طرح نگهداشت و افزایش تولید ۲۷ مخزن

HAZID REPORT FOR COMPRESSOR STATION

نگهداشت و افزایش تولید میدان نفتی بینک

D01	OCT. 2022	FI	F. Nourai	M.Fakharian	M.Mehrshad	
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Status:

IDC: Inter-Discipline Check
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
FI: Final Issue

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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 Facilities; 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 scope of HAZID study covers New Gas Compressor Station.

3.1 NORMATIVE REFERENCES

3.2 INTERNATIONAL CODES AND STANDARDS

- ISO 17776 — Petroleum and natural gas industries — Offshore production installations — Major accident hazard management during the design of new installations

3.3 THE PROJECT DOCUMENTS

- BK-GNRAL-HD-000-PR-DB-0001-D05 — Process Basis of Design
- BK-GCS-PEDCO-120-PI-PY-0001 — Unit Plot Plan Drawing

4.0 HAZID STUDY OVERVIEW

Meetings were conducted in two sessions on July 2 & 3, 2022 held in Neyshekar Hotel main meeting hall, Ahvaz.

A team comprising of experts from different disciplines of National Iranian South Oilfields Company (NISOC), Petro Iran Development Company (PEDCO) and Hirgan Energy Company conducted the study with a third-party HAZID Chairman. The list of team members is presented in appendix A.

5.0 ABBREVIATIONS

BTX	Benzene, Toluene, Xylenes
CCTV	Closed Circuit Television
DCS	Distributed Control System
EMC	Electromagnetic Compatibility
ERP	Emergency Response Plan
ESD	Emergency Shut Down
F&G	Fire and Gas
FW	Fire Water
GRP	Glass-Reinforced Plastic
HC	Hydrocarbon
HVAC	Heating, Ventilation and Air Conditioning
IP	Ingress Protection
LDAR	Leak Detection and Repair
LHD	Linear Heat Detector

LV	Low Voltage
MV	Medium Voltage
O&M	Operation and Maintenance
PA/GA	Public Address/General Alarm
PACS	Project Applicable Codes and Standards
PE	Polyethylene
PG	Pressure Gauge
PPE	Personal Protective Equipment
RCP	Residual Current Protection
SCBA	Self-Contained Breathing Apparatus
SIL	Safety Integrity Level
SOP	Standard Operating Procedure
TEG	Triethylene Glycol
TPD	Third-Party Damage
UPS	Uninterruptible Power Supply
VOC	Volatile Organic Carbon

6.1 PROCEDURE

HAZID methodology is in accordance with “HAZID Study Procedure” defined by ISO 17776 checklist.

HAZID study is a tool for hazard identification, used early in a project as soon as process flow diagrams, heat and material balances, and plot layouts are available. Existing site infrastructure, weather, and geotechnical data are also required, these being a source of external hazards. The method is a design-enabling tool, influencing HSE deliverables in the project.

HAZID study is undertaken in order to deliver a good identification of hazard, threat control and recovery measures. This Study helps to ensure that:

- ✓ Major Hazards with potential to affect personnel, environment and assets are revealed and identified at an early stage in the project, before significant costs have been incurred
- ✓ Hazards are recorded so that they can be avoided, mitigated or highlighted during design
- ✓ Design or construction delays and budget over-runs are avoided
- ✓ Fewer hazards remain un-revealed at commissioning and operation of facilities

6.2 STUDY METHODOLOGY

A structured approach to identify hazards will be utilized based on studying the various operational phases of the under-study plant through:

- ✓ Identifying hazards.
- ✓ Describing their failure modes.
- ✓ Suggesting risk reducing measures that can prevent or mitigate each hazard.

The approach to HAZID is using generic guidewords, generic hazard specified for each hazard identified, the causes (threats), consequences and preventative/mitigation measures identified for the event. Recommendations are recorded when the preventative/mitigation measures do not adequately reduce the risk of the hazard.

HAZID formulates a list of hazards and generic hazardous situations by considering the following process characteristics:

- ✓ Impact of the facility to its surroundings
- ✓ Impact of the surroundings to the facility
- ✓ Interference between main units
- ✓ Location / orientation of plant and equipment
- ✓ Location / orientation of plant and equipment
- ✓ Unplanned releases for isolatable sections or units
- ✓ Environmental hazards and natural hazards.

As each hazardous situation is identified, the causes (threats), consequences, and threats control, recovery measures are listed.

For this study, safety analysis will be performed using selected items from the checklist of ISO 17776 standard for hazard categories and guidewords that lead to create a picture of hazardous situations and then to analyze and specify preventative/mitigation measures typical to the facilities under study. The checklist is presented in Appendix B. Brainstorming approach is an integral part of HAZID study, which is to be performed using a team composed of client, contractors, and subcontractors delegates and a HAZID Leader.

