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| **طرح نگهداشت و افزایش تولید 27 مخزن** | | | | | | |
| **HAZOP REPORT FOR COMPRESSOR STATION**  **نگهداشت و افزایش تولید میدان نفتی بینک** | | | | | | |
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| D00 | JUL. 2022 | IFI | A.Baghaei | M.Fakharian | M.Mehrshad |  |
| **Rev.** | **Date** | **Purpose of Issue/Status** | **Prepared by:** | **Checked by:** | **Approved by:** | **CLIENT Approval** |
| **Class: 3** | | **CLIENT Doc. Number: F0Z-708725** | | | | |
| **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** | | | | | | |

**REVISION RECORD SHEET**

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| **PAGE** | **D00** | **D01** | **D02** | **D03** | **D04** |
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# 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 HAZOP study covers all P&IDs for New Gas Compressor Station. The list of P&IDs is presented in appendix B.

* 1. **NORMATIVE REFERENCES**
  2. **INTERNATIONAL CODES AND STANDARDS**
     + IEC 61882:2016 Hazard and Operability studies (HAZOP Studies) – Application guide
  3. **THE PROJECT DOCUMENTS**
     + BK-GNRAL-HD-000-PR-DB-0001-D05 Process Basis of Design
     + BK-GCS-PEDCO-120-PR-BD-0001 ESD Block Diagram
  4. **PURPOSE**

The purpose of this document is to provide the results of “HAZOP Study” for **Binak Oilfield Development – Surface Facilities; New Gas Compressor Station**.

The objective of HAZOP study is to perform and achieve the following tasks and goals as far as practicable given the latest piping and instrumentation diagrams (P&ID’s) to identify any potential hazards associated with the system and its utility systems:

* + - To identify any potential operating difficulties,
    - Examine the effectiveness of those measures already incorporated in the design to mitigate the frequency and/or consequences of such hazards;
    - To raise action items for addressing those hazards that the present design does not satisfactorily address.

# 5.0 HAZOP STUDY OVERVIEW

Meetings were conducted in 4 sessions from June 26 to 29, 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 HAZOP Chairman and Scribe. The list of team members is presented in appendix A.

# 6.0 PROCEDURE

The review methodology will be the "Guide Word" HAZOP technique and will be performed in accordance with the guidelines published by the Center for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers (AIChE) and also noted in IEC 61882.

The purpose of the review should not be only to resolve the action items but also to identify credible deviations from the design intent. The method identifies hazards and postulates possible accident sequences resulting from such hazards; Innovative thinking then identifies the consequences of these scenarios. The process demonstrates to the Owner/Management that prudent steps which have been taken to provide a safe installation and operation.

The scope of the HAZOP shall be therefore, on identifying potential process hazards or operability concerns, not on finding solutions to reduce or eliminate these concerns. Attempting to solve problems by the HAZOP team can result in a long and inefficient study process. At the same time, the HAZOP study cannot be intended as a review of Project Design Basis and Operating Philosophies, since these must be considered as resolved when the HAZOP study will be carried out.

Each system or equipment should be divided into subsystems by consensus of the review team. The selected system shall be identified by a study node numbers and for easy reference a color code can also be inserted on the related P&ID prior to the review and worksheet during the review.

**List of possible parameters and guidewords**

|  |  |  |
| --- | --- | --- |
| **Deviations** | **Guide Word** | **Parameter** |
| No/Less Flow | No/Less | Flow |
| More Flow | More | Flow |
| Reverse/Misdirected Flow | Reverse/Misdirected | Flow |
| High Temperature | High | Temperature |
| Low Temperature | Low | Temperature |
| High Pressure | High | Pressure |
| Low Pressure | Low | Pressure |
| High Level | High | Level |
| Low Level | Low | Level |
| Maintenance Hazards | Other than | Maintenance |
| Leakage | As well as | Flow |
| Corrosion | As well as | Operation |
| Composition | As well as | Composition |

|  |  |  |
| --- | --- | --- |
| **Deviations** | **Guide Word** | **Parameter** |
| Start-up/Shutdown Hazards | Other than | Start-up/Shutdown |
| Loss of Utilities | Other than | Operation |
| Miscellaneous | As well as | Operation |

# 7.0 HAZOP OUTCOMES

In order to facilitate the study, the process was broken down into 20 nodes. The node list is presented in appendix C. A total of 131 recommendations were obtained which are shown in appendix D. The recommendations are categorized in two groups, namely OPEN and CLOSED.

Closed recommendations are those that the team have arrived at a consensus that it is required to be done. 128 closed recommendation were obtained in the meetings. Open recommendations are those that need more information from vendor for the final decision. 3 open recommendations were proposed during the meetings.

Appendix E consists of detailed HAZOP Worksheets of the study.

* 1. **ATTACHMENTS**
  2. **APPENDIX A –TEAM MEMBERS**

|  |  |  |  |
| --- | --- | --- | --- |
| **First Name** | **Last Name** | **Company** | **Expertise** |
| S.Mehdi | Ashrafian | NISOC | Project Manager |
| 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 |
| Peyman | Sarvarian | NISOC | Mechanic |
| Hojjat | Jafarpour | NISOC | Mechanical |
| Faride | Parvin | NISOC | Mechanical |
| Mohammad | Khamisi | NISOC | HSE |
| Mohammad | Shirali | NISOC | Commissioning |
| Ali | Hamidan | NISOC | Commissioning |
| Naji | Hamid | NISOC | Commissioning |
| Khodadad | Kavosi | NISOC | Commissioning |
| Reza | Gholgheysari | NISOC | Process Engineer |
| Mobin | Saeedi | NISOC | Instrument |
| Mohammad | Bakhshi Mohammadi | Gachsaran NISOC | Production Engineer |
| Shahram | Valizadeh | Gachsaran NISOC | Production Engineer |
| Vahid | Mussavi | Gachsaran NISOC | Production Engineer |
| Mohammad | Fakoor | PEDCO | Process Engineer |
| Farshid | Amiri | PEDCO | Piping Lead Engineer |
| Hadi | Mozaffari | PEDCO | Electrical Engineer |
| Mahdi | Karimi | PEDCO | Head of Electrical Department |
| Pouria | Bavarsad | PEDCO | Piping Engineering |
| Sadegh | Gharacheh | PEDCO | Process |
| Morteza | Taherkhani | PEDCO | Head of I&C |
| Sepideh | Akbari | PEDCO | I&C Engineer |
| Sasan | Faramarzpour | PEDCO | Head of Process and Safety Department |
| Pouya | Maleki | PEDCO | Process Engineer |

|  |  |  |  |
| --- | --- | --- | --- |
| **First Name** | **Last Name** | **Company** | **Expertise** |
| Mehdi | Sadeghian | PEDCO | Surface Manager |
| Vahid | Abdeshadi | PEDCO | Project Engineer Manager |
| Masoud | Asgharnejad | Hirgan Energy | Engineering Manager |
| Mohsen | Aryafar | Hirgan Energy | Process |
| Saeed | Ghanbari | Hirgan Energy | Process |
| Parisa | Hajisadeghi | Hirgan Energy | Head of I&C |
| Mohammad | Fakharian | Hirgan Energy | Project Manager |
| Ali | Baghaei | HAZOP Consultant | Process Safety |
| Firoozeh | Khosravi | HAZOP Consultant | Process Safety |

* 1. **APPENDIX B – DRAWINGS LIST**

|  |  |  |
| --- | --- | --- |
| Drawing No. | Drawing Title | Place(s) Used |
| BK-GCS-PEDCO-120-PR-PI-0002\_D03 | Gas Compression Inlet Gas Pipeline (Binak) | Nodes: 1 |
| BK-GCS-PEDCO-120-PR-PI-0003\_D03 | Gas Compression Inlet Gas Pipeline (Golkhari) | Nodes: 2 |
| BK-GCS-PEDCO-120-PR-PI-0004\_D03 | Slug Catcher System (2 sheets) | Nodes: 3 |
| BK-GCS-PEDCO-120-PR-PI-0005\_D03 | Gas Compression Inlet Knock Out Drum | Nodes: 4 |
| BK-GCS-PEDCO-120-PR-PI-0006\_D03 | 1st Stage Gas Compression Suction Drums (3 sheets) | Nodes: 5 |
| BK-GCS-PEDCO-120-PR-PI-0007\_D03 | 1st Stage Gas Compression Compressors (3 sheets) | Nodes: 5 |
| BK-GCS-PEDCO-120-PR-PI-0008\_D03 | 1st Stage Gas Compression Air Coolers (3 sheets) | Nodes: 5 |
| BK-GCS-PEDCO-120-PR-PI-0009\_D03 | 2nd Stage Gas Compression Suction Drums (3 sheets) | Nodes: 6 |
| BK-GCS-PEDCO-120-PR-PI-0010\_D03 | 2nd Stage Gas Compression Compressors (3 sheets) | Nodes: 6 |
| BK-GCS-PEDCO-120-PR-PI-0011\_D03 | 2nd Stage Gas Compression Air Coolers (3 sheets) | Nodes: 6 |
| BK-GCS-PEDCO-120-PR-PI-0012\_D03 | 2nd Stage Gas Compression Discharge Drum | Nodes: 7 |
| BK-GCS-PEDCO-120-PR-PI-0013\_D03 | Gas Compression Dehydration Package (3 sheets) | Nodes: 8 |
| BK-GCS-PEDCO-120-PR-PI-0014\_D03 | Lean Glycol Storage Tank | Nodes: 9 |
| BK-GCS-PEDCO-120-PR-PI-0015\_D03 | Instrument & Plant Air System | Nodes: 10 |
| BK-GCS-PEDCO-120-PR-PI-0016\_D03 | Nitrogen Generation System | Nodes: 11 |
| BK-GCS-PEDCO-120-PR-PI-0017\_D03 | Closed Drain System (2 sheets) | Nodes: 12 |
| BK-GCS-PEDCO-120-PR-PI-0018\_D03 | Corrosion Inhibitor Package | Nodes: 13 |
| BK-GCS-PEDCO-120-PR-PI-0019\_D03 | Methanol Injecktion Package | Nodes: 14 |
| BK-GCS-PEDCO-120-PR-PI-0020\_D03 | LP Flare System (3 sheets) | Nodes: 15 |
| BK-GCS-PEDCO-120-PR-PI-0021\_D03 | Oily Water Sewer | Nodes: 16 |
| BK-GCS-PEDCO-120-PR-PI-0022\_D03 | Fuel Gas System | Nodes: 17 |
| BK-GCS-PEDCO-120-PR-PI-0023\_D03 | Diesel Oil System (2 sheets) | Nodes: 18 |
| BK-GCS-PEDCO-120-PR-PI-0024\_D03 | Potable Water System | Nodes: 19 |
| BK-GCS-PEDCO-120-PR-PI-0025\_D03 | Glycol Sump Drum | Nodes: 20 |

