scenario will not be studied.
Fixed roof tank explosion	Confined explosion of a fuel-oxidant mixture inside a closed system such as vessel, module, etc. (UKOOA).	There is no any hydrocarbon storage tank, so this scenario will not be studied.
Flare normal operation	Maximum Continuous Flaring (MCF): flaring the largest allowable steady flow of combustible gas in normal operating conditions (Client). Emergency Flaring (EF): flaring a peak flow of combustible gas in upset or emergency operating conditions (Client).	It will be studied.
Flare flame out: flammable and/or toxic	Unignited flare gas release.	It will be studied.
Cold vents	Vent handling significant flow rates generally from pressurized equipment. The word “cold” meaning without flame (Client).	Cold vent is not in scope of this project, so this scenario will not be studied.
Degassing vents	Vent handling low flow rates, generally from atmospheric equipment. A degassing vent is a non-ignited vent to atmosphere. (Client).	There is no such a case in this project, so this scenario will not be studied.
LPG pool vaporization	Vaporization of liquid LPG spilled and retained on a surface	LPG will not be used in this project, so this scenario will not be studied.

4.1.5 SOURCE

It is obvious that process condition such as composition, phase and temperature are changed through the process. In order to consider this change in consequence modeling and analysis, the process facilities should be divided to different isolated process segments (separated by SDVs,

ESDVs). Thus, each segment has its own gas and liquid inventory during a release. After this classification, any part of these segments that may cause different scenario outcomes because of different process conditions will be considered as an independent scenario. Figure 3 shows an example of Isolated process segment.

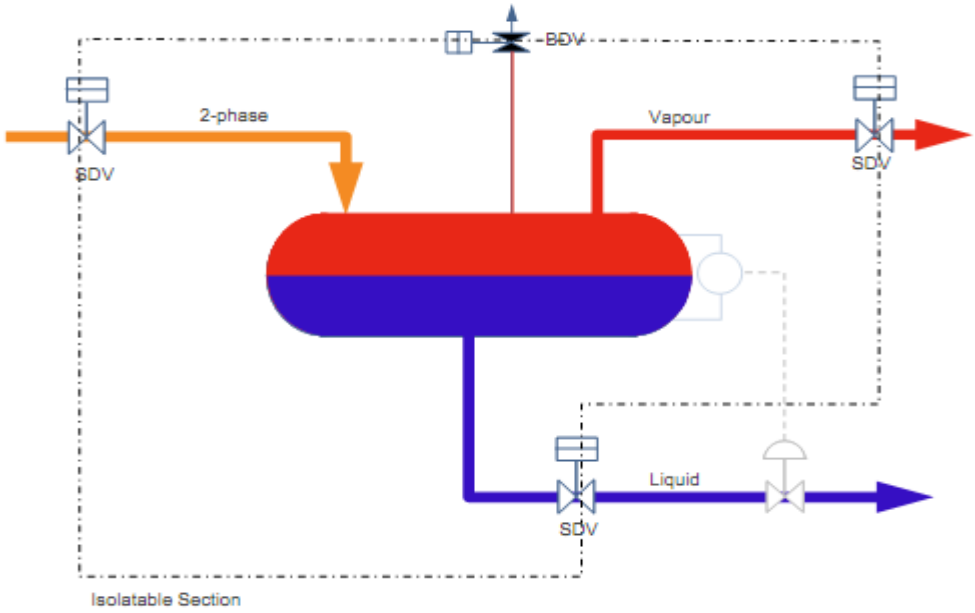

Figure 3 -An example of an isolatable process segment

4.1.5.1 SOURCE PROCESS CONDITION

New Binak gas compression station includes 3 train compressors with all related accessories and Dehydration package which handle hydrocarbon gases.

4.1.5.2 INVENTORY

Inventory is defined as the amount of potential material, which is discharged through leak; this parameter depends on both capacity and isolation time.

4.1.5.3 LEAK SIZE

In accordance with TOTAL-GS-SF-253, different leak size criteria are defined for various purposes.

4.1.5.4 LEAK ELEVATION

Leak elevation determines the height that the material is released from the leakage source. Based on TOTAS-GS-253 section 7.2, the leak elevation is considered 1.0 m for all scenarios.

4.1.5.5 SENSITIVITY OF EFFECTIVE PROCESS PARAMETER ON OUTCOMES

Sensitivity of each process parameters on outcomes has been illustrated in this section:

4.1.5.6 PRESSURE

Pressure has MAJOR effect on Fire & Dispersion scenarios. Increase in pressure leads to more momentum of discharging material from hole and consequently bigger jet fire, and dispersion effect (toxic or flammable).

4.1.5.7 TEMPERATURE

Temperature has MINOR effect on Fire & Dispersion scenarios. The prediction of behavior of discharging material by changing temperature is not easy, but generally cold material has bigger dispersion effect. This effect could be different depending on material composition, pressure and etc.

4.1.5.8 INVENTORY

Inventory has NO effect in Fire Zone study and Minor effect on Restricted and Impacted area study.

As TOTAL-GS-SF-253 mentioned, for “Flammability” and “Thermal radiation” calculation, release flow rate shall be “Initial release rate for 10 minutes” and therefore the inventory has NO effect at all.

In Restricted and Impacted scenarios, where the “release flow rate of leak” is less than “flow rate of inlet line to vessel”, inventory has NO effect at all. In comparison, for scenarios that leak flow rates are less than “flow rate of inlet line to vessel”, inventory has Minor effect on “discharging material flow rate”, unless the inventory is very low.

4.1.5.9 RELEASE DIRECTION

In most gas releases, Horizontal impingement causes bigger dispersion effect in comparison to Horizontal. For volatile liquid cases, normally Horizontal release leads more dispersion effect than of Horizontal Impingement. Furthermore, Horizontal impingement scenario reduces the effect of Jet Fire significantly almost in all scenarios.

4.2 FIRE ZONE, RESTRICTED AND IMPACTED AREA

The table below gives the different scenarios outcomes used to define distances between fire zones and to establish the contour limits of restricted and impacted areas. This table is extracted from Total-GS-EP-SAF-253 and probable scenarios which could be happened in this project.

Scenarios are described in section 4.1.4 and occurrence probability of each scenario is detailed in this section table 3.

Table 3: Fire zone, restricted /impacted area criteria

FIRE ZONE			
Effect	**Scenario**	**Specific conditions**	**Criteria**
Flammability	Un-ignited flammable gas/spray cloud dispersion from gas/ two phase or liquid release	• 20 mm leak diameter • Initial release rate for 10 minutes • Release height 1 m • Horizontal jet and horizontal impacted jet	LFL
	Flare flame out	• Emergency flow rate • Release direction according to the tip direction	
Thermal radiation	Jet fire from gas, two-phase or liquid release	• 20 mm (1) leak diameter • Initial release rate for 10 minutes • Release height 1 m • Horizontal jet	9.5 kW/m^2 **
Overpressure	Vapour cloud explosion (VCE) in unit	Unit volume half full of flammable gas at stoichiometric concentration	200 mbar
RESTRICTED AREA			
Flammability	Un-ignited flammable gas/spray cloud dispersion from gas/ two-	• Leak diameter vs. pipe diameter: 0.20 pipe diameter limited to a minimum leak size of 20 mm and a maximum leak size of 150 mm • Average release rate or release rate vs. Time • Release height 1 m • Horizontal jet and horizontal-impacted jet	LFL
Thermal radiation or Thermal dose	Jet fire from gas, two phase or liquid release	• Leak diameter vs. pipe diameter: 0.20 pipe diameter limited to a minimum leak size of 20 mm and a maximum leak size of 150 mm • Average release rate or release rate vs. time • Release height 1 m • Horizontal jet	4.73 kW/m^2 **
	Flare - emergency operation (ignited)	• Emergency flow rate • Release direction according to the tip direction	4.7 kW/m2 **