6.3 HAZID REPORTING FORMAT

Results of the HAZID study will be presented in a worksheet that tabulates the causes (threats), consequences, safeguards (Threat Control & Recovery Measures) and recommendations for each hazard identified. The method used for recording is full recording, i.e., all hazard hierarchy relevant to the context were considered and all operational issues or hazardous consequences were recorded along with any other outcome that may not raise a concern, for the sake of completeness and audit ability.

Where the existing safeguards are found to be inadequate for the hazard, recommendations will be raised. Therefore, from the worksheets it should be inferred that wherever the hazard has no recommendation, its corresponding safeguards are considered adequate.

Sample Format for HAZID worksheets

Section:

Hazard Category:

Guideword	Threats (Cause)	Consequences	Threat Control/Recovery Measures	Recommendations

6.4 HAZID STUDY OUTCOMES

A total of 19 recommendations were obtained that are shown in Appendix C. Recommendations are either closed type, i.e., they are final in their description, or open type, which means the final action depends on a study as clearly indicated in the recommendation. One shall note that all recommendations, open or closed, shall be followed up and finalized. Appendix D consists of detailed HAZID Worksheets of the study.

7.1 ATTACHMENTS

7.2 APPENDIX A –TEAM MEMBERS

First Name	Last Name	Company	Expertise
Shamsolah	Bahadori	NISOC	Construction Manager
Fatemeh	Ghodsi	NISOC	Head of I&C
Mohammad	Torfi	NISOC	Process
Sahar	Saba	NISOC	Process
Niloofar	Rezaei Baba ahmadi	NISOC	Process
Mohammad Reza	Cheraghchi	NISOC	Process
Fazel	Moafi	NISOC	Instrument
Behzad	Zandian	NISOC	Instrument
Hojjat	Jafarpour	NISOC	Mechanical
Faride	Parvin	NISOC	Mechanical
Mohammad	Khamisi	NISOC	HSE
Naji	Hamid	NISOC	Commissioning
Khodadad	Kavosi	NISOC	Commissioning
Behrouz	Khoramdel	NISOC	Commissioning
Mohammad Javad	Nazari	NISOC	Process
Shahram	Valizadeh	Gachsaran NISOC	Production Engineer
Vahid	Mussavi	Gachsaran NISOC	Production Engineer
Amir Ali	Dabiri	PEDCO	Engineering Manager
Sasan	Faramarzpour	PEDCO	Head of Process and Safety Department
Mehdi	Sadeghian	PEDCO	Surface Manager
Sadegh	Gharacheh	PEDCO	Process
Morteza	Taherkhani	PEDCO	Head of I&C
Sepideh	Akbari	PEDCO	I&C Engineer
Pouya	Maleki	PEDCO	Process Engineer
Mohammad	Fakharian	Hirgan Energy	Project Manager
Masoud	Asgharnejad	Hirgan Energy	Engineering Manager
Mohsen	Aryafar	Hirgan Energy	Process
Amir Hossein	Saber	Hirgan Energy	Process Safety
Morteza	Ansari	GOGPC	Process
Farshad	Nourai	Consultant	HAZID Leader

7.3 APPENDIX B –HAZARD CATEGORIES (ISO 17776)

Hazard Category
1. Hydrocarbons
2. Refined Hydrocarbons
3. Other Flammable Materials
4. Hazards Associated with Difference in Height
5. Environmental Hazards
6. Dynamic Situation Hazards
7. Open Flame
8. Electricity
9. Toxic Gases
10. Entrapment

7.4 APPENDIX C – RECOMMENDATIONS LIST

Recommendations	Responsibility	Place(s) Used
1. Study the effectiveness of flame detectors instead of LHDs in Slug Catcher area, acc. to PACS and best practices.	C	Consequences: 1.1.1.1
2. Check and ensure the minimum strength of Control Building walls on the side of the building not facing process area against an explosion in that area.	C	Consequences: 1.1.1.1
3. Client insists on performing SIL verification on ESD system based on IEC 61511. Contractor justification for not performing SIL verification will be submitted to Client subsequently.	N-C	Consequences: 1.1.1.1
4. Modify the location of the access road on the northwestern side of Closed Drain sump in order to minimize likelihood of mechanical handling risks in case of maintenance using cranes.	C	Consequences: 1.1.3.1
5. Consider LDAR program for operation phase.	N	Consequences: 1.1.4.1
6. In order to reduce risk of gasoil transfer across GCS from southwest to northeast for Corrosion Inhibitor package, study feeding the package from V-2206 B, which is closer to Slug Catcher.	C	Consequences: 2.3.1.2
7. Study applicability of F&G system for the Corrosion Inhibitor Injection Package area.	C	Consequences: 2.3.1.2
8. Verify the strength of Battery Room walls against explosion.	C	Consequences: 3.1.1.1
9. Consider safe access means for lighting fixtures and overhead crane not yet incorporated in 3D model in the next model review.	C	Consequences: 4.1.1.1
10. Designate on Plot plan the lay down areas for Compressors and Chemical Shelter	C	Consequences: 4.2.1.1
11. Plan for development of environmental contingency plans incl. communication with local meteorological institute.	N	Consequences: 5.2.2.2, 8.1.1.2
12. Develop a procedure for minimizing site work in times of extreme environmental conditions and provide adequate and appropriate PPE.	N	Consequences: 5.2.5.4
13. Check applicability of guard posts for hydrants/monitors close to access roads acc. to PACS.	C	Consequences: 6.1.1.1
14. Check applicability of navigation aids for Potable Water Tank and lightning arrester.	C	Consequences: 6.2.1.1
15. Consider installing a fixed barrier in front of Pig	C	Consequences: 6.4.1.1