* 1. **APPENDIX C – NODES LIST**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Nodes** | **Color** | **Type** | **Drawings** | **Equipment ID** | **Date** |
| 1. Gas Compression Inlet Gas Pipeline (Binak) | Red | Pig Receiver | BK-GCS-PEDCO-120-PR-PI- 0002\_D03 | PR-1002 | 2. 06/26/2022 |
| 2. Gas Compression Inlet Gas Pipeline (Golkhari) | Violet | Pig Receiver | BK-GCS-PEDCO-120-PR-PI- 0003\_D03 | PR-2102 | 2. 06/26/2022 |
| 3. Slug Catcher System | L Blue | Drum | BK-GCS-PEDCO-120-PR-PI- 0004\_D03 | V-2104 | 2. 06/26/2022 |
| Pump | P-2101A/B |
| 4. Gas Compression Inlet Knock Out Drum | Yellow | Drum | BK-GCS-PEDCO-120-PR-PI- 0005\_D03 | V-2105 | 3. 06/27/2022 |
| 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers | Blue | Drum | BK-GCS-PEDCO-120-PR-PI- 0006\_D03 | V-2101A/B/C | 3. 06/27/2022 |
| BK-GCS-PEDCO-120-PR-PI- 0007\_D03 | C-2101A/B/C |
| BK-GCS-PEDCO-120-PR-PI- 0008\_D03 | AE-2101A/B/C |
| 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers | Green | Drum | BK-GCS-PEDCO-120-PR-PI- 0009\_D03 | V-2102A/B/C | 3. 06/27/2022 |
| BK-GCS-PEDCO-120-PR-PI- 0010\_D03 | C-2102A/B/C |
| BK-GCS-PEDCO-120-PR-PI- 0011\_D03 | AE-2102A/B/C |
| 7. 2nd Stage Gas Compression Discharge Drum | Violet | Drum | BK-GCS-PEDCO-120-PR-PI- 0012\_D03 | V-2103 | 4. 06/28/2022 |
| 8. Gas Compression Dehydration Package | Yellow | Package | BK-GCS-PEDCO-120-PR-PI- 0013\_D03 | PK-2101 | 4. 06/28/2022 |
| 9. Lean Glycol Storage Tank | Blue | Tank | BK-GCS-PEDCO-120-PR-PI- 0014\_D03 | TK-2102 | 4. 06/28/2022 |
| Pump | P-2102 |
| P-2103A/B |
| 10. Instrument & Plant Air System | Red | Package | BK-GCS-PEDCO-120-PR-PI- 0015\_D03 | PK-DR- 2203A/B | 4. 06/28/2022 |
| PK-C-2203A/B |
| V-2203 |
| 11. Nitrogen Generation System | Green | Package | BK-GCS-PEDCO-120-PR-PI- 0016\_D03 | PK-C-2204 | 4. 06/28/2022 |
| PK-G-2204 |
| V-2204 |
| 12. Closed Drain System | Pink | Drum | BK-GCS-PEDCO-120-PR-PI- 0017\_D03 | V-2202 | 4. 06/28/2022 |
| Pump | SU-2201 |
| P-2202A/B |
| P-2203A/B |
| 13. Corrosion Inhibitor Package | Orange | Line | BK-GCS-PEDCO-120-PR-PI- | PK-TK-2207 | 4. 06/28/2022 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Nodes** | **Color** | **Type** | **Drawings** | **Equipment ID** | **Date** |
|  |  | Package | 0018\_D03 | PK- 2207A/B/C/D |  |
| Tank | P-2207E |
| Pump |
| 14. Methanol Injection Package | L Blue | Line | BK-GCS-PEDCO-120-PR-PI- 0019\_D03 | - | 4. 06/28/2022 |
| 15. LP Flare System | Violet | Line | BK-GCS-PEDCO-120-PR-PI- 0020\_D03 | - | 5. 06/29/2022 |
| Drum | SU-2201 |
| Package | V-2201 |
| Pump | P-2201A/B |
| IG-2201 |
| FST-2201 |
| 16. Oily Water Sewer | Yellow | Sump | BK-GCS-PEDCO-120-PR-PI- 0021\_D03 | SU-2202 | 5. 06/29/2022 |
| 17. Fuel Gas System | Blue | Drum | BK-GCS-PEDCO-120-PR-PI- 0022\_D03 | V-2205 | 5. 06/29/2022 |
| 18. Diesel Oil System | Green | Drum | BK-GCS-PEDCO-120-PR-PI- 0023\_D03 | V-2206A/B | 5. 06/29/2022 |
| Pump | P-2206A/B |
| 19. Potable Water System | L Blue | Tank | BK-GCS-PEDCO-120-PR-PI- 0024\_D03 | TK-2209 | 5. 06/29/2022 |
| Pump | P-2209 |
| 20. Glycol Sump Drum | Violet | Drum | BK-GCS-PEDCO-120-PR-PI- 0025\_D03 | V-2107 | 5. 06/29/2022 |
| Pump | P-2104 |

* 1. **APPENDIX D – RECOMMENDATIONS LIST**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Recommendations** | **Place(s) Used** | | **Responsibility** | **Status** |
| 1. Define in operating procedure that operator should change capacity of compressors according to inlet flow of gas from Binak and Golkhari clusters. | Consequences: 1.1.1.1,  2.1.1.1 | | Contractor | Closed |
| 2. Define low alarm on PI-2102. | Consequences: | 1.1.1.1 | Contractor | Closed |
| 3. General recommendation: Proxy limit switch signal of ESDVs in BINAK compressor station should be routed directly to DCS. | Consequences: | 1.1.2.1 | Contractor | Closed |
| 4. Note on P&ID (BK-GCS-PEDCO-120-PR-PI-0002) Min distance for purge connection of Binak line to barred tee. | Consequences: | 1.6.1.1 | Contractor | Closed |
| 5. Relocate check valve and corrosion inhibitor injection of Binak gas to V-2105 to upstream of FCV-2101. | Consequences: | 1.6.1.1 | Contractor | Closed |
| 6. Define low alarm on PI-2104. | Consequences: | 2.1.1.1 | Contractor | Closed |
| 7. Increase design pressure of piping from Golkhari pipeline tie-in point to FCV-2102 for protection against over pressure due to blocked outlet. | Consequences: 2.1.2.2,  2.4.1.1 | | NISOC/Contractor | Closed |
| 8. Show on P&ID (BK-GCS-PEDCO-120-PR-PI-0003) purge connection of Golkhari line at min distance to barred tee. | Consequences: | 2.6.1.1 | Contractor | Closed |
| 9. Ball valve on tie-in point of 10" gas pipeline Golkhari BL should be full bore. | Consequences: | 2.8.1.1 | Contractor | Closed |
| 10. Consider future connection from Golkhari pipeline to existing gas compressor station downstream of MOV- 2102B. | Consequences: | 2.8.1.1 | Contractor | Closed |
| 11. Remove auto start signal from LIC-2111 on P-2101A/B. | Consequences: | 3.1.1.1 | Contractor | Closed |
| 12. Define in operating manual of compressor station that on high level of V-2104 operator shall start P-2101A/B and open ESDV-2112. | Consequences: | 3.1.1.1 | Contractor | Closed |
| 13. Define logic that PALL-2115 should be suppressed during pump P-2101A/B start. | Consequences: | 3.1.1.1 | Contractor | Closed |
| 14. Inlet isolation of V-2104 should be locked open. | Consequences: | 3.1.5.1 | Contractor | Closed |
| 15. Define in operating manual of compressor station that always one of bypass valve and inlet valve of V-2104 shall be open. | Consequences: | 3.1.5.1 | Contractor | Closed |
| 16. Show on P&ID (BK-GCS-PEDCO-120-PR-PI-0004) pump pit for P-2101A/B. | Consequences: | 3.1.6.1 | Contractor | Closed |
| 17. Install check valve on 2" line from close drain pump P- 2202A/B to V-2104. | Consequences: | 3.3.1.1 | Contractor | Closed |
| 18. Install TRV on pipeline from P-2101A/B to Binak cluster downstream of isolation valve of CGS BL. | Consequences: | 3.4.3.1 | Contractor | Closed |
| 19. Full vacuum should be considered for design pressure of V-2104. | Consequences: | 3.5.1.1 | Contractor | Closed |
| 20. 3" drain valves on V-2104 should be connected to close drain. | Consequences: | 3.8.1.1 | Contractor | Closed |