	Flare - continuous operation (ignited)	• Maximum continuous flow rate • Release direction according to the tip direction	3.2 kW/m2 **
Overpressure	Vapour cloud explosion (VCE) in unit	Unit volume half full of flammable gas at stoichiometric concentration	140 mbar
Toxicity	Un-ignited toxic gas/spray cloud dispersion from gas/ two-phase or liquid release	• Leak diameter vs. pipe diameter: 0.20 pipe diameter limited to a minimum leak size of 20 mm and a maximum leak size of 150 mm • Average release rate or release rate vs. time • Release height 1 m • Horizontal jet and horizontal-impacted jet	Toxic gas LC1%
IMPACTED AREA			
Thermal radiation or Thermal dose	Jet fire from gas, two phase or liquid release	• Leak diameter vs. pipe diameter: 0.20 pipe diameter limited to a minimum leak size of 20 mm and a maximum leak size of 150 mm • Average release rate • Release height 1 m • Horizontal jet	3.2 kW/m^2 **
	Flare - emergency operation (ignited)	• Emergency flow rate • Release direction according to the tip direction	2.0 kW/m2 **
	Flare - continuous operation (ignited)	• Maximum continuous flow rate • Release direction according to the tip direction	1.6 kW/m2 **
Overpressure	Vapour cloud explosion (VCE) in unit	Unit volume full of flammable gas at stoichiometric concentration	50 mbar
Toxicity	Un-ignited toxic gas/spray cloud dispersion from gas/ two-phase or liquid release	• Leak diameter vs. pipe diameter: 0.20 pipe diameter limited to a minimum leak size of 20 mm and a maximum leak size of 150 mm • Average release rate or release rate vs. time • Release height 1 m • Horizontal jet and	Toxic gas IDLH

**. Including solar radiation

4.2.1 FIRE ZONE

In order to limit the consequences of the hazardous scenarios, Client installations shall be partitioned into Fire Zones. Separate fire zones are created in order to segregate hazards and limit the probability of escalation. Simultaneous independent hazardous scenarios in two separate fire zones shall not be considered (single jeopardy concept).

Fire zones should be as small as possible to increase safety; however, the number of fire zones should be reduced in order to minimize the installation complexity. The partition into fire zones shall result from the optimum combination of these conflicting requirements, compounded with asset protection constraints.

To protect a fire zone by avoiding that the hazardous inventory of the external system connected to the mentioned fire zone feeds an accident within the fire zone between two fire zones ESDV shall be installed.

The ESDV shall be designed, located or protected so that a credible event within the fire zone it protects cannot create a failure of the ESDV itself or of its outboard connected piping.

Credible events within a fire zone shall not expose their associated ESDVs to levels greater than:

- A radiation of 15.9 kW/m2 (5000 BTU/hr/ft2), solar radiation included
- An overpressure of 300 mbar.

Therefore, ESDV shall not be exposed to a radiation level of more than 15.9 kW/m2 (5000 BTU/hr/Sqft), solar radiation included, and/or an over-pressure of more than 0.3 bar in case of explosion in the fire zone it protects. If, due to any reason, an ESDV is located within radiation or explosion zone, proper fire and explosion proofing shall be considered.

4.2.1.1 FIRE ZONE CRIDIBLE SCENARIOS AND CONSEQUENCES

Below scenarios, main input data (based on retained credible events) and criteria are applicable to establish the fire zone safety distances based on TOTAL GS 253.

Pool fire will not be occurred due to not availability of dike or bund walls. Other pool fire scenarios in this plant will be just from lubricating oil or diesel which the affected zones will be covered by other scenarios due to low volume of them.

Only Process units with Pipe racks that are surrounded by equipment (Vessels, compressors, pumps …) have been considered as congested Zone.

4.2.1.2 FIRE ZONES DESCRIPTION

Each Fire Zone composed of one or more units. In a process unit, “Isolated Process Segments” and “congested areas” are prone to threat other facilities by leading to fire, explosion or toxic Gas Dispersion.

Based on location of ESDVs and SDVs, each fire zone (or Unit), has been divided to number of isolated process segments. Each segment has its own gas and liquid inventory during a release. After this classification, any part of these segments that may cause different scenario outcomes, based on different process conditions, will be considered as an independent source of release.

Fire zones of this site will be as following:

- Process area *
- Flare

* Due to this fact that equipment is located close together and plant is not a big plant, whole process facilities is considered as one fire zone (study assumption), but is divided to number of isolated process segments (IPS) as following:

Table 4 - List of isolated process segments (IPS)

IPS No.	Concern Equipment	Process data						Maximum Line Pipe bore (in)	IPS isolating XVs/ESDVs	Density Kg/m^3	Inventory (kg)
		vessel dimension ID X TT (m)	Stream Number	Pressure (barg)	Temperature (C)	Phase	Flow rate (kg/h) Note 1				
IPS-01 Note 3	V-2104	3.60 X 10.50	2	5.5	48	Vapor	11661.57	8	ESDV-2102, ESDV-2112 & ESDV-2111	5.87	1097.03
IPS-02	P-2101A/B	-	(Slug)	28.5	47.97	Liquid	7898	10	ESDV-2112 & ESDV-1215	857	Not specified
IPS-03	V-2105	1.1 X 3.2	3	5.3	47.89	Vapor	17921.01	10	ESDV-2111, ESDV-2113 & ESDV-2114	5.92	31.47
IPS-04 Note 2 & 3	V-2101A	0.9 X 2.55	11	54.10	145.81	Vapor	8925.5	8	XV-2121A & XV-2132A	59.21	622.41
	C-2101A	--									
	AE-2101A	--									
	V-2102A	0.9 X 2.55									
	C-2102A	--									
	AE-2102A	--									
IPS-05	V-2101B	0.9 X 2.55	11	54.10	145.81	Vapor	8925.5	8		59.21	622.41

IPS No.	Concern Equipment	Process data						Maximum Line Pipe bore (in)	IPS isolating XVs/ESDVs	Density Kg/m^3	Inventory (kg)
		vessel dimension ID X TT (m)	Stream Number	Pressure (barg)	Temperature (C)	Phase	Flow rate (kg/h) Note 1				
Not 2 & 3	C-2101B	--							XV-2121B & XV-2132B		
	AE-2101B	--									
	V-2102B	0.9 X 2.55									
	C-2102B	--									
	AE-2102B	--									
IPS-06 Note 2 & 3	V-2101C	0.9 X 2.55	11	54.10	145.81	Vapor	8925.5	8	XV-2121C & XV-2132C	59.21	622.41
	C-2101C	--									
	AE-2101AC	--									
	V-2102C	0.9 X 2.55									
	C-2102C	--									
	AE-2102C	--									
IPS-07	V-2103	0.9 X 2.55	13	54.1	60.1	Vapor	17678.37	6	XV-2132A/B/C & ESDV-2141	59.21	169.1
IPS-08	PK-2101	Not specified	14	53.1	63.5	Vapor	17597.9	6	ESDV-2141& B.L. valve	56.89	Not specified
IPS-09	V-2202	2.5 X 7.5	H/C	--	--	Liquid	--	6	Isolated by sump	--	--
IPS-10 Note 2 & 6	PK-V-2208	1.1 X 3.2	Methanol	8	33	Liquid	--	2	Boundary isolating valve, XV-2131A/B/C,	778.6	6341.7