Recommendations	Responsibility	Place(s) Used
Receiver door in case of pig throw.		
16. Plan for improving process safety culture, and effectiveness of training incl. H_2S awareness, and enforcing appropriate PPE.	N	Consequences: 9.1.1.1, 9.1.2.1, 10.1.1.1
17. In consultation with Dehydration package vendor, consider minimizing BTX emissions and ensure minimal personnel exposure.	C	Consequences: 9.2.1.1
18. In consultation with Dehydration package vendor, consider minimizing SO_2 emissions and ensure minimal personnel exposure.	C	Consequences: 9.3.1.1
19. Consider providing an additional emergency exit door for Control building.	C	Consequences: 10.1.1.2

7.5 APPENDIX D – HAZID WORKSHEETS

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Gas and condensate	1. Leakage due to corrosion, erosion, or rupture due to TPD, etc.	1.1. Fire and explosion with possibility of injury/fatality	1	B	H	1.1.1. Material selection	3	C	M	1. Study the effectiveness of flame detectors instead of LHDs in Slug Catcher area, acc. to PACS and best practices.	C
						1.1.2. Corrosion coupons and probes at manifold area and GCS				2. Check and ensure the minimum strength of Control Building walls on the side of the building not facing process area against an explosion in that area.	C
						1.1.3. Corrosion allowance				3. Client insists on performing SIL verification on ESD system based on IEC 61511. Contractor justification for not performing SIL verification will be submitted to Client subsequently.	N-C
						1.1.4. Corrosion inhibitor injection					
						1.1.5. Minimizing dead points and pockets in piping design					
						1.1.6. Drain connections at dead points					
						1.1.7. Maximum allowable fluid velocity to minimize erosion					
						1.1.8. Stone trap at wellhead area					
						1.1.9. Strainers/filters are provided					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						1.1.10. Controlled entry of vehicles in GCS					
						1.1.11. F&G system, incl. flammable and toxic gas detectors in process area, LHDs in Slug Catcher area, flame detectors in Compressors area (under shelter)					
						1.1.12. Line monitoring for F&G system					
						1.1.13. ESD and depressurization upon flammable and toxic gas detection and also LHD activation					
						1.1.14. Manual activation of ESD levels from Control Room push buttons					
						1.1.15. Paving is provided instead of gravel to minimize probability of explosion upon gas leakage					
						1.1.16. Slope and open drain connection for collection and disposal of liquid leaks					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						1.1.17. Drip trays for Pig Receiver, Slug Catcher and pumps					
						1.1.18. Hazardous area classification					
						1.1.19. Safe separation distance acc. to PACS (no piperacks in GCS)					
						1.1.20. HVAC trip and closure of dampers of air intake of Control Building in case of flammable gas detection					
						1.1.21. Independent new firewater pumping system and FW ring at GCS; to be connected to the existing fire water ring main					
						1.1.22. Deluge valves for cooling of Compressor trains, Slug Catcher, condensate transfer pumps, and TEG Storage Tank activated through F&G system and local manual activation					
						1.1.23. Fire hydrants and monitors in process area with water					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						or water/foam application					
						1.1.24. Fire sheds in process area with portable and wheeled fire extinguishers and other necessary devices					
						1.1.25. Fireproofing for steel structure of Dehydration Column and vessel supports					
						1.1.26. Blast proof design for all buildings in process area, incl. Control Building					
						1.1.27. See also Entrapment category					
		1.2. Toxic release with possibility of fatality; see Toxic Gas category									
		1.3. Environmental pollution	2	B	H	1.3.1. Material selection	3	C	M		
						1.3.2. Corrosion coupons and probes at wellhead area and GCS					
						1.3.3. Corrosion allowance					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						1.3.4. Corrosion inhibitor injection					
						1.3.5. Minimizing dead points and pockets in piping design					
						1.3.6. Drain connections at dead points					
						1.3.7. Maximum allowable fluid velocity to minimize erosion					
						1.3.8. Stone trap at wellhead area					
						1.3.9. Strainers/filters are provided					
						1.3.10. Controlled entry of vehicles in GCS					
						1.3.11. F&G system, incl. flammable and toxic gas detectors in process area					
						1.3.12. Line monitoring for F&G system					
						1.3.13. ESD and depressurization upon flammable and toxic gas detection and also LHD activation					
						1.3.14. Manual activation of ESD levels from Control Room push buttons					
						1.3.15. Slope and open drain					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						connection for collection and disposal of liquid leaks					
						1.3.16. Drip trays for Pig Receiver, Slug Catcher and pumps					
		1.4. Loss of product, loss of production and damage to assets in case of fire/explosion, which also causes loss of reputation	2	B	H	1.4.1. Material selection	3	C	M		
						1.4.2. Corrosion coupons and probes at wellhead area and GCS					
						1.4.3. Corrosion allowance					
						1.4.4. Corrosion inhibitor injection					
						1.4.5. Minimizing dead points and pockets in piping design					
						1.4.6. Drain connections at dead points					
						1.4.7. Maximum allowable fluid velocity to minimize erosion					
						1.4.8. Stone trap at wellhead area					
						1.4.9. Strainers/filters are provided					
						1.4.10. Controlled entry of vehicles in GCS					
						1.4.11. F&G system, incl. flammable and toxic gas detectors in process area, LHDs in Slug Catcher area,					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						flame detectors in Compressors area (under shelter)					
						1.4.12. Line monitoring for F&G system					
						1.4.13. ESD and depressurization upon flammable and toxic gas detection and also LHD activation					
						1.4.14. Manual activation of ESD levels from Control Room push buttons					
						1.4.15. Paving is provided instead of gravel to minimize probability of explosion upon gas leakage					
						1.4.16. Slope and open drain connection for collection and disposal of liquid leaks					
						1.4.17. Drip trays for Pig Receiver, Slug Catcher and pumps					
						1.4.18. Hazardous area classification					
						1.4.19. Safe separation distance acc. to PACS (no piperacks					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						in GCS)					
						1.4.20. Independent new firewater pumping system and FW ring at GCS; to be connected to the existing fire water ring main					
						1.4.21. Deluge valves for cooling of Compressor trains, Slug Catcher, condensate transfer pumps, and TEG Storage Tank activated through F&G system and local manual activation					
						1.4.22. Fire hydrants and monitors in process area with water or water/foam application					
						1.4.23. Fire sheds in process area with portable and wheeled fire extinguishers and other necessary devices					
						1.4.24. Fireproofing for steel structure of Dehydration Column and vessel supports					
						1.4.25. Blast proof design for all					