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| **Recommendations** | | **Place(s) Used** | | **Responsibility** | **Status** |
| 21. Suction and discharge flanges of P-2101A/B should be 300#. | | Consequences: 3.10.1.1 | | Contractor | Closed |
| 22. Bypass valve of V-2104 should be ball type. | | Consequences: 3.10.1.1 | | Contractor | Closed |
| 23. | Show on P&ID (BK-GCS-PEDCO-120-PR-PI-0004) vent  connection of P-2101. | Consequences: 3.10.1.1 | | Contractor | Closed |
| 24. Inlet isolation valve of V-2105 should be locked open. | | Consequences: | 4.4.1.1 | Contractor | Closed |
| 25. Full vacuum should be considered for design pressure of V-2105. | | Consequences: | 4.5.1.1 | Contractor | Closed |
| 26. Remove bypass over XV-2110. | | Consequences: | 4.5.2.2 | Contractor | Closed |
| 27. LAHH-2117 should activate ESD-1. | | Consequences: | 4.6.1.1 | Contractor | Closed |
| 28. | LCV-2114 should be FC. | Consequences: | 4.7.1.1 | Contractor | Closed |
| 29. Valve arrangement on close drain connection of 1st stage gas compression manifold should be as ball valve, spectacle , check valve. | | Consequences: | 4.8.1.1 | Contractor | Closed |
| 30. Consider spectacle blind on 2" drain line of V-2105, nozzle D. | | Consequences: | 4.8.1.1 | Contractor | Closed |
| 31. Change type of 10" bypass valve over V-2105 to ball type. | | Consequences: 4.10.1.1 | | Contractor | Closed |
| 32. | Remove TIT-2111 and TIT-2113. | Consequences: 4.10.1.1 | | Contractor | Closed |
| 33. Remove LG-2115 and LIT-2116 from V-2105 and connect upper leg of LG-2116 and LIT-2119 to nozzle L1 of vessel. | | Consequences: 4.10.1.1 | | Contractor | Closed |
| 34. Define in operating manual of compressor station that operator should adjust compressor capacity according to station flow rate. | | Consequences: | 5.1.1.1 | Contractor | Closed |
| 35. Install check valve at 2nd stage discharge, downstream of spill back branch (at min distance to XV-2133A) and install check valve at inlet to each compressor train upstream of spill back branch. | | Consequences: | 5.2.1.1 | Contractor | Closed |
| 36. Consider limit switch for spill back valve PCV-2123A. | | Consequences: | 5.2.1.1 | Contractor | Closed |
| 37. Study requirement to consider over pressure protection for V-2101 due to opening of spill back valve PCV-2123A. | | Consequences: | 5.2.1.1 | Contractor | Open |
| 38. Correct P&ID of air coolers of compressors according to data sheet. | | Consequences: 5.4.3.1,  6.4.3.1 | | Contractor | Closed |
| 39. Consider block valves for N2 supply lines to compressor packages. | | Consequences: 5.10.1.1 | | Contractor | Closed |
| 40. Consider maintenance lock for fan of air coolers in data sheet. | | Consequences: 5.10.1.1 | | Contractor | Closed |
| 41. Consider drain connection on low point of line between V- 2101A and compressor. | | Consequences: 5.11.1.1 | | Contractor | Closed |
| 42. General recommendation: All solenoids with signal in ESD system should have manual reset. | | Consequences: 5.12.1.1 | | Contractor | Closed |
| 43. Relocate sample connections of compressor suctions to Binak and Golkhari inlet lines and also on Inlet KO Drum outlet line. | | Consequences: 5.12.1.1 | | Contractor | Closed |

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| **Recommendations** | | **Place(s) Used** | | **Responsibility** | **Status** |
| 44. Provide XV with remote access for depressurizing of 1st stage suction drum of compressors to give more operability during maintenance. | | Consequences: | 6.7.2.2 | NISOC/Contractor | Closed |
| 45. Define high level alarm on LT-2132 also define discrepancy alarm between LT-2131 and LT-2132 in DCS. | | SIL determination: 6.8.1.1 | | Contractor | Closed |
| 46. Consider drain connection on low point of line between V- 2102A and compressor. | | Consequences: 6.11.1.1 | | Contractor | Closed |
| 47. Remove sample connection on suction and discharge of compressor 2nd stage. | | Consequences: 6.12.1.1 | | Contractor | Closed |
| 48. Correct on P&ID that outlet pipe of BDV 2141 is connected directly to flare header separated from tail pipe of PSVs | | Consequences: | 7.5.1.1 | Contractor | Closed |
| 49. Full vacuum should be considered for design pressure of V-2103. | | Consequences: | 7.5.2.1 | Contractor | Closed |
| 50. Show on P&ID stand pipe for LG-2141 and LIT-2141. | | Consequences: | 7.6.1.1 | Contractor | Closed |
| 51. As per drain configuration, consider gate valve, spectacle and globe valve arrangement for bypass of XV-2144. | | Consequences: | 7.7.1.2 | Contractor | Closed |
| 52. Consider spectacle blind on B2 nozzle of V-2103. | | Consequences: | 7.8.1.1 | Contractor | Closed |
| 53. Consider spectacle blind on corrosion inhibitor injection line to V-2103 after check valve. | | Consequences: | 7.8.1.1 | Contractor | Closed |
| 54. Show on P&ID line number and inlet reducer of XV-2143. | | Consequences: 7.10.1.1 | | Contractor | Closed |
| 55. | Remove TG-2143. | Consequences: 7.10.1.1 | | Contractor | Closed |
| 56. Define high alarm on PIC-2152. | | Consequences: | 8.1.1.1 | Contractor | Closed |
| 57. Show dedicated control blocks for PCV-2152 and PCV- 2151. | | Consequences: | 8.1.1.1 | Contractor | Closed |
| 58. Failure mode of PCV-2151 should be FC and failure mode of PCV-2152 should be FO. | | Consequences: | 8.1.2.2 | Contractor | Closed |
| 59. | Class of PCV-2151, PCV-2152 and BDV-2151 should be 600#. | Consequences: | 8.1.2.2 | Contractor | Closed |
| 60. General recommendation: check size of control valves to be compatible with IPS requirements. | | Consequences: | 8.1.2.2 | Contractor | Closed |
| 61. Consider check valve on 2" closed drain connection from dehydration package. | | Consequences: | 8.3.1.1 | Contractor | Closed |
| 62. Check with vendor requirement for sizing PSV on dehydration package for blocked outlet scenario. | | Consequences: | 8.4.1.1 | Contractor | Open |
| 63. Define low alarm on PIC-2152. | | Consequences: | 8.5.1.1 | Contractor | Closed |
| 64. Show on P&ID of dehydration package detail of corrosion inhibitor injection valving. | | Consequences: | 8.6.1.1 | Contractor | Closed |
| 65. Equalizing valve on bypass of dehydration package should be 2" and gate valve on this bypass should be changed to ball valve. | | Consequences: | 8.7.1.1 | Contractor | Closed |
| 66. Consider block valve of fuel gas supply line to dehydration package. | | Consequences: | 8.7.1.1 | Contractor | Closed |

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| **Recommendations** | | **Place(s) Used** | | **Responsibility** | **Status** |
| 67. Show on P&ID of dehydration package, BMS and min required signals to/from plant DCS and ESD. | | Consequences: | 8.7.1.1 | Contractor | Closed |
| 68. HAZOP study of dehydration package shall be performed with participation of package vendor. | | Consequences: | 8.7.1.1 | Contractor | Closed |
| 69. Correct on P&ID min flow (including RO) of P-2103A/B to be connected directly to nozzle B2 of TK-2102. | | Consequences: | 9.1.1.1 | Contractor | Closed |
| 70. Remove auto/manual signal from P-2103A/B. | | Consequences: | 9.1.1.1 | Contractor | Closed |
| 71. Consider check valve on glycol line from P-2103A/B to PK-2101. | | Consequences: | 9.3.1.1 | Contractor | Closed |
| 72. Blanketing of TK-2102 should be with N2. | | Consequences: | 9.4.1.1 | Contractor | Closed |
| 73. Consider safety hatch for TK-2102. | | Consequences: | 9.4.1.1 | Contractor | Closed |
| 74. Consider pressure transmitter with high and low alarm on TK-2102. | | Consequences: | 9.4.1.1 | Contractor | Closed |
| 75. PVSV-2161/2162 should be vented to ATM. | | Consequences: | 9.4.1.1 | Contractor | Closed |
| 76. Show vacuum set point of PVSV-2161/2162. | | Consequences: | 9.5.1.1 | Contractor | Closed |
| 77. LIT-2161 and LIT-2162 should be readable at grade in loading area. | | Consequences: | 9.6.1.1 | Contractor | Closed |
| 78. Consider spectacle blind on 2" drain nozzle D of TK-2102. | | Consequences: | 9.8.1.1 | Contractor | Closed |
| 79. Remove check valve on suction of P-2103A/B. | | Consequences: 9.10.1.1 | | Contractor | Closed |
| 80. Correct P&ID of glycol tank and show nozzle A at top of tank. | | Consequences: 9.10.1.1 | | Contractor | Closed |
| 81. Consider PG on discharge of P-2102. | | Consequences: 9.10.1.1 | | Contractor | Closed |
| 82. Number, signal and set points of PTs (PT-2203) for start/stop of standby air compressor should be according to IPS requirements. | | Consequences: 10.1.1.1 | | Contractor | Closed |
| 83. ESD level on PALL-2201A/B/C should be 1A. | | Consequences: 10.1.1.1,  10.1.4.1 | | Contractor | Closed |
| 84. | PCV-2201 should be FC. | Consequences: 10.1.2.1 | | Contractor | Closed |
| 85. Remove ESDV-2231 and consider solenoid on PCV-2201 to close valve by ESD-3. | | Consequences: 10.1.3.1 | | Contractor | Closed |
| 86. Remove mechanical trap from V-2203 and consider mechanical trap for wet air KO drum. | | Consequences: 10.7.1.1 | | Contractor | Closed |
| 87. | PCV-2211 should be FO. | Consequences: 11.1.2.1 | | Contractor | Closed |
| 88. Consider check valve on nitrogen branches to gas compressors. | | Consequences: 11.3.1.1 | | Contractor | Closed |
| 89. Remove mechanical trap from V-2204 and consider mechanical trap for wet air KO drum inside compressor package. | | Consequences: 11.7.1.1 | | Contractor | Closed |
| 90. Remove HC analyzer from nitrogen package. | | Consequences: 11.8.1.1 | | Contractor | Closed |
| 91. Consider check valve on 2" line from P-2201A/B to existing burn pit. | | Consequences: 12.1.1.1 | | Contractor | Closed |
| 92. Remove 2" line connection from closed drain drum to oily | | Consequences: 12.1.1.1 | | Contractor | Closed |