IPS No.	Concern Equipment	Process data						Maximum Line Pipe bore (in)	IPS isolating XVs/ESDVs	Density Kg/m^3	Inventory (kg)
		vessel dimension ID X TT (m)	Stream Number	Pressure (barg)	Temperature (C)	Phase	Flow rate (kg/h) Note 1				
									XV-2132A/B/C, XV-2142		
IPS-11 Note 6	V-2205	0.4 X 2.4	4	5.1	47.8	Vapor	--	2	ESDV-2251, XV-2252 & Boundary isolating valves	5.73	3.18
IPS-12	TK-2102	4.0 X 5.0	LEAN GLYCOL	0.5	47.97	Liquid	--	3	By dike wall	--	--

Note 1: ESDV closing time is assumed 1 s/in.

Note 2: Process condition such as Pressure & Temperature of gas streams are the maximum condition in the specified IPS.

Note 3: For gas compressor and air coolers 1 m3 inventory is considered. Due to not probability of calculating the volume of gas inside these pipes, 20% extra volume is considered for inventory calculation.

Note 4: Pig Launcher is not considered as credible scenarios for Fire Zone study due to limited time of service during plant operation.

Note 5: Vessel dimensions are approximately and conservatively considered same as V-2105.

Note 6: Due to not probability of calculating the volume of vapor inside these pipes, 50% extra volume is considered for inventory calculation.

- **List of congested area**

Process area consisting Pipe rack and adjacent equipment within Fire Zone is congested.

Average height of compressor shelter and pipe racks heights have been considered 6m. For Pipe racks with more than 6m height, it is assumed that cloud height maximum height is 6m.

Below air cooler, congested height is considered 4m.

This plant is divided to 6 independent congested Zones which have been listed in table 5 and is shown in Figure 4.

Table 5- List of congested area

No.	Description	Pipe rack congested volume m^3	Shelter/equipment congested volume m^3	Total Congested Zone m^3
Congested Zone 1	Compressor shelter C-210A/B/C	--	72 X 12 X 6	5184
Congested Zone 2	AE-210C	--	8.5 X 6 X 4	204
Congested Zone 3	AE-210B	--	8.5 X 6 X 4	204
Congested Zone 4	AE-210A	--	8.5 X 6 X 4	204
Congested Zone 5	Pipe Rack	168 X 8 X 6	--	8064
Congested Zone 6	CR-103	--	10 X 5 X 6	300

Total congested are is 14160 M3

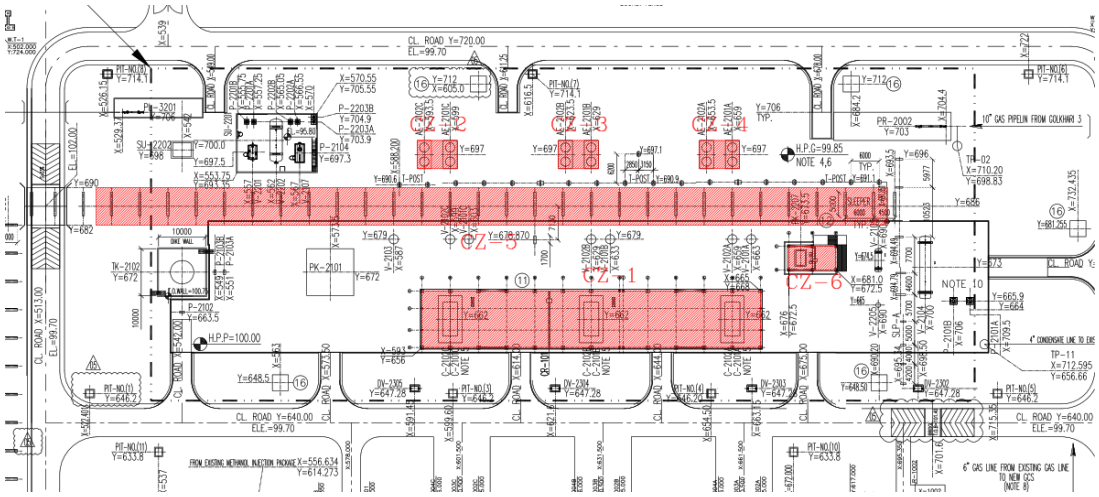

Figure 4 - Congested areas within plant

4.2.1.3 FIRE ZONE STUDY RESULTS

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (9.5 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (200 mbar)
SC1-L-HI IPS-01 V-2104 Leak Horizontal Impingment	2/F	2	2	-	-
	5/D	3	2	-	-
	15/D	4.5	-	-	-
	28/D	6	-	-	-
SC1-L-H IPS-01 V-2104 Leak Horizontal	2/F	4	7	-	-
	5/D	3.5	7	-	-
	15/D	2.5	-	-	-
	28/D	2	-	-	-
SC2A-L-HI IPS-02A P-2101A/B Leak Horizontal Impingment	2/F	11	7.5	-	-
	5/D	14.5	11	-	-
	15/D	5.5	11	-	-
	28/D	4	11	-	-
SC2A-L-H IPS-02A P-2101A/B Leak Horizontal **SC2A-VCE** Congested volume= 2316/2 m3 R0= 8.2 m	2/F	12.5	22.5	-	-
	5/D	10.5	20.5	-	-
	15/D	5.5	20	One fourth of CZ-5 & CZ-6	31.3
	28/D	4.5	20	-	-
SC3-L-HI IPS-03 V-2105 Leak Horizontal Impingment	2/F	6	2	-	-
	5/D	4.5	2.5	-	-
	15/D	3	-	-	-
	28/D	2	-	-	-
SC3-L-I	2/F	4	7	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (9.5 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (200 mbar)
IPS-03 V-2105 Leak Horizontal	5/D	3.5	7	-	-
	15/D	3	-	-	-
	28/D	2	-	-	-
SC4-L-HI IPS-04 V-2101A, C-2101A, AE-2101A, V-2102A, C-2102A, AE-2102A, Leak Horizontal Impingment **SC4-VCE** Congested volume= 7704/2 m3 R0=12.3 m	2/F	20	8	CZ-1, CZ-4, one fourth of CZ-5 & CZ-6	42
	5/D	16	8.5	-	-
	15/D	8	7.5	-	-
	28/D	5	7.5	-	-
SC4-L-H IPS-04 V-2101A, C-2101A, AE-2101A, V-2102A, C-2102A, AE-2102A, Leak Horizontal	2/F	10	21	-	-
	5/D	9	21.5	-	-
	15/D	6.5	20	-	-
	28/D	5	20	-	-
SC5-L-HI IPS-05 V-2101B, C-2101B, AE-2101B, V-2102B, C-2102B, AE-2102B, Leak Horizontal Impingment **SC5-VCE** Congested volume= 7404/2 m3 R0=12.1 m	2/F	20	8	CZ-1, CZ-4 & one fourth of CZ-5	41.5
	5/D	16	8.5	-	-
	15/D	8	7.5	-	-
	28/D	5	7.5	-	-
SC5-L-H IPS-05 V-2101B, C-2101B, AE-2101B, V-2102B, C-2102B, AE-2102B	2/F	10	21	-	-
	5/D	9	21.5	-	-
	15/D	6.5	20	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (9.5 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (200 mbar)
Leak Horizontal	28/D	5	20	-	-
SC6-L-HI IPS-06 V-2101C, C-2101C, AE-2101C, V-2102C, C-2102C, AE-2102C, Leak Horizontal Impingment **SC6-VCE** Congested volume= 7404/2 m3 R0=12.1 m	2/F	20	8	CZ-2, CZ-4 & one fourth of CZ-5	41.5
	5/D	16	8.5	-	-
	15/D	8	7.5	-	-
	28/D	5	7.5	-	-
SC6-L-H IPS-06 V-2101C, C-2101C, AE-2101C, V-2102C, C-2102C, AE-2102C, Leak Horizontal	2/F	10	21	-	-
	5/D	9	21.5	-	-
	15/D	6.5	20	-	-
	28/D	5	20	-	-
SC7-L-HI IPS-07 V-2103 Leak Horizontal Impingment **SC7-VCE** Congested volume= 8076/2 R0= 12.4	2/F	31	9.5	CZ-1, one third of CZ-5 & CZ-2	43
	5/D	23	10	-	-
	15/D	10	10	-	-
	28/D	6	10	-	-
SC7-L-H IPS-07 V-2103 Leak Horizontal	2/F	12	24	-	-
	5/D	11	24.5	-	-
	15/D	7.5	24.5	-	-
	28/D	6	25	-	

