# HAZOP Report

| REV. | DATE | PURPOSE OF ISSUE | PREPARE | CHECK | REVIEW | APPROVE |
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| 0 | 28-10-2016 | Final Issue | YING YI NING | Wang Shih Huang | Wang Shih Huang | |
| A | 05-09-2016 | Issued for Comments | YING YI NING | Wang Shih Huang | Wang Shih Huang | |

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## Objectives

The objective of this HAZOP project is Advanced Control and Information Technology, Inc. (ACIT) to contract TCC in conducting HAZOP study as well as the layer of protection analysis (LOPA) on “MEKPCO Methanol Project”. In order to finalize the design of process packages, it is imperative to have a third party conduct Hazard and Operability (HAZOP) study, so that the fitness of safety and risk control measures in the detailed design can be verified.

The analysis methodology of HAZOP as implemented in this project is in accordance with relevant requirements of “Safety design management guidelines for chemical construction projects” (AQ/T 3033-2010), and the assignment of required Safety Integrity Level (SIL) for Safety Instrumented System (SIS) is in accordance with “Functional safety—Safety instrumented systems for the process industry sector” National Standard (GB/T 21109-2007 / IEC 61511-2003).

## Scope

The assessment scope includes gas station and NG distribution, Desulphuridation, NG saturating, pre-reformer feed and pre-reformer, primary reformer, process oxygen, secondary reformer, waste heat boiler and HHP steam drum, RFG cool down and separation, synthesis gas compressing, methanol reaction, MP steam drum, HP separation, LP separation, raw methanol buffer tank, stabilizer column, LP methanol column, MP methanol column, product polisher, methanol product buffer tank, drain drum, methanol tank, HHP-HP steam control system, MP steam control system, LP steam control system, BFW, instrument air, power system, polishing unit and cooling water unit in “MEKPCO Methanol Project”. Description of each node and its associated P&ID’s are shown below.

| Node ID_NO | Node Description | Relative Equipments | P&ID | Remark |
|---|---|---|---|---|
| 1001 | Gas Station and NG Distribution | X-1901 1/2, X-1001, D-1001 | 1000-PID-001/002 | |
| 1002 | Desulphurisation | E-2006, E-2004, R-1001, R-1002 1, R-1002 2 | 2000-PID-006/007 1000-PID-003 | |
| 1003 | NG Saturating | E-6001, T-6001 1/2, X-6001A/B,D-6001, X-6002A/B, E-6004, P-6001A/B, P-2002A/B, E-6002, D-6002, P-7003A/B, | 6000-PID-003/002, 001, 004, 7000-PID-015 | Include process condensate, MP steam, saturator blowdown |

| | | | | |
|---|---|---|---|---|
| | | E-6003, TK-7002, P-7004A/B | | |
| 2001 | Pre-reformer Feed and Pre-reformer | E-2002, R-2003 | 2000-PID-003/004/007/008 | |
| 2002 | Primary Reformer | E-2001, H-2001, X-2003, F-2002, FT-2002, E-2007, F-2001, FT-2001, S-2001 | 2000-PID-007/009/017/005/006 | |
| 2003 | Process Oxygen | X-2001A/B, E-2008, D-2011 | 2000-PID-001/002 | |
| 2004 | Secondary Reformer | X-2002A/B, SI-2001, R-2004 | 2000-PID-002/010 | |
| 2005 | Waste Heat Boiler and HHP Steam Drum | E-2020 1/2, E-2021 1/2, SI-2004, E-2021 3, D-2001, SI-2002, E-2022 1/2/3(tube side) | 2000-PID-011/012/014/013 | |
| 2006 | RFG Cool down and Separation | E-2022 1/2/3(shell side), D-2002, P-2001A/B, E-5023(tube side), D-2003, E-5024 1/2(tube side), D-2004, P-2002A/B, E-2025, AE-2026, E-2027, D-2005, P-2003A/B | 2000-PID-014/015/016 | |
| 3001 | Synthesis Gas Compressing | C-3001/C-3002, FT-3001 1/2 | 3000-PID-001 | |
| 3002 | Methanol Reaction | R-3001 1/2/3, J-3002 1/2/3, E-3001 1/2/3 | 3000-PID-003/004 | |
| 3003 | MP Steam Drum | D-3003, SI-3002 | 3000-PID-002 | Include blowdown |
| 3004 | HP Separation | AE-3002 1/2/3, E-3003 1/2/3, D-3001 | 3000-PID-005/006 | |
| 3005 | LP Separation | D-3002 | 3000-PID-007 | |
| 5001 | Raw Methanol Buffer Tank | TK-5001, T-5004, P-5001A/B | 5000-PID-001, 5000-PID-020 | Include NaOH sol'n dosing |
| 5002 | Stabilizer Column | T-5001, E-5024 1/2(shell side), E-5001, D-5009, P-5011A/B, E-7003 1, AE-5004, D-5001, P-5003A/B, E-5010, P-5002A/B | 5000-PID-002/003/004/005 | |
| 5003 | LP Methanol | T-5002, E-5002 1/2/3/4(shell | 5000-PID-006/007/008/ | |