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| **Recommendations** | **Place(s) Used** | **Responsibility** | **Status** |
| water sump. |  |  |  |
| 93. Globe valve on flare nozzle of V-2202 should be changed to ball type. | Consequences: 12.2.1.1 | Contractor | Closed |
| 94. Full vacuum should be considered for design pressure of V-2202. | Consequences: 12.3.1.1 | Contractor | Closed |
| 95. LIT-2223A/B should be float type and consider only one common LT for P-2203A/B. | Consequences: 12.4.2.1 | Contractor | Closed |
| 96. Relocate PALL-2222A/B to between pumps P-2202A/B and suction strainers. | Consequences: 12.5.1.1 | Contractor | Closed |
| 97. Consider spectacle blind on inlet and outlet of P-2201A/B. | Consequences: 12.6.1.1 | Contractor | Closed |
| 98. Relocate PIT-2252 (currently PIT-2222A) from closed drain drum to flare KO drum. | Consequences: 12.7.1.1 | Contractor | Closed |
| 99. valves down stream of P-2202A/B to V-2104 should be LO. | Consequences: 12.7.1.1 | Contractor | Closed |
| 100. Consider PG at discharge of P-2202A/B. | Consequences: 12.7.1.1 | Contractor | Closed |
| 101. Consider remote stop for corrosion inhibitor package (XSP corrected to HSP). | Consequences: 13.1.1.1 | Contractor | Closed |
| 102. Check coverage of CCTV and if required consider CCTV for flare monitoring in control room. | Consequences: 15.1.1.1 | Contractor | Closed |
| 103. Relocate PALL-2251A/B to between pumps P-2201A/B and suction strainers. | Consequences: 15.7.1.1 | Contractor | Closed |
| 104. Consider spectacle blinds on suction and discharge isolation valves of P-2201A/B. | Consequences: 15.8.1.1 | Contractor | Closed |
| 105. Define in operating manual that operator should ensure that always one discharge route of P-2201A/B is open. | Consequences: 15.8.1.1 | Contractor | Closed |
| 106. LIT-2273 should be float type with cage. | Consequences: 16.1.1.1 | Contractor | Closed |
| 107. Define low alarm on PI-2271. | Consequences: 17.1.2.1,  17.1.4.1 | Contractor | Closed |
| 108. Replace PRV-2272 with local flow gauge, ball valve, check valve and globe valve. | Consequences: 17.1.3.1 | Contractor | Closed |
| 109. PSV on V-2205 should be sized for fire case. | Consequences: 17.4.1.1 | Contractor | Closed |
| 110. Full vacuum should be considered for design pressure of V-2205. | Consequences: 17.5.1.1 | Contractor | Closed |
| 111. Note in duty spec of dehydration package that requirement for fuel gas filter should be checked by vendor. | Consequences: 17.9.1.1 | Contractor | Closed |
| 112. Remove fuel gas lines used for blanketing of TK-2102 and V-2107. | Consequences: 17.10.1.1 | Contractor | Closed |
| 113. Remove PT-2281A/B from suction of P-2206A/B and consider local pressure gauge. | Consequences: 18.1.3.1 | Contractor | Closed |
| 114. Define high high and low low trip interlock on LI-2281A/B to trip P-2206A/B. | Consequences: 18.1.3.1 | Contractor | Closed |
| 115. Any surface contamination on diesel oil drum area | Consequences: 18.6.1.1 | Contractor | Closed |

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| **Recommendations** | **Place(s) Used** | **Responsibility** | **Status** |
| should be directed to oily water header. |  |  |  |
| 116. Remove steam out connection for V-2206A/B. | Consequences: 18.8.1.1 | Contractor | Closed |
| 117. Relocate globe valve at discharge of P-2206A/B to downstream of tank filling branch. | Consequences: 18.8.1.1 | Contractor | Closed |
| 118. Consider drain connection at suction and discharge of P- 2206A/B. | Consequences: 18.8.1.1 | Contractor | Closed |
| 119. Remove ESD-1 signal from P-2209. | Consequences: 19.1.1.1 | Contractor | Closed |
| 120. Remove start signal from LT-2293 on P-2104. | Consequences: 20.1.1.1 | Contractor | Closed |
| 121. Consider proper type for LIT-2293. | Consequences: 20.1.1.1 | Contractor | Open |
| 122. Consider PSV on V-2207 sized for regulator failure and fire case scenario. | Consequences: 20.3.1.1,  20.3.2.1 | Contractor | Closed |
| 123. Consider PT with high alarm on V-2107. | Consequences: 20.3.3.1 | Contractor | Closed |
| 124. Full vacuum should be considered for design pressure of V-2107. | Consequences: 20.4.1.1 | Contractor | Closed |
| 125. Consider isolation valve downstream of PRV-2291. | Consequences: 20.7.1.1 | Contractor | Closed |
| 126. Consider spectacle on inlet and outlet lines (nozzle A, nozzle B and pump outlet) of V-2107. | Consequences: 20.7.1.1 | Contractor | Closed |
| 127. Consider drain connection under V-2107. | Consequences: 20.7.1.1 | Contractor | Closed |
| 128. Consider slop for V-2107 towards pump side. | Consequences: 20.7.1.1 | Contractor | Closed |
| 129. Consider connection from P-2104 to oily water system. | Consequences: 20.8.1.1 | Contractor | Closed |
| 130. ESD level on P-2104 should be ESD-1A. | Consequences: 20.9.1.1 | Contractor | Closed |
| 131. Consider connection for loading spent glycol to truck downstream of P-2104. | Consequences: 20.9.1.1 | Contractor | Closed |

* 1. **APPENDIX E – HAZOP WORKSHEETS**

Node: 1. Gas Compression Inlet Gas Pipeline (Binak) Deviation: 1. No/Less Flow

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No/less flow from upstream due to any reason | 1. Low suction pressure for station and waste of energy | 1. Low suction pressure protection of compressor | 1. Define in operating procedure that operator should change capacity of compressors according to inlet flow of gas from Binak and Golkhari clusters. |
| 2. Low pressure alarm on compressor 1st stage and spill back control | 2. Define low alarm on PI-2102. |
| 3. FAL-2101 |
| 2. ESDV-2101 closed by failure or error | 1. Low suction pressure for station and decreased production | 1. Low suction pressure protection of compressor | 3. General recommendation: Proxy limit switch signal of ESDVs in BINAK compressor station should be routed directly to DCS. |
| 2. Low pressure alarm on compressor 1st stage and spill back control |
| 3. Limit switch on valve |
| 4. FAL-2101 |
| 2. Increased pressure upstream of valve with possibility of damage to pipeline | 1. High pressure protection in Binak Cluster |  |
| 3. High pressure at inlet of existing station | 1. High pressure protection (flare) in existing Binak gas station inlet K.O drum |  |
| 3. FCV-2101 closed more by a failure in any elements of its control loop | 1. Same as above | 1. Low suction pressure protection of compressor |  |
| 2. Low pressure alarm on compressor 1st stage and spill back control |
| 3. FAL-2101 (dependent) |
| 4. High pressure protection in Binak Cluster |
| 5. High pressure protection (flare) in existing Binak gas station inlet K.O drum |

Node: 1. Gas Compression Inlet Gas Pipeline (Binak) Deviation: 2. More Flow

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. FCV-2101 open more by a failure in any elements of its control loop | 1. Increased pressure in compressor suction with no hazardous consequence for compressors but decreased efficiency of dehydration package | 1. See Dehydration package node for safeguard |  |
| 2. FAH-2101  (dependent) |

Node: 1. Gas Compression Inlet Gas Pipeline (Binak) Deviation: 3. Reverse/Misdirected Flow

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 1. Gas Compression Inlet Gas Pipeline (Binak) Deviation: 4. High Pressure

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. High pressure from Binak cluster due to any reason | 1. No hazardous consequence due to design pressure |  |  |
| 2. Shutdown of downstream compressor station | 1. Increased pressure up to Binak cluster max pressure with possibility of damage to inlet K.O drum | 1. PAHH-2116 that will activate ESD-1 |  |
| 2. PSV-2113/2114 on V-  2105 |

Node: 1. Gas Compression Inlet Gas Pipeline (Binak) Deviation: 5. Low Pressure

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No new issue was identified |  |  |  |

Node: 1. Gas Compression Inlet Gas Pipeline (Binak) Deviation: 6. Maintenance Hazards

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 4. Note on P&ID (BK-GCS- PEDCO-120-PR-PI-0002) Min distance for purge connection of Binak line to barred tee. |
| 5. Relocate check valve and corrosion inhibitor injection of Binak gas to V-2105 to upstream of FCV-2101. |

Node: 1. Gas Compression Inlet Gas Pipeline (Binak) Deviation: 7. Corrosion

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Moisture and sulphur content in gas | 1. Damage to equipment and piping | 1. Corrosion monitoring (CP/CC) |  |
| 2. Corrosion inhibitor injection |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 1. No/Less Flow

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No/less flow from upstream due to any reason | 1. Low suction pressure for station and waste of energy | 1. Low suction pressure protection of compressor | 1. Define in operating procedure that operator should change capacity of compressors according to inlet flow of gas from Binak and Golkhari clusters. |
| 2. Low pressure alarm on compressor 1st stage and spill back control | 6. Define low alarm on PI-2104. |
| 3. FAL-2102 |
| 2. MOV-2102B closed by error | 1. Low suction pressure for station and decreased production | 1. Low suction pressure protection of compressor |  |
| 2. Low pressure alarm on compressor 1st stage and spill back control |
| 3. Limit switch on valve |
| 4. FAL-2102 |
| 2. Increased pressure upstream of valve with possibility of damage to piping upstream of valve |  | 7. Increase design pressure of piping from Golkhari pipeline tie-in point to FCV-2102 for protection against over pressure due to blocked outlet. |
| 3. ESDV-2102 closed by failure or error | 1. Low suction pressure for station and decreased production | 1. Low suction pressure protection of compressor |  |
| 2. Low pressure alarm on compressor 1st stage and spill back control |
| 3. Limit switch on valve |
| 4. FAL-2102 |
| 2. Increased pressure upstream |  |  |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 1. No/Less Flow

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  | of valve with possibility of damage to piping upstream of valve |  |  |
| 4. FCV-2102 closed more by a failure in any elements of its control loop | 1. Same as above | 1. Low suction pressure protection of compressor |  |
| 2. Low pressure alarm on compressor 1st stage and spill back control |
| 3. FAL-2102 (dependent) |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 2. More Flow

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. FCV-2102 open more by a failure in any elements of its control loop | 1. Increased pressure in compressor suction with no hazardous consequence for compressors but decreased efficiency of dehydration package | 1. See Dehydration package node for safeguard |  |
| 2. FAH-2102  (dependent) |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 3. Reverse/Misdirected Flow

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 4. High Pressure

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| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. High pressure from Golkhari cluster due to any reason | 1. Possibility of damage to piping due to over pressure and fire and personnel injury |  | 7. Increase design pressure of piping from Golkhari pipeline tie-in point to FCV-2102 for protection against over pressure due to blocked outlet. |
| 2. Shutdown of downstream compressor station | 1. Increased pressure up to Golkhari cluster max pressure with possibility of damage to slug catcher | 1. PAHH-2111 that will activate ESD-1 |  |
| 2. PSV-2111/2112 on V-  2104 |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No new issue was identified |  |  |  |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 6. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 8. Show on P&ID (BK-GCS- PEDCO-120-PR-PI-0003) purge connection of Golkhari line at min distance to barred tee. |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 7. Corrosion

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Moisture and sulphur content in gas | 1. Damage to equipment and piping | 1. Corrosion monitoring (CP/CC) |  |
| 2. Corrosion inhibitor injection |

Node: 2. Gas Compression Inlet Gas Pipeline (Golkhari) Deviation: 8. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 9. Ball valve on tie-in point of 10" gas pipeline Golkhari BL should be full bore. |
| 10. Consider future connection from Golkhari pipeline to existing gas compressor station downstream of MOV- 2102B. |