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (9.5 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (200 mbar)
SC8-L-HI IPS-08 Pk-2101 Leak Horizontal Impingment **SC8-VCE** Congested volume= 5280/2 m3 R0= 10.8	2/F	30	9.5	Half of CZ-1 & one third of CZ-5	37.2
	5/D	22	10	-	-
	15/D	10	10	-	-
	28/D	6	10	-	-
SC8-L-H IPS-08 PK-2101 Leak Horizontal	2/F	12	23.5	-	-
	5/D	10.5	24	-	-
	15/D	7.5	24	-	-
	28/D	5.5	24.5	-	-
SC9-P IPS-09 V-2202 Pool fir in sump Sump area= 13.6 X 5.6 m2 R0= 4.9 m	2/F	-	9	-	-
	5/D	-	11.5	-	-
	15/D	-	12.5	-	-
	28/D	-	12.5	-	-
SC10-L-HI IPS-10 Pk-2208 Leak Horizontal Impingment **SC10-VCE** Congested volume= 5280/2 m3 R0=10.8	2/F	7.5	13.5		-
	5/D	-	15.5	Half of CZ-1 & one third of CZ-5	37.5
	15/D	-	24		-
	28/D	10	24		-
SC10-L-H IPS-10 PK-2208 Leak Horizontal	2/F	8	13.5		-
	5/D	-	15.5		-
	15/D	-	24	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (9.5 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (200 mbar)
	28/D	10	24	-	-
SC11-L-HI IPS-11 V-2205 Leak Horizontal Impingment	2/F	6	2	-	-
	5/D	4.5	2	-	-
	15/D	3	-	-	-
	28/D	2	-	-	-
SC11-L-H IPS-11 V-2205 Leak Horizontal	2/F	3.5	7	-	-
	5/D	3.5	7	-	-
	15/D	2.5	-	-	-
	28/D	2	-	-	-
SC12-P IPS-12 TK-2102 Pool fir in dike Dike area= 10 X 10 m2 R0= 5.6 m	2/F	-	-	12.5	-
	5/D	-	-	16.5	-
	15/D	-	-	18.5	-
	28/D	-	-	18.5	-

4.2.1.4 ESDV FIRE ZONE RESULTS

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (15.9 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (300 mbar)
SC1-L-HI IPS-01 V-2104 Leak Horizontal Impingment	2/F	2	-	-	-
	5/D	3	-	-	-
	15/D	4.5	-	-	-
	28/D	6	-	-	-
SC1-L-H IPS-01 V-2104 Leak Horizontal	2/F	4	-	-	-
	5/D	3.5	-	-	-
	15/D	2.5	-	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (15.9 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (300 mbar)
	28/D	2	-	-	-
SC2A-L-HI IPS-02A P-2101A/B Leak Horizontal Impingment	2/F	11	6.5	-	-
	5/D	14.5	9.5	-	-
	15/D	5.5	9	-	-
	28/D	4	9	-	-
SC2A-L-H IPS-02A P-2101A/B Leak Horizontal **SC2A-VCE** Congested volume= 2316/2 m3 R0= 8.2 m	2/F	10.5	20	-	-
	5/D	12.5	17.5	-	-
	15/D	5.5	17	One fourth of CZ-5 & CZ-6	22
	28/D	4.5	17	-	-
SC3-L-HI IPS-03 V-2105 Leak Horizontal Impingment	2/F	6	-	-	-
	5/D	4.5	-	-	-
	15/D	3	-	-	-
	28/D	2	-	-	-
SC3-L-I IPS-03 V-2105 Leak Horizontal	2/F	4	-	-	-
	5/D	3.5	-	-	-
	15/D	3	-	-	-
	28/D	2	-	-	-
SC4-L-HI IPS-04 V-2101A, C-2101A, AE-2101A, V-2102A, C-2102A, AE-2102A, Leak Horizontal Impingment	2/F	20	7	CZ-1, CZ-4, one fourth of CZ-5 & CZ-6	21.5
SC4-VCE Congested volume=	5/D	16	7	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (15.9 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (300 mbar)
7704/2 m3 R0=12.3 m	15/D	8	7	-	-
	28/D	5	5.5	-	-
SC4-L-H IPS-04 V-2101A, C-2101A, AE-2101A, V-2102A, C-2102A, AE-2102A, Leak Horizontal	2/F	10	19.5	-	-
	5/D	9	19.5	-	-
	15/D	6.5	19	-	-
	28/D	5	19	-	-
SC5-L-HI IPS-05 V-2101B, C-2101B, AE-2101B, V-2102B, C-2102B, AE-2102B, Leak Horizontal Impingment	2/F	20	7	CZ-1, CZ-4 & one fourth of CZ-5	22
SC5-VCE Congested volume= 7404/2 m3 R0=12.1 m	5/D	16	7	-	-
	15/D	8	7	-	-
	28/D	5	5.5	-	-
SC5-L-H IPS-05 V-2101B, C-2101B, AE-2101B, V-2102B, C-2102B, AE-2102B Leak Horizontal	2/F	10	19.5	-	-
	5/D	9	19.5	-	-
	15/D	6.5	19	-	-
	28/D	5	19	-	-
SC6-L-HI IPS-06 V-2101C, C-2101C, AE-2101C, V-2102C, C-2102C, AE-2102C, Leak Horizontal Impingment	2/F	20	7	CZ-1, CZ-4 & one fourth of CZ-5	22
SC6-VCE Congested volume= 7404/2 m3 R0=12.1 m	5/D	16	7	-	-
	15/D	8	7	-	-
	28/D	5	5.5	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (15.9 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (300 mbar)
SC6-L-H IPS-06 V-2101C, C-2101C, AE-2101C, V-2102C, C-2102C, AE-2102C, Leak Horizontal	2/F	10	19.5	-	-
	5/D	9	19.5	-	-
	15/D	6.5	19	-	-
	28/D	5	19	-	-
SC7-L-HI IPS-07 V-2103 Leak Horizontal Impingment **SC7-VCE** Congested volume= 8076/2 R0= 12.4	2/F	31	8	CZ-1, one third of CZ-5 & CZ-2	22.5
	5/D	23	8.5	-	-
	15/D	10	9	-	-
	28/D	6	9.5	-	-
SC7-L-H IPS-07 V-2103 Leak Horizontal	2/F	12	22	-	-
	5/D	11	22.5	-	-
	15/D	7.5	23	-	-
	28/D	6	24	-	
SC8-L-HI IPS-08 Pk-2101 Leak Horizontal Impingment **SC8-VCE** Congested volume= 5280/2 m3 R0= 10.8	2/F	30	8	Half of CZ-1 & one third of CZ-5	19.7
	5/D	22	8.5	-	-
	15/D	10	9	-	-
	28/D	6	9	-	-
SC8-L-H IPS-08 PK-2101	2/F	12	21.5	-	-
	5/D	10.5	22	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (15.9 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (300 mbar)
Leak Horizontal	15/D	7.5	23	-	-
	28/D	5.5	24	-	-
SC9-P IPS-09 V-2202 Pool fir in sump Sump area= 13.6 X 5.6 m2 R0= 4.9 m	2/F	-	6.6	-	-
	5/D	-	9.6	-	-
	15/D	-	11.1	-	-
	28/D	-	11.1	-	-
SC10-L-HI IPS-10 Pk-2208 Leak Horizontal Impingment **SC10-VCE** Congested volume= 5280/2 m3 R0=10.8	2/F	6	8		-
	5/D	6	14	Half of CZ-1 & one third of CZ-5	19.7
	15/D	3.5	21		-
	28/D	2	21		-
SC10-L-H IPS-10 PK-2208 Leak Horizontal Note 1	2/F	18	57		-
	5/D	18	44.5		-
	15/D	13.5	42	-	-
	28/D	11	41	-	-
SC11-L-HI IPS-11 V-2205 Leak Horizontal Impingment	2/F	6	-	-	-
	5/D	4.5	-	-	-
	15/D	3	-	-	-
	28/D	2	-	-	-
SC11-L-H IPS-11 V-2205 Leak Horizontal	2/F	3.5	-	-	-
	5/D	3.5	-	-	-
	15/D	2.5	-	-	-
	28/D	2	-	-	-