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						buildings in process area, incl. Control Building					
	2. See also Environmental Hazards category										
	3. Bad Operation or Maintenance due to human error	3.1. Extreme process conditions or overload of equipment, also damage due to impact and similar events, which leads to leakage and fire/explosion or toxic release	2	C	S	3.1.1. O&M Manuals of process packages 3.1.2. Operating manual 3.1.3. Maintenance requirements are foreseen in plant layout 3.1.4. Training for the operation phase 3.1.5. Level of automation to minimize human error 3.1.6. Process CCTV, with monitoring capability from Control Room	3	D	M	4. Modify the location of the access road on the northwestern side of Closed Drain sump in order to minimize likelihood of mechanical handling risks in case of maintenance using cranes.	C
		3.2. See also HAZOP Report									
	4. VOC	4.1. Personnel	3	B	S		3	C	M	5. Consider LDAR program for	N

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
		exposure may cause chronic health problems and also environmental problem								operation phase.	
	5. Loss of utility (compressor sealing nitrogen); see HAZOP Report										
	6. Damage to pipeline due to surge; see HAZOP Report										
	7. See also Toxic Gas category										
	8. Dispersion of HC vapors upon draining into Open Drain in routine										

Hazard Category: 1. Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
	operations										
	9. Improper operation of Dehydration Heater; see HAZOP Report of Dehydration Package										

Hazard Category: 2. Refined Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Diesel Fuel for Emergency Generator	1. Leakage or spillage due to TPD	1.1. Environmental pollution due to soil contamination in case of spillage	3	B	S	1.1.1. Paved area for the pumps	4	B	M		
		1.2. Small local fire in case of ignition	3	C	M	1.2.1. Portable and wheeled type fire extinguishers are provided	4	C	L		
						1.2.2. F&G (LHD) is provided in the area					
						1.2.3. Hydrants and monitors are provided					
2. Diesel Fuel for Diesel Fire Pump	1. Leakage or spillage due to TPD	1.1. Environmental pollution due to soil contamination in case of spillage	3	B	S	1.1.1. Paved area for the pumps	4	B	M		
		1.2. Small local fire in case of ignition	3	C	M	1.2.1. Portable and wheeled type fire extinguishers are provided	4	C	L		
						1.2.2. Hydrants and monitors are provided					
						1.2.3. Process CCTV, with					