Node: 3. Slug Catcher System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. P-2101A/B fail to start when required | 1. Accumulation of liquid in slug catcher with no hazardous consequence | 1. LAH-2111 | 11. Remove auto start signal from LIC-2111 on P-2101A/B. |
| 2. Standby pump | 12. Define in operating manual of compressor station that on high level of V-2104 operator shall start P-2101A/B and |

Node: 3. Slug Catcher System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  |  | open ESDV-2112. |
| 13. Define logic that PALL-2115 should be suppressed during pump P-2101A/B start. |
| 2. Plugging of pump strainer | 1. Possibility of damage to pump | 1. PALL-2114A/B that will activate ESD-3 and stop pump P- 2101A/B |  |
| 2. Local PDG-2114A/B |
| 3. FCV-2111 closed more by a failure in any elements of its control loop | 1. Possibility of damage to pump due to high pressure | 1. PAHH-2116A/B that will activate ESD-3 |  |
| 4. ESDV-2112 closed by failure or error | 1. Same as above | 1. Limit switch on valve |  |
| 5. Downstream compressor shutdown | 1. High pressure of V-2104 up to Golkhari cluster pressure with possibility of damage, fire and injury | 1. PAHH-2111 that will activate ESD-1 | 14. Inlet isolation of V-2104 should be locked open. |
| 2. PAH-2112 | 15. Define in operating manual of compressor station that always one of bypass valve and inlet valve of V-2104 shall be open. |
| 3. PSV-2111/2112 on V-  2104 |
| 6. Plugging of demister pad in V-2104 | 1. Low suction pressure for compressors and also possibility of damage to demister | 1. PDAH-2111 | 16. Show on P&ID (BK-GCS- PEDCO-120-PR-PI-0004) pump pit for P-2101A/B. |

Node: 3. Slug Catcher System Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. FCV-2111 open more by a failure in any elements of its control loop | 1. Possibility of over current for P-2101A/B | 1. Over current protection in MCC |  |

Node: 3. Slug Catcher System Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 17. Install check valve on 2" line from close drain pump P- 2202A/B to V-2104. |
| 2. Check valves are considered where required for other streams |  |  |  |

Node: 3. Slug Catcher System Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. External fire case for V-2104 | 1. Damage to equipment | 1. PSV-2111/2112 on V-  2104 |  |
| 2. Blocked outlet at gas line from V-2104 | 1. Damage to equipment | 1. PSV-2111/2112 on V-  2104 |  |
| 3. Line box-in and thermal expansion for pipeline from P-2101A/B to Binak cluster | 1. Damage to pipeline |  | 18. Install TRV on pipeline from P-2101A/B to Binak cluster downstream of isolation valve of CGS BL. |

Node: 3. Slug Catcher System Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Maloperation during steam out at startup | 1. Vacuum formation and V- 2104 collapse |  | 19. Full vacuum should be considered for design pressure of V-2104. |

Node: 3. Slug Catcher System Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Entrance of large amount of liquid to V-2104 due to upset in Golkhari cluster | 1. Carry over of liquid to inlet KO drum and compressors with possibility of damage to compressor | 1. LAHH-2112 that will activate ESD-1 |  |
| 2. LAHH-2117 that will activate ESD-3 on inlet KO drum |
| 3. LAHH-2122A/B/C that will activate ESD-2 and trip compressor |

Node: 3. Slug Catcher System Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. P-2101A/B remain in service when not required | 1. Damage to pump | 1. LAL-2111 that will stop pump |  |
| 2. LALL-2112 that will activate ESD-3 and stop pumps |
| 3. PALL-2114A/B that will activate ESD-3 and stop pumps |

Node: 3. Slug Catcher System Deviation: 8. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 20. 3" drain valves on V-2104 should be connected to close drain. |

Node: 3. Slug Catcher System Deviation: 9. Corrosion

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Corrosion due to sulphur and moisture content | 1. Damage to equipment and piping in long term | 1. Corrosion monitoring (CP/CC) |  |
| 2. Liquid line from V- 2104 to P-2101A/B is Stainless Steel |

Node: 3. Slug Catcher System Deviation: 10. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 21. Suction and discharge flanges of P-2101A/B should be 300#. |
| 22. Bypass valve of V-2104 should be ball type. |
| 23. Show on P&ID (BK-GCS- PEDCO-120-PR-PI-0004) vent connection of P-2101. |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Compressors shutdown due to any reason | 1. Blocked outlet for V-2105 and possibility of damage, fire and personnel injury | 1. PAH-2117 |  |
| 2. PAHH-2116 that will activate ESD-1 |
| 3. PSV-2113/2114 on V-  2105 |
| 2. Plugging of demister pad in V-2105 | 1. Low suction pressure for compressors and also possibility of damage to demister | 1. PDAH-2112 |  |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. External fire case for V-2105 | 1. Damage to equipment | 1. PSV-2113/2114 on V-  2105 | 24. Inlet isolation valve of V-2105 should be locked open. |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Maloperation during steam out at startup | 1. Vacuum formation and V- 2105 collapse |  | 25. Full vacuum should be considered for design pressure of V-2105. |
| 2. XV-2110 open by failure or error | 1. Waste of gas to flare with environmental effect | 1. Limit switch on valve |  |
| 2. PAL-2117 |
| 2. Loss of suction pressure for compressors | 1. Low suction pressure protection of compressor | 26. Remove bypass over XV- 2110. |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. LCV-2114 remained closed for long time | 1. Accumulation of liquid in inlet KO drum and carry over to compressors suction drums and fuel gas KO drum | 1. LAH-2119  (dependent) | 27. LAHH-2117 should activate ESD-1. |
| 2. LAHH-2117 that will activate ESD-3 |
| 3. High level alarm protection on compressor suction drum and fuel gas KO drum |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 2. ESDV-2113 remained closed by failure or error for long time | 1. Same as above |  |  |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. LCV-2114 remained open when not required | 1. Low level in V-2105 and gas blowby via closed drain to flare | 1. LAL-2119 (dependent) | 28. LCV-2114 should be FC. |
| 2. LALL-2118 that will activate ESD-3 and close ESDV-2113 |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 8. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 29. Valve arrangement on close drain connection of 1st stage gas compression manifold should be as ball valve, spectacle , check valve. |
| 30. Consider spectacle blind on 2" drain line of V-2105, nozzle D. |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 9. Corrosion

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Corrosion due to sulphur and moisture content | 1. Damage to equipment and piping in long term | 1. Corrosion monitoring (CP/CC) |  |
| 2. Corrosion inhibitor injection is considered |
| 3. Liquid line from V- 2105 to LCV-2104 is Stainless Steel |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 10. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 31. Change type of 10" bypass valve over V-2105 to ball type. |

Node: 4. Gas Compression Inlet Knock Out Drum Deviation: 10. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  |  | 32. Remove TIT-2111 and TIT- 2113. |
| 33. Remove LG-2115 and LIT- 2116 from V-2105 and connect upper leg of LG-2116 and LIT-2119 to nozzle L1 of vessel. |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Decreased flow from upstream due to any reason | 1. Low suction pressure with possibility of damage to compressors due to over heating | 1. PAL-2121A | 34. Define in operating manual of compressor station that operator should adjust compressor capacity according to station flow rate. |
| 2. PALL-2122A that will activate ESD-2 |
| 3. PAL-2123A/PAL- 2124A/PAL- 2132A/FAL- 2121A/FAL-2131A inside compressor package |
| 4. Spill back valve will open by PIC-2121A |
| 5. Internal high temperature protection in compressor package |
| 2. XV-2121A closed by failure or error (any failure out of UCP) | 1. Loss of suction pressure for one compressor with possibility of damage to compressor due to over heating | 1. PAL-2121A |  |
| 2. PALL-2122A that will activate ESD-2 |
| 3. PAL-2123A/PAL- 2124A/PAL- 2132A/FAL- 2121A/FAL-2131A inside compressor package |
| 4. Limit switch on valve |
| 5. Spill back valve will open by PIC-2121A |
| 6. Internal high temperature protection in compressor package |
| 3. XV-2121A closed by failure | 1. Loss of suction pressure for | 1. PAL-2121A |  |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| or error (any failure inside UCP) | one compressor with possibility of damage to compressor due to over heating | 2. PALL-2122A that will activate ESD-2 |  |
| 4. PCV-2123A closed more when required to be open | 1. Low suction pressure in compressor with possibility of vacuum formation | 1. V-2101A is designed for full vacuum |  |
| 2. PAL-2121A  (dependent) |
| 3. PALL-2122A that will activate ESD-2 |
| 4. PAL-2123A/PAL- 2124A/PAL- 2132A/FAL- 2121A/FAL-2131A inside compressor package |
| 5. Plugging of demister pad | 1. Same as above |  |  |
| 2. Possibility of damage to demister pad | 1. PDAH-2121A |  |
| 6. Plugging of compressor suction strainer | 1. Low suction pressure in compressor and damage to strainer | 1. PDIT-2122A inside compressor package |  |
| 7. Compressor failure or trip | 1. Decreased capacity of station | 1. Spare compression train is considered |  |
| 2. Increased pressure upstream of compressor with possibility of damage due to over pressure, leakage and fire | 1. PSVs on V-2104 and V-2105 are designed for blocked outlet |  |
| 2. PAHH-2122 that will activate ESD-2 |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. PCV-2123A open more when required to be closed | 1. High suction pressure with possibility of damage to suction, leakage and fire | 1. PAH-2124A/PAH- 2123A/PAH-2132A inside compressor package | 35. Install check valve at 2nd stage discharge, downstream of spill back branch (at min distance to XV-2133A) and install check valve at inlet to each compressor train upstream of spill back branch. |
| 2. PAHH-2122A that will activate ESD-2 | 36. Consider limit switch for spill back valve PCV-2123A. |
| 37. Study requirement to consider over pressure protection for V- |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  |  | 2101 due to opening of spill back valve PCV-2123A. |
| 2. High suction temperature with possibility of damage to compressor | 1. TAH-2121A |  |
| 2. TAH-2122A inside compressor package |
| 3. TAHH-2124A that will activate ESD-2 |
| 4. High temperature protection inside compressor package |
| 3. Low 2nd stage discharge pressure and decreased capacity of train | 1. PAL-2132A |  |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 4. High Temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Mechanical failure in compressor package | 1. Damage to compressor or discharge piping | 1. TAH-2123A inside compressor package |  |
| 2. TAHH-2124A that will activate ESD-2 |
| 2. Decreased flow through compressor | 1. Same as above | 1. FAL-2121A |  |
| 2. TAH-2123A inside compressor package |
| 3. TAHH-2124A that will activate ESD-2 |
| 3. Air cooler fan failure or trip | 1. High temperature of 2nd stage with possibility of damage to it | 1. TAH-2126A | 38. Correct P&ID of air coolers of compressors according to data sheet. |
| 2. TAHH-2125A that will activate ESD-2 |
| 3. Two pairs of air coolers are considered |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers

Deviation: 5. Low Temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. More cooling in air coolers due to wrong adjustment of pitch | 1. Waste of energy with no hazardous consequence | 1. TAL-2126A |  |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 6. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. External fire case for V- 2101A | 1. Damage to equipment | 1. PSV-2121A |  |
| 2. Blocked outlet for compressor 1st stage discharge | 1. Damage to equipment | 1. PSV-2122A/2123A |  |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 7. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No new issue was identified |  |  |  |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 8. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2122A remained closed when required to be open | 1. Accumulation of liquid in V- 2101A and carry over to compressor with possibility of damage | 1. LAH-2121A  (dependent) |  |
| 2. LAHH-2122A that will activate ESD-2 and trip compressor |
| 3. LAHH-2117 that will activate ESD-3 on inlet KO drum |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 9. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2122A remained open | 1. Gas blowby via closed drain header to flare and waste of gas | 1. LAL-2121A  (dependent) |  |
| 2. LALL-2122A that will activate ESD-3 and close XV-2122A |
| 2. Slight decreased suction pressure of compressor | 1. PAL-2121A |  |
| 2. PAL-2123A/PAL- |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 9. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  | 2124A/PAL-  2132A/FAL-  2121A/FAL-2131A  inside compressor package |  |
| 3. Spill back valve will open by PIC-2121A |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 10. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 39. Consider block valves for N2 supply lines to compressor packages. |
| 40. Consider maintenance lock for fan of air coolers in data sheet. |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 11. Loss of Utilities

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. failure of electrical tracing at compressor suction | 1. Possibility of condensation in cold season | 1. Inspection & maintenance procedures | 41. Consider drain connection on low point of line between V- 2101A and compressor. |

Node: 5. 1st Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 12. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 42. General recommendation: All solenoids with signal in ESD system should have manual reset. |
| 43. Relocate sample connections of compressor suctions to Binak and Golkhari inlet lines and also on Inlet KO Drum outlet line. |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Decreased flow from upstream due to any reason | 1. Low suction pressure with possibility of damage to compressors due to over heating | 1. PALL-2131A that will activate ESD-2 |  |
| 2. PAL-2123A/PAL- 2124A/PAL- 2132A/FAL- 2121A/FAL-2131A inside compressor package |
| 3. Spill back valve will open by PIC-2121A |
| 4. Internal high temperature protection in compressor package |
| 2. Plugging of demister pad | 1. Same as above |  |  |
| 2. Possibility of damage to demister pad | 1. PDAH-2131A |  |
| 3. Plugging of compressor suction strainer | 1. Low suction pressure in compressor and damage to strainer | 1. PDIT-2132A inside compressor package |  |
| 4. Compressor failure or trip | 1. Decreased capacity of station | 1. Spare compression train is considered |  |
| 2. Increased pressure upstream of compressor with possibility of damage due to over pressure | 1. PSVs on V-2104 and V-2105 are designed for blocked outlet |  |
| 2. PAHH-2122 that will activate ESD-2 |
| 5. XV-2133A closed by failure or error | 1. Blocked outlet for compressor and damage to it | 1. PSV-2132A/2133A |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 4. High Temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Mechanical failure in compressor package | 1. Damage to compressor or discharge piping | 1. TAH-2133A inside compressor package |  |
| 2. TAHH-2134A that will activate ESD-2 |
| 2. Decreased flow through compressor | 1. Same as above | 1. FAL-2131A |  |
| 2. TAH-2133A inside compressor package |
| 3. TAHH-2134A that will activate ESD-2 |
| 3. Air cooler fan failure or trip | 1. High temperature of 2nd stage discharge with possibility of damage to downstream piping | 1. TAH-2135A | 38. Correct P&ID of air coolers of compressors according to data sheet. |
| 2. TAHH-2136A that will activate ESD-2 |
| 3. Two pairs of air coolers are considered |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 5. Low Temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. More cooling in air coolers due to wrong adjustment of pitch | 1. Waste of energy with no hazardous consequence | 1. TAL-2135A |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 6. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. External fire case for V- 2102A | 1. Damage to equipment | 1. PSV-2131A |  |
| 2. Blocked outlet for compressor 2nd stage discharge | 1. Damage to equipment, leakage and fire | 1. PSV-2132A/2133A |  |
| 2. PAHH-2134 that will activate ESD-2 |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 7. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. BDV-2134A open by failure or error | 1. Waste of gas to flare with environmental effect | 1. Limit switch on valve |  |
| 2. Low suction pressure for 2nd stage and possibility of | 1. PALL-2131A that will activate ESD-2 |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 7. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  | damage to compressor due to over heating | 2. Internal high temperature protection in compressor package |  |
| 3. Low temperature after BDV with no hazardous consequence |  |  |
| 2. BDV-2132A open by failure or error | 1. Waste of gas to flare with environmental effect | 1. Limit switch on valve |  |
| 2. Low temperature after BDV with possibility of freezing | 1. Methanol injection is considered | 44. Provide XV with remote access for depressurizing of 1st stage suction drum of compressors to give more operability during maintenance. |
| 3. PCV-2135A open more when required to be closed | 1. Waste of gas to flare with environmental effect | 1. PAL-2135A  (dependent) |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 8. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2131A remained closed when required to be open | 1. Accumulation of liquid in V- 2102A and carry over to compressor with possibility of damage | 1. LAH-2131A  (dependent) |  |
| 2. LAHH-2132A that will activate ESD-2 and trip compressor |
| 3. Operator will be alerted by high level alarm (recommendation) |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 9. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2131A remained open | 1. Gas blowby via closed drain header to flare and waste of gas | 1. LAL-2131A  (dependent) |  |
| 2. LALL-2132A that will activate ESD-3 and close XV-2131A |
| 2. Possibility of high pressure in closed drain drum | 1. Closed drain in connected to flare header with locked open valve |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 9. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  | 3. Slight decreased suction pressure of compressor | 1. FAL-2131A/PAL- 2132A inside compressor package |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 10. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No new issue was identified |  |  |  |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 11. Loss of Utilities

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. failure of electrical tracing at compressor suction | 1. Possibility of condensation in cold season | 1. Inspection & maintenance procedures | 46. Consider drain connection on low point of line between V- 2102A and compressor. |

Node: 6. 2nd Stage Gas Compression Suction Drums, Compressors and Air Coolers Deviation: 12. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 47. Remove sample connection on suction and discharge of compressor 2nd stage. |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2142 closed by failure or error | 1. Blocked outlet for compressor station and damage to equipment, fire and personnel injury | 1. PSV-2141/2142 |  |
| 2. High pressure safeguards on compressor discharge |
| 2. XV-2143 closed by failure or error during startup | 1. Delay in startup |  |  |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. External fire case for V-2103 | 1. Damage to equipment | 1. PSV-2141 |  |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. BDV-2141 open by failure or error | 1. Waste of gas to flare with environmental effect | 1. Limit switch on valve | 48. Correct on P&ID that outlet pipe of BDV 2141 is connected directly to flare header separated from tail pipe of PSVs |
| 2. Possibility of freezing of line | 1. Methanol injection is considered |  |
| 2. Maloperation during steam out at startup | 1. Vacuum formation and V- 2103 collapse |  | 49. Full vacuum should be considered for design pressure of V-2103. |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2144 closed by failure or error | 1. High level in V-2103 and carry over to dehydration package and degradation of glycol | 1. LAH-2141  (dependent) | 50. Show on P&ID stand pipe for LG-2141 and LIT-2141. |
| 2. LAHH-2142 that will activate ESD-1 |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2144 remained open by failure or error | 1. Gas blowby via closed drain header to flare and waste of gas | 1. LAL-2141 (dependent) |  |
| 2. LALL-2142 that will activate ESD-3 and close XV-2144 |
| 2. Possibility of high pressure in closed drain drum | 1. Closed drain in connected to flare | 51. As per drain configuration, consider gate valve, spectacle |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  | header with locked open valve | and globe valve arrangement for bypass of XV-2144. |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 8. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 52. Consider spectacle blind on B2 nozzle of V-2103. |
| 53. Consider spectacle blind on corrosion inhibitor injection line to V-2103 after check valve. |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 9. Corrosion

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Corrosion due to sulphur and moisture content | 1. Damage to equipment and piping in long term | 1. Corrosion monitoring (CP/CC) |  |
| 2. Corrosion inhibitor injection is considered |
| 3. Liquid line from V- 2103 to XV-2144 is Stainless Steel |

Node: 7. 2nd Stage Gas Compression Discharge Drum Deviation: 10. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 54. Show on P&ID line number and inlet reducer of XV-2143. |
| 55. Remove TG-2143. |

Node: 8. Gas Compression Dehydration Package Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Decreased flow to downstream due to any blockage in pipeline or Siahmakan facilities | 1. Increased pressure for dehydration package and change in operating condition of it that will lead to more tail gas to flare | 1. PIC-2152 will open PCV-2152 to flare | 56. Define high alarm on PIC- 2152. |
| 57. Show dedicated control blocks for PCV-2152 and PCV-2151. |

Node: 8. Gas Compression Dehydration Package Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 2. PCV-2151 closed more by a failure in any elements of its control loop | 1. Same as above | 1. PIC-2152 will open PCV-2152 to flare (dependent) |  |
| 2. Blocked outlet for compressor station and damage to equipment, fire and personnel injury | 1. Upstream PSVs are designed for blocked outlet | 58. Failure mode of PCV-2151 should be FC and failure mode of PCV-2152 should be FO. |
| 59. Class of PCV-2151, PCV- 2152 and BDV-2151 should be 600#. |
| 60. General recommendation: check size of control valves to be compatible with IPS requirements. |

Node: 8. Gas Compression Dehydration Package Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. PCV-2151 open more by a failure in any elements of its control loop | 1. Decreased pressure and more flow through dehydration package and increased moisture in gas to pipeline | 1. Moisture analyzer inside package with high alarm |  |