Scenario	Weather Condition	Cloud Dispersion distance downwind(m) (LFL); 20 mm hole size	Jet Fire / Pool Fire Radius (m) (15.9 kW/m2)	Congested Volume (m3)	Vapor Cloud Explosion (300 mbar)
SC12-P IPS-12 TK-2102 Pool fir in dike Dike area= 10 X 10 m2 R0= 5.6 m	2/F	-	9	-	-
	5/D	-	13	-	-
	15/D	-	16	-	-
	28/D	-	16.5	-	-

Note 1: Due to existing roadway and process equipment, jet fir for horizontal is not credible. Therefore, for ESD fire zone layout horizontal impingement is considered.

4.2.2 RESTRICTED & IMPACTED AREA

The Restricted Area is the area within the boundaries of the installation and hence under the control of Client. The restricted area is affected:

- Permanently by normal operation of the facility
- Exceptionally by the consequences of an emergency situation caused by a major failure.

Within the restricted area, Client shall have control of all possible sources of ignition, including vehicles.

The Impacted Area is the area that extends beyond the boundaries of the installation but which is nevertheless affected either permanently by normal operation of the facility (e.g., noise or radiation) or exceptionally by the consequences of an emergency situation caused by a major failure.

4.2.2.1 RESTRICTED & IMPACTED AREA CREDIBLE SCENARIOS AND CONSEQUENCES RESTRICTED AREA CRITERIA

The restricted area is the area within the boundaries of the installation and hence under the control of the Client

BLEVE and boil over will not be occurred due to not availability of open top tanks or liquefied gas.

There is any fixed roof tank inside plant, so overpressure made by this system will not be studied.

Flare will be studied as separate fire zone.

Also, there is not any LPG tank inside this plant.

4.2.2.2 IMPACTED AREA CRITERIA

The Impacted Area is the area that extends beyond the boundaries of the installation but which is nevertheless affected either permanently by normal operation of the facility (e.g. noise or radiation) or exceptionally by the consequences of an emergency situation caused by a major failure.

BLEVE and boil over will not be occurred due to not availability of open top tanks or liquefied gas.

There is fixed roof tank inside plant and overpressure made by this system will not be studied.

Also, there is not any LPG tank inside this plant.

4.2.2.3 RESTRICTED AND IMPACTED AREA RESULTS FOR FLAMMABILITY AND THERMAL RADIATION

Scenario	Leak Size (mm)	Weather Condition	Cloud Dispersion distance downwind (m) (LFL)		Jet / Pool Fire Radius (m) (4.7 kW/m2)	Jet / Pool Fire Radius (m) (3.2 kW/m2)	RA Max. Distance	IA Max. Distance
			Horizontal Jet	Horizontal Impingmen jet				
SC1-L-HI/H IPS-01 V-2104 Leak	41	2/F	7.5	15	8	9	15	9
		5/D	7	10	7.5	8.5		8.5
		15/D	5	5.5	7	8		
		28/D	4	4	7	7.5		
SC2A-L-HI/H IPS-02A P-2101A/B Leak	5.5	2/F	12	11	26.5	29.5	26.6	
		5/D	10.5	14.5	26.5	31		
		15/D	5.5	5.5	25.5	30.5		
		28/D	4.5	4	25.5	30.5		30.5
SC3-L-HI/H IPS-03 V-2105 Leak	51	2/F	10	21	23	24.5		
		5/D	9	16	24	26.5	24	26.5
		15/D	6	7	23	24.5		

Scenario	Leak Size (mm)	Weather Condition	Cloud Dispersion distance downwind (m) (LFL)		Jet / Pool Fire Radius (m) (4.7 kW/m2)	Jet / Pool Fire Radius (m) (3.2 kW/m2)	RA Max. Distance	IA Max. Distance
			Horizontal Jet	Horizontal Impingmen jet				
		28/D	5	5	22	23		
SC4-L-HI/H IPS-04 V-2101A, C-2101A, AE-2101A, V-2102A, C-2102A, AE-2102A, Leak	41	2/F	27	44	51	55.5		
		5/D	24.5	54	53	60	54	60
		15/D	19.5	32	51	55.5		
		28/D	14.5	19	47	49.5		
SC5-L-HI/H IPS-05 V-2101B, C-2101B, AE-2101B, V-2102B, C-2102B,	41	2/F	27	44	51	55.5		
		5/D	24.5	54	53	60	54	60
		15/D	19.5	32	51	55.5		
		28/D	14.5	19	47	49.5		
SC6-L-HI/H IPS-06 V-2101C, C-2101C, AE-2101C, V-2102C, C-2102C,	41	2/F	27	44	51	55.5		
		5/D	24.5	54	53	60	54	60
		15/D	19.5	32	51	55.5		
		28/D	14.5	19	47	49.5		
SC7-L-HI/H IPS-07 V-2103 Leak	30.5	2/F	22.5	46	42.5	46		
		5/D	20	48	44.5	50	48	50
		15/D	14.5	23	42.5	46		
		28/D	10.5	13	39.5	41		