| | | | | |
|---|---|---|---|---|
| | Column | side), AE-5005, D-5002, P-5004A/B, E-5008, P-5005A/B | 009 | |
| 5004 | MP Methanol Column | T-5003, E-5023(shell side), E-5003 1/2, E-7003 2, E-5002 1/2/3/4(tube side), D-5003, P-5006A/B, E-5012, P-5007A/B, AE-5006, E-5007, P-5010A/B | 5000-PID-010/011/012/013 | |
| 5005 | Product Polisher | X-5001A/B | 5000-PID-014 | |
| 5006 | Methanol Product Buffer Tank | TK-5002 1, P-5012A/B, TK-5002 2, P-5008A/B/C, TK-5003, P-5009A/B, E-5011 | 5000-PID-015/016/017 | |
| 5007 | Drain Drum | D-5011, P-5013 | 5000-PID-019 | |
| 4001 | Methanol Tank | TK-4001 1, TK-4001 2, P-4001A/B, D-4001, P-4002 | 4000-PID-001/002 | |
| 7001 | HHP-HP Steam Control System | X-7010, X-7011A/B, SI-7010, X-7012A/B, DS-7010A/B, DS-7011A/B | 7000-PID-006/007/008/009/010 | |
| 7002 | MP Steam Control System | X-7013A/B, X-7014A/B, SI-7011 | 7000-PID-008 | |
| 7003 | LP Steam Control System | X-7015A/B, SI-7012 | 7000-PID-009/011 | |
| 7004 | BFW | D-7001, P-7001A/B, FT-7001A/B, P-7001C, TK-7060, P-7060A/B, TK-7070, P-7070A/B, D-7002, D-7003, D-7004, E-7001, P-7005A/B | 7000-PID-012/013/014, 7000-PID-024/025/026 | Include deaerator, dosing systems |
| 7005 | Instrument Air | | 7000-PID-019 | |
| 7006 | Power System | | | |
| 7201 | Polishing Unit | TK-7001 1/2, P-7002A/B, P-7204A/B, TK-7202/7204, P-7202/7203, J-7201/7202, D-7205, PD-7206, P-7205A/B, TK-7201, P-7201A/B, R-7201A/B, X-7201, E-7201A/B | 7200-PID-001～005 | |

| | | | | |
|---|---|---|---|---|
| 0501 | Cooling Water Unit | F-0501A/B/C/D, T-0501A/B/C/D, PD-0501, P-0501 1/2, P-0502A/B, P-0504A/B, F-0502 1/2, P-0505A/B, PD-0502, P-0506A/B, TK-0503, P-0507, TK-0508, P-0510A/B, TK-0509, P-0511A/B, TK-0510, P-0512A/B, E-0501 | 0500-PID-001～006<br>7000-PID-016 | |

Assessment should include the following,

1. Process and utility systems including vendor packages. If vendor packages are not available at the time of the HAZOP, they should be the subject of a later HAZOP when details are available.
2. Normal and abnormal operational modes, e.g. startup, shutdown, emergency shutdown, and special or abnormal operations, e.g., maintenance.
3. Safety/health and environmental hazard consequences.
4. Major operability problems.
5. The boundaries of the review, particularly if the overall HAZOP program involves multiple reviews and interfaces.
6. Consideration of human factors.
7. A review of applicable process safety incidents that have occurred in the subject facility and in the facilities that have the same process design in industry, if information is available.
8. Project or existing unit associated process safety information.

**Methodology**

The description of HAZOP and LOPA assessment methodology as applied in this project is as follows.