Node: 8. Gas Compression Dehydration Package Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 61. Consider check valve on 2" closed drain connection from dehydration package. |

Node: 8. Gas Compression Dehydration Package Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Blocked outlet | 1. Damage to equipment |  | 62. Check with vendor requirement for sizing PSV on dehydration package for blocked outlet scenario. |

Node: 8. Gas Compression Dehydration Package Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. BDV-2151 open by failure or error | 1. Waste of gas to flare with environmental effect | 1. Limit switch on valve | 63. Define low alarm on PIC- 2152. |
| 2. PCV-2152 open more by a failure in any elements of its control loop | 1. Waste of gas to flare with environmental effect |  |  |

Node: 8. Gas Compression Dehydration Package Deviation: 6. Corrosion

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Corrosion due to sulphur and moisture content | 1. Damage to equipment and piping in long term | 1. Corrosion monitoring (CP/CC) | 64. Show on P&ID of dehydration package detail of corrosion inhibitor injection valving. |
| 2. Corrosion inhibitor injection is considered |

Node: 8. Gas Compression Dehydration Package Deviation: 7. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 65. Equalizing valve on bypass of dehydration package should be 2" and gate valve on this bypass should be changed to ball valve. |
| 66. Consider block valve of fuel gas supply line to dehydration package. |
| 67. Show on P&ID of dehydration package, BMS and min required signals to/from plant DCS and ESD. |
| 68. HAZOP study of dehydration package shall be performed with participation of package vendor. |

Node: 9. Lean Glycol Storage Tank Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. P-2103A/B failure or trip | 1. Delay in makeup glycol flow to dehydration | 1. Standby pump is considered | 69. Correct on P&ID min flow (including RO) of P-2103A/B to be connected directly to nozzle B2 of TK-2102. |

Node: 9. Lean Glycol Storage Tank Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  | 2. Intermittent operation | 70. Remove auto/manual signal from P-2103A/B. |

Node: 9. Lean Glycol Storage Tank Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 9. Lean Glycol Storage Tank Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 71. Consider check valve on glycol line from P-2103A/B to PK-2101. |

Node: 9. Lean Glycol Storage Tank Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. PRV-2162 open more by failure | 1. Possibility of damage to tank | 1. PVSV-2161/PVSV- 2162 | 72. Blanketing of TK-2102 should be with N2. |
| 73. Consider safety hatch for TK- 2102. |
| 74. Consider pressure transmitter with high and low alarm on TK-2102. |
| 75. PVSV-2161/2162 should be vented to ATM. |
| 2. PRV-2161 closed more by failure during tank filling | 1. Same as above | 1. PVSV-2161/PVSV- 2162 |  |
| 3. External fire case for TK- 2101 | 1. Damage to tank | 1. PVSV-2161/PVSV- 2162 |  |
| 4. Blocked outlet for P- 2103A/B | 1. High pressure of pump discharge | 1. Min flow is considered |  |

Node: 9. Lean Glycol Storage Tank Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. PRV-2161 closed more by failure during tank level | 1. Vacuum formation and TK- | 1. PVSV-2161/PVSV- | 76. Show vacuum set point of |

Node: 9. Lean Glycol Storage Tank Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| decreasing | 2102 collapse | 2162 | PVSV-2161/2162. |

Node: 9. Lean Glycol Storage Tank Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Operator error and over filling of tank | 1. Over flow from tank and waste of material | 1. LAH-2162 | 77. LIT-2161 and LIT-2162 should be readable at grade in loading area. |
| 2. Dike |

Node: 9. Lean Glycol Storage Tank Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. TK-2102 not refilled at proper time due to error | 1. Loss of fresh glycol to dehydration package | 1. LAL-2162 |  |
| 2. Possibility of damage to P- 2103A/B | 1. LALL-2161 that will activate ESD-3 and stop P-2103A/B |  |

Node: 9. Lean Glycol Storage Tank Deviation: 8. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 78. Consider spectacle blind on 2" drain nozzle D of TK-2102. |

Node: 9. Lean Glycol Storage Tank Deviation: 9. Corrosion

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Corrosion | 1. Damage to equipment and piping in long term | 1. Corrosion monitoring (CC) |  |

Node: 9. Lean Glycol Storage Tank Deviation: 10. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 79. Remove check valve on suction of P-2103A/B. |
| 80. Correct P&ID of glycol tank and show nozzle A at top of tank. |

Node: 9. Lean Glycol Storage Tank Deviation: 10. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  |  | 81. Consider PG on discharge of P-2102. |

Node: 10. Instrument & Plant Air System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Any failure inside instrument air package and compressors | 1. Low pressure of instrument air and loss of plant control | 1. Instrument air receiver V-2203 with 15 min holdup | 82. Number, signal and set points of PTs (PT-2203) for start/stop of standby air compressor should be according to IPS requirements. |
| 2. Fault alarm on package | 83. ESD level on PALL- 2201A/B/C should be 1A. |
| 3. PAL-2201 |
| 4. PALL-2202 that will activate ESD-3 and closed ESDV-2231 |
| 5. PAL-2203 |
| 6. PALL-2201A/B/C with 2oo3 voting that will activate ESD-1A |
| 2. Low pressure of plant air with no hazardous consequence |  |  |
| 2. PCV-2201 closed more by a failure in any elements of its control loop | 1. Low pressure of plant air with no hazardous consequence |  | 84. PCV-2201 should be FC. |
| 3. ESDV-2231 closed by failure or error | 1. Same as above |  | 85. Remove ESDV-2231 and consider solenoid on PCV- 2201 to close valve by ESD-3. |
| 4. PRV-2201 closed by failure | 1. Low pressure of instrument air and loss of plant control | 1. PALL-2201A/B/C with 2oo3 voting that will activate ESD-1 | 83. ESD level on PALL- 2201A/B/C should be 1A. |

Node: 10. Instrument & Plant Air System Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 10. Instrument & Plant Air System Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 10. Instrument & Plant Air System Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. external fire case for V-2203 | 1. Damage to equipment | 1. PSV-2201A/B |  |
| 2. PRV-2201 open by failure | 1. No hazardous consequence |  |  |
| 3. PCV-2201 open more by a failure in any elements of its control loop | 1. High pressure of plant air header and possible low pressure of instrument air header | 1. PAL-2201  (dependent) |  |
| 2. PALL-2202 that will activate ESD-3 and closed ESDV-2231 |

Node: 10. Instrument & Plant Air System Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. High consumption rate of plant air | 1. Low pressure of instrument air and loss of plant control | 1. Instrument air receiver V-2203 with 15 min holdup |  |
| 2. Fault alarm on package |
| 3. PAL-2201 |
| 4. PALL-2202 that will activate ESD-3 and closed ESDV-2231 |
| 5. PAL-2203 |
| 6. PIC-2201 will control PCV-2201 |

Node: 10. Instrument & Plant Air System Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Accumulation of liquid in V- 2203 | 1. Possibility of damage to instrumentation | 1. Local LG-2201 may be checked by operator |  |

Node: 10. Instrument & Plant Air System Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Failure of mechanical trap | 1. Waste of instrument air |  | 86. Remove mechanical trap from V-2203 and consider mechanical trap for wet air KO drum. |

Node: 10. Instrument & Plant Air System Deviation: 8. Composition

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Loss of performance of dryers | 1. Increased moisture content of instrument air and damage to instrumentation | 1. Moisture analyzer inside package with high alarm |  |

Node: 11. Nitrogen Generation System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Any failure inside Nitrogen package and compressors | 1. Low pressure of nitrogen and loss of seal gas for compressor and also leakage of gas to ATM with possible personnel injury | 1. Nitrogen receiver V- 2204 with 15 min holdup |  |
| 2. Fault alarm on package |
| 3. PAL-2213 |
| 4. PAL-2211 inside package |
| 5. PALL-2211 that will activate ESD-1 |
| 6. Low seal pressure protection inside compressor package |
| 2. Low pressure of nitrogen for utility with no hazardous consequence |  |  |
| 2. PCV-2211 closed more by a failure in any elements of its control loop | 1. Same as above |  | 87. PCV-2211 should be FO. |

Node: 11. Nitrogen Generation System Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. PCV-2211 open more by a failure in any elements of its control loop | 1. Slightly high pressure of nitrogen header with no hazardous consequence |  |  |

Node: 11. Nitrogen Generation System Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 88. Consider check valve on nitrogen branches to gas compressors. |

Node: 11. Nitrogen Generation System Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. external fire case for V-2204 | 1. Damage to equipment | 1. PSV-2211A/B |  |

Node: 11. Nitrogen Generation System Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No new issue was identified |  |  |  |

Node: 11. Nitrogen Generation System Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Accumulation of liquid in V- 2204 | 1. Possibility of damage to compressor seal | 1. Local LG-2211 may be checked by operator |  |

Node: 11. Nitrogen Generation System Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Failure of mechanical trap | 1. Waste of nitrogen |  | 89. Remove mechanical trap from V-2204 and consider mechanical trap for wet air KO drum inside compressor package. |

Node: 11. Nitrogen Generation System Deviation: 8. Composition

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Loss of performance of PSA | 1. Increased moisture/oxygen content of nitrogen and damage to compressor seal | 1. Moisture analyzer inside package with high alarm | 90. Remove HC analyzer from nitrogen package. |
| 2. oxygen analyzer |

Node: 11. Nitrogen Generation System Deviation: 8. Composition

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
|  |  | inside package with high alarm |  |

Node: 12. Closed Drain System Deviation: 1. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 91. Consider check valve on 2" line from P-2201A/B to existing burn pit. |
| 92. Remove 2" line connection from closed drain drum to oily water sump. |

Node: 12. Closed Drain System Deviation: 2. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue since V-2202 is connected to flare header with LO valve |  |  | 93. Globe valve on flare nozzle of V-2202 should be changed to ball type. |

Node: 12. Closed Drain System Deviation: 3. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Maloperation during steam out at startup | 1. Vacuum formation and V- 2202 collapse |  | 94. Full vacuum should be considered for design pressure of V-2202. |

Node: 12. Closed Drain System Deviation: 4. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Accumulation of liquid in V- 2202 | 1. Carry over of liquid to flare KO drum | 1. LIC-2221 will start 1st pump on H1 setpoint and 2nd pump on H2 |  |
| 2. LAH-2221 |
| 2. Accumulation of surface water/rain in closed drain sump | 1. Damage to equipment in sump | 1. LIC-2222A/B will start sump pump | 95. LIT-2223A/B should be float type and consider only one common LT for P-2203A/B. |