Scenario	Leak Size (mm)	Weather Condition	Cloud Dispersion distance downwind (m) (LFL)		Jet / Pool Fire Radius (m) (4.7 kW/m2)	Jet / Pool Fire Radius (m) (3.2 kW/m2)	RA Max. Distance	IA Max. Distance
			Horizontal Jet	Horizontal Impingmen jet				
SC8-L-HI/H IPS-08 Pk-2101 Leak	30.5	2/F	33.5	21	41.5	45.5		
		5/D	42	19.5	44	49	44	49
		15/D	22	14	42	45.5		
		28/D	12.5	10	39	4.5		
SC9-P IPS-09 V-2202 Pool fire in sump Sump area= 13.6 X 5.6 m2 R0= 4.9 m	30.5	2/F	-	-	19.5	9		
		5/D	-	-	23	12.5		
		15/D	-	-	23	13	23	13
		28/D	-	-	22	13		
SC10-L-HI/H IPS-10 Pk-2208 Leak	20	2/F	9	12	57	62		
		5/D	21	11.5	60	68.5	60	68.5
		15/D	17.5	17	57	68.5		
		28/D	10	10	60	64.5		
SC11-L-HI/H IPS-11 V-2205 Leak	20	2/F	4	8	8	8.5		
		5/D	3.5	4.5	8	9	8	9
		15/D	2.5	3	6.5	7.5		
		28/D	2	2	7	7.5		
SC12-P IPS-12 TK-2102 Pool fire in dike Dike		2/F	-	-	15.5	19		
		5/D	-	-	19	24.5	19	24.5
		15/D	-	-	19	23		

Scenario	Leak Size (mm)	Weather Condition	Cloud Dispersion distance downwind (m) (LFL)		Jet / Pool Fire Radius (m) (4.7 kW/m2)	Jet / Pool Fire Radius (m) (3.2 kW/m2)	RA Max. Distance	IA Max. Distance
			Horizontal Jet	Horizontal Impingmen jet				
area= 10 X 10 m2 R0= 5.6 m		28/D	-	-	18.5	22		

4.2.2.4 CONGESTED AREAS SPECIFICATIONS AND OVERPRESSURE RESULTS FOR RESTRICTED AND IMPACTED

Congested Area	Volume	R0	Congested Level	Strength Factor	Distance to 140 mbar (RA)	Distance to 50 mbar (IA)
CZ-1	5184	-	Low	5.6	-	-
CZ-2	204	-	Low	5.6	-	-
CZ-3	204	-	Low	5.6	-	-
CZ-4	204	-	Low	5.6	-	-
CZ-5	8064	-	Low	5.6	-	-
CZ-6	300	-	Low	5.6	-	-
Total congesed volume	11472	17.6	Low	5.6	100.5	283

Note 1: Due to the long pipe rack, two thirds of the pipe rack will be filled by flammable gas clous. Therefore, two thirds of the CZ-5 has been considered in total conjected volume.

Note 2: 2152 kg Flammable mass in cloud is calculated based on IPS-04 initial inventory (662 kg) plus discharge rate 2.55 kg/s multipy by 600 s esdv closure duration

4.2.2.1 RESTRICTED AND IMPACTED AREA RESULTS FOR TOXICITY

Scenario	Leak Size (mm)	Weather Condition	Toxic Gas Cloud Dispersion distance downwind (m) (LC1%)		Toxic Gas Cloud Dispersion distance downwind (m) (IDLH)		RA Max. Distance	IA Max. Distance
			Horizontal Jet	Horizontal Impingmen jet	Horizontal Jet	Horizontal Impingmen jet		
SC1-L-HI/H IPS-01 V-2104 Leak	41	2/F	85	109.5	286.5	248	109.5	286.5
		5/D	53.5	54.5	137	96		
		15/D	22.5	19	52.5	38.5		

Scenario	Leak Size (mm)	Weather Condition	Toxic Gas Cloud Dispersion distance downwind (m) (LC1%)		Toxic Gas Cloud Dispersion distance downwind (m) (IDLH)		RA Max. Distance	IA Max. Distance
			Horizontal Jet	Horizontal Impingmen jet	Horizontal Jet	Horizontal Impingmen jet		
		28/D	13	10	29.5	25		
SC3-L-HI/H IPS-03 V-2105 Leak	51	2/F	45	47.5	82.5	67		
		5/D	55	56	96.5	77	56	96.5
		15/D	25.5	22.5	62	44		
		28/D	15	12	35	28		
SC4-L-HI/H IPS-04 V-2101A, C-2101A, AE-2101A, V-2102A, C-2102A, AE-2102A, Leak	41	2/F	158	102.5	250	238	158	
		5/D	120	143.5	322	188		322
		15/D	90	71	166	126.5		
		28/D	56.5	41	102	81		
SC5-L-HI/H IPS-05 V-2101B, C-2101B, AE-2101B, V-2102B, C-2102B, AE-2102B, Leak	41	2/F	158	102.5	250	238	158	
		5/D	120	143.5	322	188		322
		15/D	90	71	166	126.5		
		28/D	56.5	41	102	81		
SC6-L-HI/H IPS-06 V-2101C, C-2101C, AE-2101C, V-2102C, C-2102C, AE-2102C, Leak	41	2/F	158	102.5	250	238	158	
		5/D	120	143.5	322	188		322
		15/D	90	71	166	126.5		
		28/D	56.5	41	102	81		
SC7-L-HI/H IPS-07 V-2103 Leak	30.5	2/F	90	83	148.5	111.5		
		5/D	113.5	98	169	129.5	98	169
		15/D	71	54.5	130.5	97.5		

Scenario	Leak Size (mm)	Weather Condition	Toxic Gas Cloud Dispersion distance downwind (m) (LC1%)		Toxic Gas Cloud Dispersion distance downwind (m) (IDLH)		RA Max. Distance	IA Max. Distance
			Horizontal Jet	Horizontal Impingmen jet	Horizontal Jet	Horizontal Impingmen jet		
		28/D	41.5	29.5	76.5	62		
SC8-L-HI/H IPS-08 Pk-2101 Leak	30.5	2/F	59.5	54	85.5	70		
		5/D	73	60	94	71.5	73	
		15/D	68	53.5	112.5	86.5		112.5
		28/D	41	29	74.5	61		
SC11-L-HI/H IPS-11 V-2205 Leak	20	2/F	13	17.5	35.5	30.5	17.5	
		5/D	9	12.5	41	32.5		41
		15/D	5.5	5	16.5	11.5		
		28/D	4	4	9	8		

5.0 CONCLUSION

5.1 FIRE ZONE

As mentioned in previous section, new Gas Compressor Station is considered as one fire zone.

Calculation results indicate that max distance for fire zone is 43 m which is related to VCE scenario SC7-VCE. So, fire zone extent for new Gas Compressor Station shall be considered 43 m minimum safety distance. Based on calculated data, governing fire zone studied cases are for VCE over pressure. Based on the result, fire zone affected by some IPSs are shown in Figure 5 as well as Appendix A.