Hazard Category: 2. Refined Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						monitoring capability from Control Room					
3. Corrosion Inhibitor (soluble in gasoil)	1. Leakage or spillage due to TPD	1.1. Environmental pollution due to soil contamination in case of spillage	3	B	S	1.1.1. Paved area for the pumps	4	B	M		
		1.2. Small local fire in case of ignition	3	C	M	1.2.1. Portable and wheeled type fire extinguishers are provided	4	C	L	6. In order to reduce risk of gasoil transfer across GCS from southwest to northeast for Corrosion Inhibitor package, study feeding the package from V-2206 B, which is closer to Slug Catcher.	C
						1.2.2. Hydrants and monitors are provided				7. Study applicability of F&G system for the Corrosion Inhibitor Injection Package area.	C
						1.2.3. Process CCTV, with monitoring capability from Control Room					
4. Lube Oil for Compressors	1. Leakage or spillage	1.1. Fire in Compressors area with possibility of damage	3	C	M	1.1.1. Compressor package safeguards	4	D	L		
						1.1.2. F&G and automatic deluge water spray system is provided					

Hazard Category: 2. Refined Hydrocarbons

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						1.1.3. Portable and wheeled type fire extinguishers are provided					
5. Transformer Oil	1. Leakage due to corrosion, TPD, maloperation, etc.	1.1. Local fire with possibility of damage to transformer	4	C	L	1.1.1. F&G (LHD) for transformer area 1.1.2. Portable and wheeled fire extinguishers					
	2. Transformer oil evaporation due to overcurrent	2.1. Severe damage to transformers	2	D	M	2.1.1. Buchholz relay and relief valve	3	D	M		

Hazard Category: 3. Other Flammable Materials

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Hydrogen in Battery Room in Control Building	1. Leakage in case of battery charging	1.1. Explosion and damage to Battery Room	2	B	H	1.1.1. Explosion-proof exhaust fan and other electrical devices for hydrogen service in Battery Room 1.1.2. F&G (H_2 detector) inhibits boost charging upon confirmed H_2 concentration and starts second exhaust fan	3	D	M	8. Verify the strength of Battery Room walls against explosion.	C
2. Fuel Gas for Dehydration Package Heater; see Hydrocarbons category											
3. Pig Trash (pyrophoric material)	1. Exposure to atmosphere upon opening of Pig Receiver door	1.1. Local fire with possibility of personnel injury	2	B	H	1.1.1. Fire shed close to Pig Receiver 1.1.2. Hydrants and monitors are provided 1.1.3. SOP and ERP 1.1.4. Pigging Safety Requirements (document)	3	C	M		

Hazard Category: 4. Hazards Associated with Difference in Height

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Personnel working at height or depth	1. Trip and fall	1.1. Personnel injury with possibility of fatality	1	C	H	1.1.1. Platforms for maintenance are provided with adequate floor, access stairway or ladders with appropriate fall protection and handrails	2	D	M	9. Consider safe access means for lighting fixtures and overhead crane not yet incorporated in 3D model in the next model review.	C
						1.1.2. Guard rails for Closed Drain Pit to keep from personnel fall					
						1.1.3. Cages for monkey ladders on Control Building, Potable Water Tank and Flare Stack					
						1.1.4. Operational controls and PPE					
2. Overhead equipment and objects	1. Fall of load	1.1. Personnel injury with possibility of fatality, and also damage to equipment	1	C	H	1.1.1. Space for loads are provided in Compressors area	2	D	M	10. Designate on Plot plan the lay down areas for Compressors and Chemical Shelter	C
						1.1.2. Space for loads in Chemicals Shelter					
						1.1.3. Toe boards are provided on platforms in case of hand tools, etc.					
						1.1.4. Cross over bridges on outgoing pipelines reduce impact from personnel movements					

Hazard Category: 5. Environmental Hazards

Hazard	Causes	Consequences	Risk Matrix S	L	RR	Safeguards	Risk Matrix S	L	RR	Recommendation	Resp.
1. Tectonic	1. Natural disasters like earthquake or other earth movement	1.1. Damage to equipment and possible injury/fatality for personnel	1	B	H	1.1.1. Geotechnical study 1.1.2. Seismic design acc. to PACS 1.1.3. Operational controls like contingency plans, drills, etc. 1.1.4. For other safeguards, see Hydrocarbons category 1.1.5. For other safeguards, see Entrapment category	3	C	M		
		1.2. Possibility of spillage from storage tanks or pits due to earth movement with subsequent pollution problems	3	B	S	1.2.1. Freeboard allowance	4	C	L		
2. Weather	1. Local ambient extremes like high winds, sandstorm, rain, salty air,										