Node: 12. Closed Drain System Deviation: 5. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Pump remained in service when not required | 1. Damage to pump | 1. PALL-2222A/B that will activate ESD-3 and stop pump | 96. Relocate PALL-2222A/B to between pumps P-2202A/B and suction strainers. |
| 2. LAL-2221 |

Node: 12. Closed Drain System Deviation: 6. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 97. Consider spectacle blind on inlet and outlet of P-2201A/B. |

Node: 12. Closed Drain System Deviation: 7. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 98. Relocate PIT-2252 (currently PIT-2222A) from closed drain drum to flare KO drum. |
| 99. valves down stream of P- 2202A/B to V-2104 should be LO. |
| 100. Consider PG at discharge of P-2202A/B. |

Node: 13. Corrosion Inhibitor Package Deviation: 1. Loss of Performance

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 101. Consider remote stop for corrosion inhibitor package (XSP corrected to HSP). |

Node: 14. Methanol Injection Package Deviation: 1. Loss of Performance

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No HAZOP issue was identified |  |  |  |

Node: 15. LP Flare System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No/less flow of fuel gas for pilots due to any reason | 1. Pilot flame-off and possibility of dispersion of flammable/toxic gas at flare tip | 1. Pilot status indication | 102. Check coverage of CCTV and if required consider CCTV for flare monitoring in control room. |
| 2. LPG bottle |
| 3. Auto ignition for pilots |

Node: 15. LP Flare System Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Flare system is designed for Max flare scenario |  |  |  |
| 2. More flow of fuel gas for pilots due to any reason | 1. Pilot flame-out and possibility of dispersion of flammable/toxic gas at flare tip | 1. Pilot status indication |  |
| 2. LPG bottle |
| 3. Auto ignition for pilots |

Node: 15. LP Flare System

Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 15. LP Flare System Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Emergency flaring | 1. Pressurizing of flare header and problem for operation of PSVs due to back pressure | 1. flare system is designed for max back pressure |  |

Node: 15. LP Flare System Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 15. LP Flare System Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Accumulation of liquids in flare KO drum due to | 1. Carry over of liquid to stack and damage to it and also | 1. LIC-2251 will start 1st pump on H1 setpoint |  |

Node: 15. LP Flare System Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| process upset | possibility of personnel injury | and 2nd pump on H2 |  |
| 2. LAHH-2252A/B/C that will activate ESD-1 on 2oo3 voting |

Node: 15. LP Flare System Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. P-2201A/B remain in service when not required | 1. Damage to pump | 1. LAL-2251 will stop pump (dependent) | 103. Relocate PALL-2251A/B to between pumps P-2201A/B and suction strainers. |
| 2. LALL-2253 that will activate ESD-3 and stop pumps |
| 3. PALL-2251A/B that will activate ESD-3 and stop pumps |

Node: 15. LP Flare System Deviation: 8. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 104. Consider spectacle blinds on suction and discharge isolation valves of P- 2201A/B. |
| 105. Define in operating manual that operator should ensure that always one discharge route of P-2201A/B is open. |

Node: 16. Oily Water Sewer Deviation: 1. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Accumulation of water in sumo | 1. Over flow from sump to open ditch with environmental effect | 1. LAH-2273 | 106. LIT-2273 should be float type with cage. |

Node: 17. Fuel Gas System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. ESDV-2272 closed by | 1. Loss of fuel gas and loss of | 1. PAL-2272 |  |

Node: 17. Fuel Gas System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| failure or error | operating glycol regeneration | 2. Limit switch on valve |  |
| 2. Loss of fuel gas to flare pilots | 1. LPG bottle |  |
| 3. Loss of flare sweep gas and possibility of flame back to flare stack | 1. Molecular seal is considered for flare |  |
| 2. PCV-2272 closed more by a failure in any elements of its control loop | 1. Same as above | 1. PAL-2272  (dependent) | 107. Define low alarm on PI-2271. |
| 3. PRV-2272 closed by failure | 1. Loss of flare sweep gas and possibility of flame back to flare stack | 1. Molecular seal is considered for flare | 108. Replace PRV-2272 with local flow gauge, ball valve, check valve and globe valve. |
| 4. Plugging of demister | 1. Low pressure of fuel gas system |  | 107. Define low alarm on PI-2271. |

Node: 17. Fuel Gas System Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. PCV-2272 open more by a failure in any elements of its control loop | 1. No hazardous consequence | 1. PAH-2272 |  |

Node: 17. Fuel Gas System

Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 17. Fuel Gas System Deviation: 4. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. external fire case for V-2205 | 1. Damage to equipment | 1. PSV-2271A/B | 109. PSV on V-2205 should be sized for fire case. |

Node: 17. Fuel Gas System Deviation: 5. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Maloperation during steam out at startup | 1. Vacuum formation and V- 2205 collapse |  | 110. Full vacuum should be considered for design pressure of V-2205. |

Node: 17. Fuel Gas System Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Accumulation of liquid in V- 2205 due to carry over from inlet KO drum | 1. Carry over of liquid to fuel gas header and disturbance for users | 1. LAH-2271 |  |
| 2. LIC-2271 will open XV-2271 |
| 3. LAHH-2272 that will activate ESD-3 and close ESDV-2272 |

Node: 17. Fuel Gas System Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. XV-2271 remained open | 1. Gas blowby via closed drain header to flare and waste of gas | 1. LAL-2271 (dependent) |  |
| 2. LIC-2271 will close XV-2271 (dependent) |
| 3. LALL-2272 that will activate ESD-3 and close XV-2271 |

Node: 17. Fuel Gas System Deviation: 8. Corrosion

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Corrosion due to sulphur and moisture content | 1. Damage to equipment and piping in long term | 1. Corrosion monitoring (CP/CC) |  |
| 2. Corrosion inhibitor injection is considered |

Node: 17. Fuel Gas System Deviation: 9. Composition

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 111. Note in duty spec of dehydration package that requirement for fuel gas filter should be checked by vendor. |

Node: 17. Fuel Gas System Deviation: 10. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 112. Remove fuel gas lines used for blanketing of TK-2102 and V-2107. |

Node: 18. Diesel Oil System Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. P-2206A failure or trip | 1. No flow to PK-2207 or fire water pump | 1. Intermittent operation |  |
| 2. P-2206B failure or trip | 1. No flow to diesel generator | 1. Intermittent operation |  |
| 3. Plugging of strainer | 1. Possibility of damage to pump | 1. Intermittent operation | 113. Remove PT-2281A/B from suction of P-2206A/B and consider local pressure gauge. |
| 114. Define high high and low low trip interlock on LI-2281A/B to trip P-2206A/B. |

Node: 18. Diesel Oil System Deviation: 2. More Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 18. Diesel Oil System

Deviation: 3. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 18. Diesel Oil System Deviation: 4. Low Temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. No issue was identified |  |  |  |

Node: 18. Diesel Oil System Deviation: 5. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Blocked in and thermal expansion | 1. Damage to piping | 1. TSV-2281A/B |  |

Node: 18. Diesel Oil System Deviation: 6. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Over filling of vessel by operator error | 1. Over flow from vent and waste of material | 1. LAH-2281A/B | 115. Any surface contamination on diesel oil drum area should be directed to oily water header. |

Node: 18. Diesel Oil System Deviation: 7. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Tank not refilled at proper time by error | 1. Delay in filling daily tank | 1. Intermittent operation |  |
| 2. LAL-2281A/B |

Node: 18. Diesel Oil System Deviation: 8. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 116. Remove steam out connection for V-2206A/B. |
| 117. Relocate globe valve at discharge of P-2206A/B to downstream of tank filling branch. |
| 118. Consider drain connection at suction and discharge of P- 2206A/B. |

Node: 19. Potable Water System Deviation: 1. Loss of Performance

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 119. Remove ESD-1 signal from P-2209. |

Node: 20. Glycol Sump Drum Deviation: 1. No/Less Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. P-2104 failure or trip | 1. Delay in transferring glycol from V-2107 | 1. Intermittent operation | 120. Remove start signal from LT- 2293 on P-2104. |
| 2. LAH-2293 | 121. Consider proper type for LIT- 2293. |

Node: 20. Glycol Sump Drum Deviation: 2. Reverse/Misdirected Flow

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Check valves are considered where required |  |  |  |

Node: 20. Glycol Sump Drum Deviation: 3. High Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. PRV-2291 open by failure | 1. Damage to V-2107 |  | 122. Consider PSV on V-2207 sized for regulator failure and fire case scenario. |
| 2. External fire case for V-2107 | 1. Damage to equipment |  | 122. Consider PSV on V-2207 sized for regulator failure and fire case scenario. |
| 3. PRV-2292 closed by failure when level in V-2107 is increasing | 1. Damage to V-2107 |  | 123. Consider PT with high alarm on V-2107. |

Node: 20. Glycol Sump Drum Deviation: 4. Low Pressure

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Maloperation during steam out at startup | 1. Vacuum formation and V- 2107 collapse |  | 124. Full vacuum should be considered for design pressure of V-2107. |
| 2. PRV-2291 closed by failure when level in V-2107 is decreasing | 1. Possibility of vacuum formation and damage to equipment |  |  |

Node: 20. Glycol Sump Drum Deviation: 5. High Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Accumulation of liquid in V- 2107 | 1. Over filling of vessel and carry over of glycol to vent | 1. LAH-2293 |  |

Node: 20. Glycol Sump Drum Deviation: 6. Low Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. P-2104 remain in service when not required | 1. Damage to pump | 1. LAL-2293 that will stop pump |  |

Node: 20. Glycol Sump Drum Deviation: 7. Maintenance Hazards

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 125. Consider isolation valve downstream of PRV-2291. |
| 126. Consider spectacle on inlet and outlet lines (nozzle A, nozzle B and pump outlet) of V-2107. |
| 127. Consider drain connection under V-2107. |
| 128. Consider slop for V-2107 towards pump side. |

Node: 20. Glycol Sump Drum Deviation: 8. Composition

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. Off spec spent glycol | 1. Contamination of glycol in dehydration package |  | 129. Consider connection from P- 2104 to oily water system. |

Node: 20. Glycol Sump Drum Deviation: 9. Miscellaneous

|  |  |  |  |
| --- | --- | --- | --- |
| **Causes** | **Consequences** | **Safeguards** | **Recommendations** |
| 1. See Recommendation |  |  | 130. ESD level on P-2104 should be ESD-1A. |
| 131. Consider connection for loading spent glycol to truck downstream of P-2104. |

* 1. **APPENDIX F – MARKED-UP P&IDS**