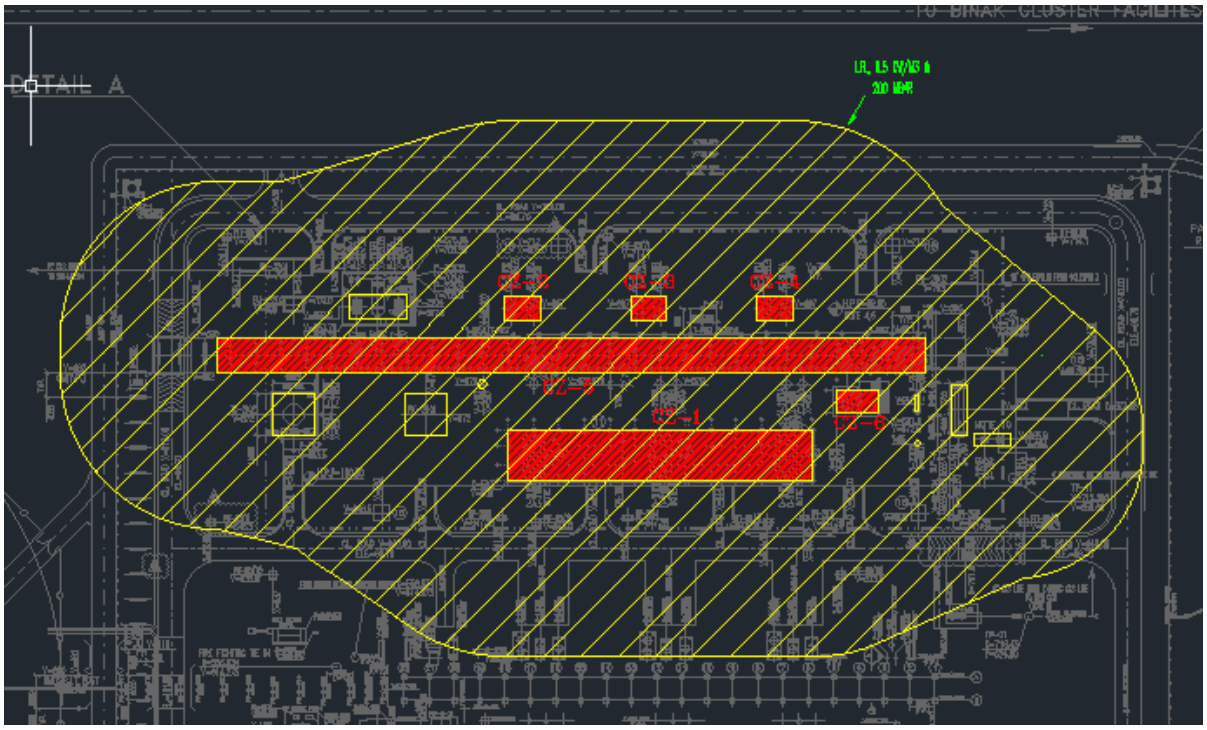

Figure 5- Fire Zone Layout

5.2 EMERGENCY SHUTDOWN VALVES (ESDV)

All ESDVs should be protected against radiation higher than 15.9 kW/m2 and overpressure higher than 300 mbar. According to obtained results, the mentioned overpressure level will extend up to 22.5 m. Also jet fire radiation results in a 24 m extent.

Based on the result, ESDVs affected by some IPSs are shown in Figure 6 as well as Appendix A.

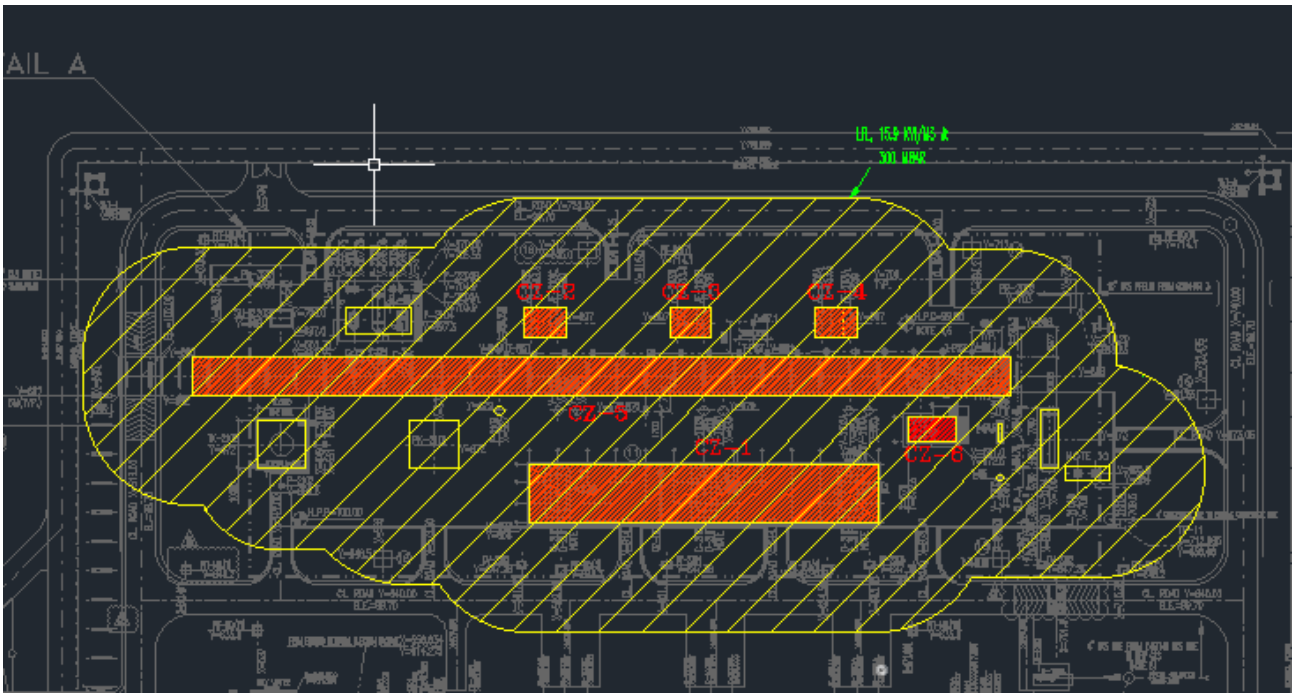

Figure 6- Fire Zone Layout for ESDVs

5.3 RESTRICTED AREA

Results indicate that restricted area extent is 158 m which is related to toxic gas clouds LC1% explosion scenario.

The restricted area contours and graphs is provided in Figure 7 as well as Appendix A. Other scenarios including VCE, LFL dispersion and jet fire radiation lead to 100.5 m, 60 m and 48 m radius respectively.

Regarding existing distance of fence from new GCS (30 m from North and 18 m from West), beyond the fence and road ways will be exposed to Toxicity, fire and explosion scenarios.

According to the LC1% restricted area and other scenarios, fire and explosion impacts can extend beyond the fence. Therefore, no residential area should be constructed in these regions.

It is notable that emergency planning within plant shall be performed by CLIENT in case of occurrence of a major accident containing Fire, Explosion or Gas Dispersion.

In addition, it’s recommended to consider integrated F&G system including gas detectors nearby fences which can initiates emergency shutdown.