Hazard Category: 5. Environmental Hazards

Hazard	Causes	Consequences	Risk Matrix S	L	RR	Safeguards	Risk Matrix S	L	RR	Recommendation	Resp.
	temperature extremes, excessive solar radiation, etc. see below										
	2. Flood	2.1. Damage to equipment due to plant area flooding	4	D	L	2.1.1. Environmental design data	4	E	L		
						2.1.2. Ground slope, ditches and trenches lead to open drain for surface run-off					
						2.1.3. Area topology reduces likelihood of plant area flooding					
						2.1.4. Diversion channel					
						2.1.5. Flood control study based on hydrology survey results					
						2.1.6. Sump pumps are provided					
		2.2. Possibility of soil and water pollution	3	C	M	2.2.1. Pits design accommodates annual rainfall statistics	4	D	L	11. Plan for development of environmental contingency plans incl. communication with local meteorological institute.	N
						2.2.2. Facility to divert rain water (clean surface run-off) from storm basin to the environment					
	3. High winds,	3.1. Possibility of	3	C	M	3.1.1. Environmental design data	4	D	L		

Hazard Category: 5. Environmental Hazards

Hazard	Causes	Consequences	Risk Matrix S	L	RR	Safeguards	Risk Matrix S	L	RR	Recommendation	Resp.
	storm	damage to plant equipment and injury to personnel				3.1.2. Mechanical design for buildings and structures/piping 3.1.3. Flare flame out and radiation impact zone as well as flare location are considered in design to minimize impact					
	4. Temperature extremes	4.1. Interference in performance of instrumentation	2	B	H	4.1.1. Environmental design data 4.1.2. Sunshade for instrumentation exposed to the sunlight 4.1.3. Instrument cables are buried or run in cable trays	3	C	M		
		4.2. Damage or performance reduction of sun-exposed electrical equipment	3	A	S	4.2.1. Environmental design data 4.2.2. Sunshade for electrical motors exposed to sunlight 4.2.3. Electrical cables are buried or their covers are suitable for sun exposure	4	B	M		
		4.3. Scalding and personnel injury in	3	A	S	4.3.1. Environmental design data 4.3.2. Insulation for Potable Water Tank 4.3.3. Potable water piping are	4	B	M		

Hazard Category: 5. Environmental Hazards

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
		outdoor eyewash fountains and safety showers due to increased temperature of potable water				buried 4.3.4. Safety shower and eye wash in chemical storage area are installed under shelter					
		4.4. Fatigue, injury and increased risk of human error in case of maintenance	3	A	S	4.4.1. Environmental design data 4.4.2. Air and Gas Compressors are installed under shelter 4.4.3. Operational controls and PPE	4	B	M		
		4.5. Damage to or reduced useful life of chemicals barrels, transformers, GRP/PE pipes or fire	3	B	S	4.5.1. Environmental design data 4.5.2. Chemicals storage area is under shelter 4.5.3. Transformer are installed under shelter 4.5.4. GRP/PE pipes are buried 4.5.5. Fire extinguishers are	4	C	L		

Hazard Category: 5. Environmental Hazards

Hazard	Causes	Consequences	S	L	RR	Safeguards	S	L	RR	Recommendation	Resp.
		extinguishes if sun-exposed				installed under Fire Sheds					
		4.6. Reduced performance or damage to HVAC equipment, which may reduce performance of indoor instrumentation and other equipment	2	B	H	4.6.1. Environmental design data 4.6.2. HVAC equipment are installed under shelter 4.6.3. HVAC performance design margins 4.6.4. Spare is provided for HVAC compressors	4	C	L		
		4.7. Reduced performance of compressors	3	B	S	4.7.1. Environmental design data 4.7.2. Air and Gas Compressors are installed under shelter 4.7.3. Air Compressors performance design margins	4	C	L		
	5. Dust	5.1. Damage to electrical equipment, instrumentation/telecom equipment and CCTV	2	B	H	5.1.1. Environmental design data 5.1.2. IP protection of instrumentation, telecom and electrical enclosures	3	C	M		

Hazard Category: 5. Environmental Hazards

Hazard	Causes	Consequences	Risk Matrix S	L	RR	Safeguards	Risk Matrix S	L	RR	Recommendation	Resp.
		5.2. Reduced performance of Air Compressors, Diesel Generator and Nitrogen Compressors	3	B	S	5.2.1. Environmental design data 5.2.2. Intake Air Filter for Air and Nitrogen Compressors; Diesel Generator operation is intermittent	4	C	L		
		5.3. Reduced quality of conditioned air and damage to HVAC Compressors	2	B	H	5.3.1. Environmental design data 5.3.2. Intake Air Filter for HVAC Compressors 5.3.3. Spare is provided for HVAC compressors	3	C	M		
		5.4. Personnel injury and health problems and increased possibility of human error	2	B	H	5.4.1. Environmental design data 5.4.2. Operational controls	2	C	S	12. Develop a procedure for minimizing site work in times of extreme environmental conditions and provide adequate and appropriate PPE.	N
		5.5. Reduced performance	4	C	L	5.5.1. Environmental design data	4	C	L		

Hazard Category: 5. Environmental Hazards

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
		of Dehydration Package heater									

Hazard Category: 6. Dynamic Situation Hazards

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Vehicles in Plant Area	1. TPD	1.1. Leakage or spillage due to impact; see Hydrocarbons category for details [Note: No pipe racks in process area]	2	C	S	1.1.1. Safe separation distance between access roads and process equipment 1.1.2. Operational controls for in-site traffic 1.1.3. Safety signs, incl. traffic 1.1.4. CCTV in process area 1.1.5. For other safeguards, see Hydrocarbons category	3	D	M	13. Check applicability of guard posts for hydrants/monitors close to access roads acc. to PACS.	C
2. Aircraft (from nearby IOOC flight corridor)	1. Impact during flight with tall structures	1.1. Damage to equipment and possibility of fire/explosion	1	D	S	1.1.1. Navigation aids for Flare stack 1.1.2. Area lighting	1	E	M	14. Check applicability of navigation aids for Potable Water Tank and lightning arrester.	C
3. Damaging Noise	1. Vibration in piping due to reciprocating compressors	1.1. Personnel injury (hearing loss) and damage to equipment, which may cause leakage	3	A	S	1.1.1. Piping stress analysis in case of leakage 1.1.2. Noise specification for equipment 1.1.3. Visual as well as audible alarms in high noise area 1.1.4. Vibration switches with alarm/shut down are provided on Compressors 1.1.5. Operational controls and PPE	4	C	L		

Hazard Category: 6. Dynamic Situation Hazards

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
4. Pig	1. Pig Receiver door is opened before barrel adequately depressurized	1.1. Possibility of severe personnel injury or fatality upon impact or damage to equipment, etc.	1	B	H	1.1.1. Mechanical interlock on Pig Receiver door 1.1.2. Pressure balance line, vent connection and PGs are provided for the operator to control and check barrel pressure 1.1.3. SOP for pigging 1.1.4. Pig sigs are provided for monitoring pig location	3	D	M	15. Consider installing a fixed barrier in front of Pig Receiver door in case of pig throw.	C

Hazard Category: 7. Open Flame

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Flare	1. Radiation and possibility of liquid carry over to flare stack (golden rain)	1.1. Personnel injury	2	A	H	1.1.1. Stack height (preliminary) 1.1.2. Sterile area around flare stack 1.1.3. Separation distance beyond sterile area from manned areas	3	C	M		
	2. Noise	2.1. Personnel injury	3	A	S	2.1.1. Stack height (preliminary) 2.1.2. Sterile area around flare stack 2.1.3. Separation distance beyond sterile area from manned areas 2.1.4. Maximum Mach number for Flare header	4	C	L		

Hazard Category: 8. Electricity

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Lightning Discharge	1. Local atmospheric conditions cause lightning strike	1.1. Damage to electrical equipment, instrumentation/telecom equipment and CCTV	1	B	H	1.1.1. Lightning arrester 1.1.2. Separate discharge wells for electrical, lightning and instrumentation earthing systems with surge diverters	3	D	M		
		1.2. Personnel injury with possibility of fatality	1	C	H	1.2.1. Lightning arrester 1.2.2. Operational controls	3	D	M	11. Plan for development of environmental contingency plans incl. communication with local meteorological institute.	N
		1.3. Possibility of fire/explosion	1	B	H	1.3.1. Lightning arrester 1.3.2. For safeguards, see Hydrocarbons category	3	D	M		
2. Electrical equipment including but not limited to diesel generator, electric motors, panels, transformers, UPS, electrical tracing lines and cables	1. Electrical fire and explosion (indoors/outdoors)	1.1. In case of outdoors, damage to electrical equipment, which can lead to loss of production	2	C	S	1.1.1. Protection relays 1.1.2. Buried cables are less sensitive to damage by fire 1.1.3. ESD and F&G cables are fire-resistant 1.1.4. Electrical and control cables are flame retardant 1.1.5. Fire protection in process area in the form of ABC fire extinguishers	3	D	M		

Hazard Category: 8. Electricity

Hazard	Causes	Consequences	Risk Matrix S	L	RR	Safeguards	Risk Matrix S	L	RR	Recommendation	Resp.
						1.1.6. CCTV in process area 1.1.7. F&G in process area in case of fire					
		1.2. In case of indoors, damage to electrical equipment; also, personnel injury with possibility of fatality	1	C	H	1.2.1. Protection relays 1.2.2. ESD and F&G cables are fire-resistant 1.2.3. Electrical and control cables are flame retardant 1.2.4. Smoke detectors in false floors/ceilings and concrete cable trench 1.2.5. Fire protection in buildings in the form of ABC fire extinguishers 1.2.6. CO_2 total flooding system for capacitor room only 1.2.7. F&G (smoke and heat) in Control Building in case of fire	3	D	M		
	2. Electrocution	2.1. Personnel injury with possibility of fatality	1	C	H	2.1.1. Earthing 2.1.2. Minimization of personnel exposure to MV applications through remote relays in LV	3	D	M		