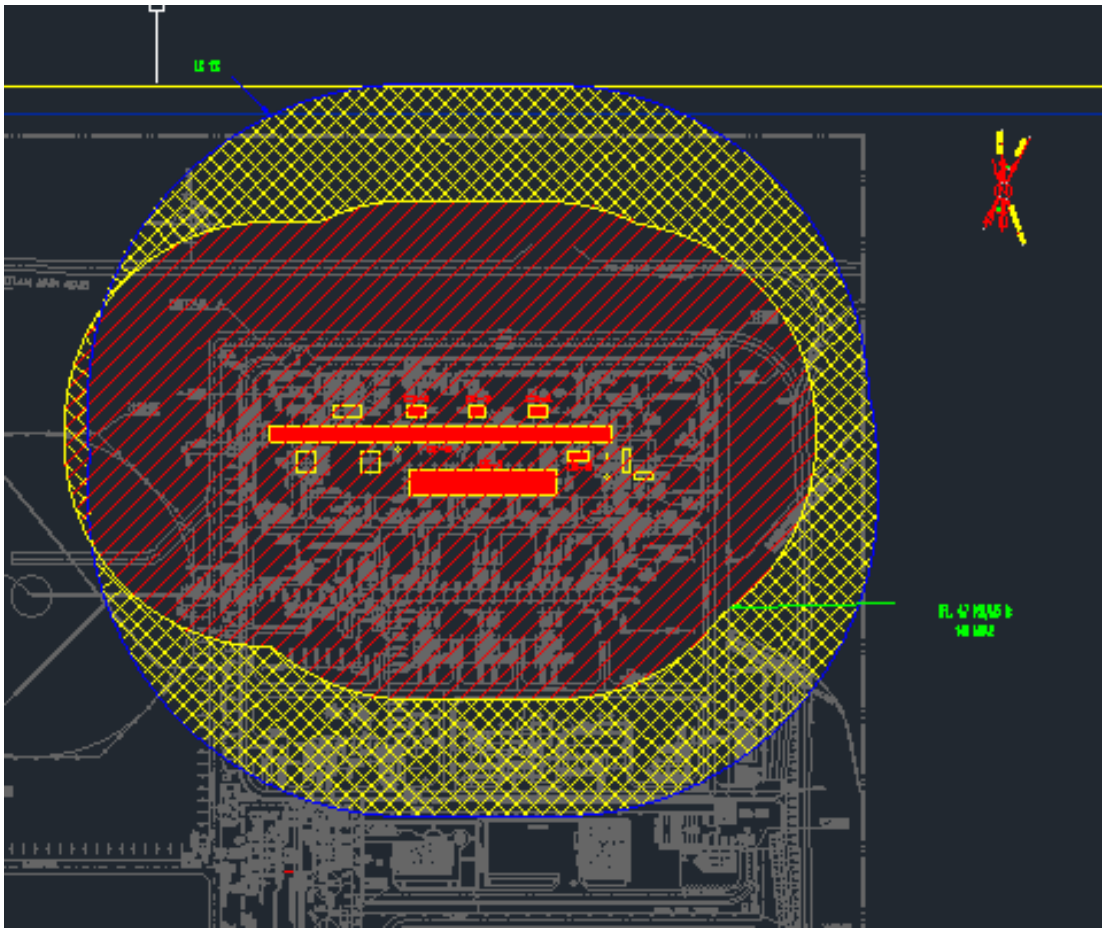

Figure 7 - Restricted affected area

5.4 IMPACTED AREA

Impacted area is defined for public areas in the vicinity of process plants. Impacted area is calculated as 283 m and 322 which corresponds to vapor cloud explosion and IDLH.

The impacted area layout is provided in Figure 8 as well as Appendix A.

Existing fence has a 30 m distance from new GCS in North side, and 19 m from East side respectively. So, some areas beyond GCS fence will be exposed to toxic, fire and explosion impacts.

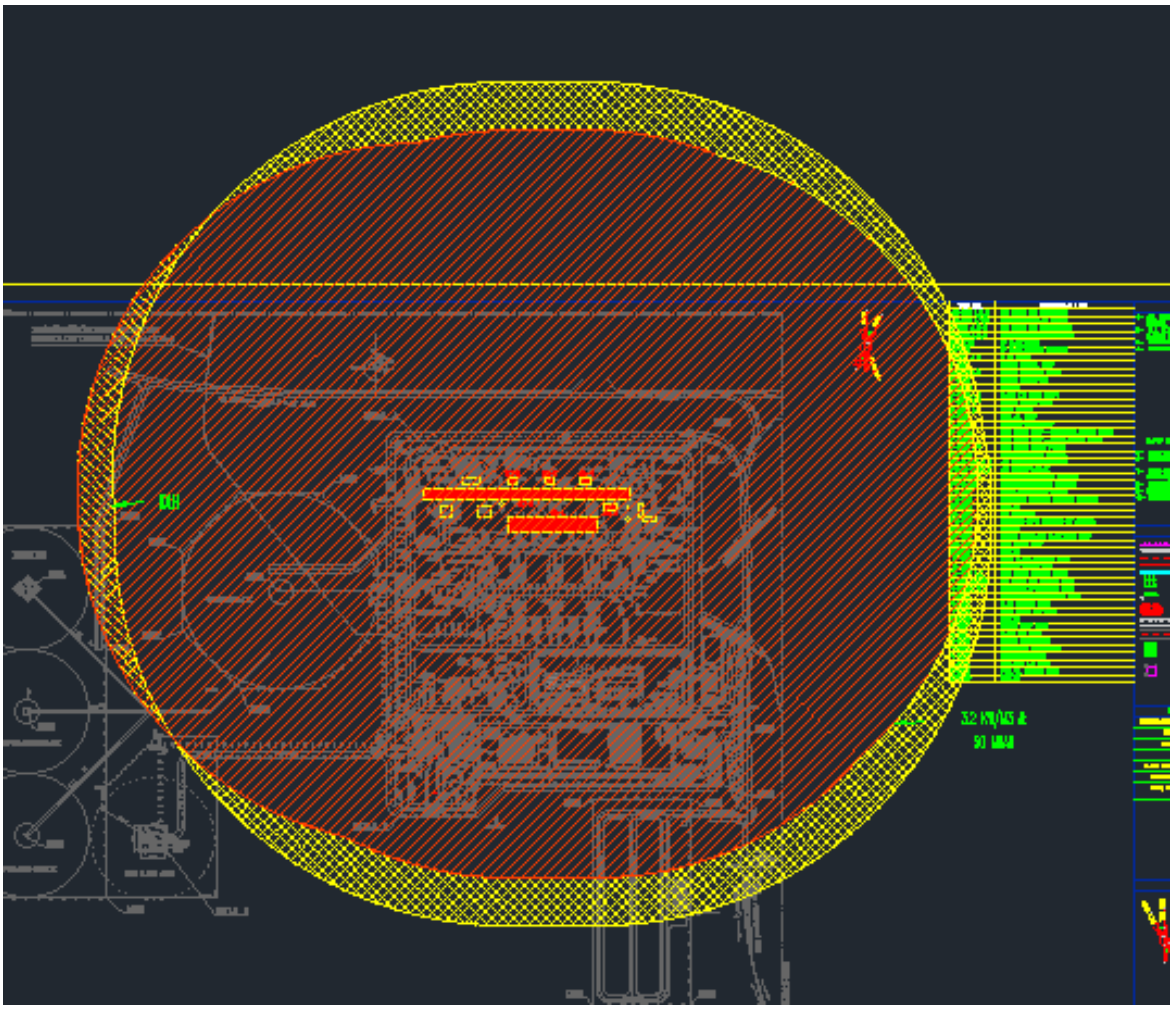

Figure 8- Impacted Area Layout

6.0 APPENDIX A – FIRE ZONE, IMPACTED AND RESTRICTED AREA LAYOUTS

7.0 APPENDIX B – SIMULATION (PHAST) FILES