Hazard Category: 8. Electricity

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
						room with RCP					
						2.1.3. Protection relays					
						2.1.4. Cable termination					
						2.1.5. Limited exposure in electrical panels					
						2.1.6. Personnel protection relays electrical racks					
						2.1.7. Existing plant clinic					
	3. Induction	3.1. Interference in performance of instrumentation	2	C	S	3.1.1. Segregation between instrument and electrical MV/LV cables	3	D	M		
						3.1.2. Instrument cables screen shields					
						3.1.3. 3-core arrangement for electrical cables					
						3.1.4. EMC level of instrumentation					
						3.1.5. Minimum safe distance between existing and new cables in case of crossings, to minimize EMC influence					
	4. Power failure	4.1. Severe disturbance in	1	A	H	4.1.1. Fail safe design	3	D	M		
						4.1.2. Redundancy in electrical supply through dedicated					

Hazard Category: 8. Electricity

Hazard	Causes	Consequences	Risk Matrix S	L	RR	Safeguards	Risk Matrix S	L	RR	Recommendation	Resp.
		production with risk of accidents, and also loss of production				buses					
						4.1.3. Back-up power for DCS/F&G/ESD through UPS with operator monitoring capability to support safe emergency shut-down					
						4.1.4. Diesel generator for emergency consumers					

Hazard Category: 9. Toxic Gases

Hazard	Causes	Consequences	Risk Matrix S	L	RR	Safeguards	Risk Matrix S	L	RR	Recommendation	Resp.
1. H_2S in Process Streams	1. Leakage	1.1. Personnel injury with possibility of fatality	1	C	H	1.1.1. F&G for toxic gas 1.1.2. Audible and visual alarms in process area 1.1.3. Operational controls and PPE 1.1.4. Portable H_2S detector 1.1.5. For other safeguards, see Hydrocarbons category 1.1.6. HVAC trip and closure of dampers of air intake of Control Building in case of toxic gas detection 1.1.7. Safety signs for H_2S service	2	D	M	16. Plan for improving process safety culture, and effectiveness of training incl. H_2S awareness, and enforcing appropriate PPE.	N
	2. Flare flame out	2.1. Personnel injury with possibility of fatality	1	C	H	2.1.1. F&G for toxic gas 2.1.2. Audible and visual alarms in process area 2.1.3. Operational controls and PPE 2.1.4. Portable H_2S detector 2.1.5. For other safeguards, see Hydrocarbons category 2.1.6. Safety signs for H_2S service 2.1.7. Stack height (preliminary)	2	D	M	16. Plan for improving process safety culture, and effectiveness of training incl. H_2S awareness, and enforcing appropriate PPE.	N
2. BTX in Dehydration Package Regeneration	1. Continuous venting from	1.1. Environmental pollution and	1	B	H	1.1.1. Height of Regeneration Column	2	C	S	17. In consultation with Dehydration package vendor,	C

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
Column	Column top	chronic personnel health problems (carcinogenics)								consider minimizing BTX emissions and ensure minimal personnel exposure.	
3. SO_2	1. Dehydration Package Heater consumes sour feed gas as fuel; also, in Flare	1.1. Personnel exposure may cause health problems and also environmental problem	2	B	H	1.1.1. Height of the Heater	3	C	M	18. In consultation with Dehydration package vendor, consider minimizing SO_2 emissions and ensure minimal personnel exposure.	C

Hazard Category: 10. Entrapment

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
1. Emergency Case	1. Limited access to escape routes	1.1. In case of accidents in process area, personnel injury with possibility of fatality	1	C	H	1.1.1. PA/GA system is provided 1.1.2. Portable H_2S detector 1.1.3. Escape routes with safety signs 1.1.4. Wind sock 1.1.5. Muster point 1.1.6. Escape mask as regular PPE (not regularly used) 1.1.7. SCBA 1.1.8. Photo-luminescent escape route signs in process area 1.1.9. For other safeguards, see Hydrocarbons category 1.1.10. For other safeguards, see Environment category	2	C	S	16. Plan for improving process safety culture, and effectiveness of training incl. H_2S awareness, and enforcing appropriate PPE.	N
		1.2. In case of accidents inside Control Building,	1	C	H	1.2.1. PA/GA system is provided 1.2.2. Electrical and instrument cable covers are low-smoke type 1.2.3. F&G (smoke and heat) in	2	C	S	19. Consider providing an additional emergency exit door for Control building.	C

Hazard	Causes	Consequences	Risk Matrix			Safeguards	Risk Matrix			Recommendation	Resp.
			S	L	RR		S	L	RR		
		personnel injury with possibility of fatality				Control Building in case of fire 1.2.4. Relatively small size of Control Building means quick access to exit door 1.2.5. Photo-luminescent escape route signs in Control Building 1.2.6. For other safeguards, see Electricity category					