1. Qualitative analysis: traditional HAZOP analysis method is applied to each process node. Guidewords (refer to the Attachment) are used to probe for potential process deviations in the node. List all possible causes for the process deviation, analyze its related hazardous consequences and identify existing safeguards that prevent the process deviation from occurring.
2. Assess the risk following the definitions listed in Tables 2~5. First determine the severity level of the hazard following Table 4, and by doing so one can determine its tolerable risk target (refer to Table 5).

3. If there is a dispute over the severity level in the process of determining severity level of the hazard following Table 4, or if the consequence under discussion is deemed a critical hazardous event by the assessment team, proceed with model-based consequence analysis.
4. For consequence with severity level 4 or above, proceed to LOPA. The assessment team can also proceed to LOPA for the consequence with severity level 3, if necessary.
5. LOPA format in GB/T 21109-3/ IEC 61511-3 appendix F should be followed.
6. Principle and guidance listed below for each LOPA item should be considered,

(1) Impact event description - following the consequence in a process deviation from the HazOp study

(2) Severity - following the severity level for the consequence from the HazOp study

(3) Initiating cause - all potential causes for a process deviation from the HazOp study. Each cause will be discussed accordingly.

(4) Initiation likelihood – values of the typical initiating cause failure rate can be looked up from Mr. Safety software database. Alternatively, one can refer to "*Layer of Protection Analysis: Simplified Process Risk Assessment(2001)*" published by AIChE.

(5) General process design – check to see if the process area for the initiating cause or impact event under discussion is designed with explosion proof classification, double cannula for toxic or incompatible material leakage prevention, vessel wall thickness or attached with refractory material or any other intrinsically safer design in accordance with the general safety design specifications such as API, ASME or NFPA. Such design must be independent and effective for protection against the event under discussion. Yes(0.1); No(1)

(6) Basic process control system (BPCS) – check to see if in addition to the control system that fails, there is any other relevant monitor and control system such as DCS, PLC or PANEL to prevent or mitigate the hazardous event, and such monitor and control system is independent and effective. Yes(0.1); No(1)

(7) Alarm, etc. – check to see if there is any independent safety system alarm in addition to the automatic operating system from item 4 or item 6, and if there is corresponding SOP to complement the alarm in preventing or mitigating the impact event under discussion. Yes (0.1); No(1)

(8) Additional mitigation, restricted access – external mitigation measures with a lower degree of reliability such as working permit or restricted access to the operating area during process operation, etc. Such additional mitigation measures must be implemented against the initiating cause. Look for the additional mitigation data table in Mr. Safety software database. Alternatively, one can refer to "*Layer of Protection Analysis: Simplified Process Risk Assessment(2001)*" published by AIChE

(9) IPL additional mitigation, dike, pressure relief – mitigating system with a higher degree of reliability such as dike, safety relief valve, rupture disc or automatic

firefighting sprinkler system. The failure rate of IPL additional mitigation must be less than or equal to 0.01. Look for IPL data table in Mr. Safety software database. Alternatively, one can refer to "*Layer of Protection Analysis: Simplified Process Risk Assessment(2001)*" published by AIChE

(10) Intermediate event likelihood – the product of multiplying assigned values of item 4 through item 9

(11) Safety Instrumented Function (SIF) Integrity Level –Probability of Failure on Demand (PFD) and the Safety Integrity Level (SIL) that corresponds to it

(12) Mitigated event likelihood – possibility of failure event in which all the risk control measures are in effect. The risk must be less than or equal to the tolerable risk target (Table 4).

7. Check the mitigated event likelihood against Table 4 to see if the risk meets the tolerable risk target.

8. If the risk of the mitigated event likelihood meets (less than or equal to the frequency of) the tolerable risk target, then determine the likelihood level based on Table 2, determine the risk class based on Table 1 and check whether the risk class is within 4. Also, if necessary, provide safety improvement recommendations with regards to the operation

9. In case that the risk of the mitigated event likelihood does not meet (less than or equal to the frequency of) the tolerable risk target, then determine the required safety integrity level (SIL) as follows

(Intermediate event likelihood) = (Mitigated event likelihood) x RRF

Where RRF = Risk Reduction Factor

PFD = 1/RRF

Proceed to determine the required SIL for the safety instrumented function (SIF) or other risk prevention or mitigation measures with a PFD that is equivalent to this SIL, and provide safety improvement recommendations. HAZOP and LOPA assessment workflow is depicted below in figure 1

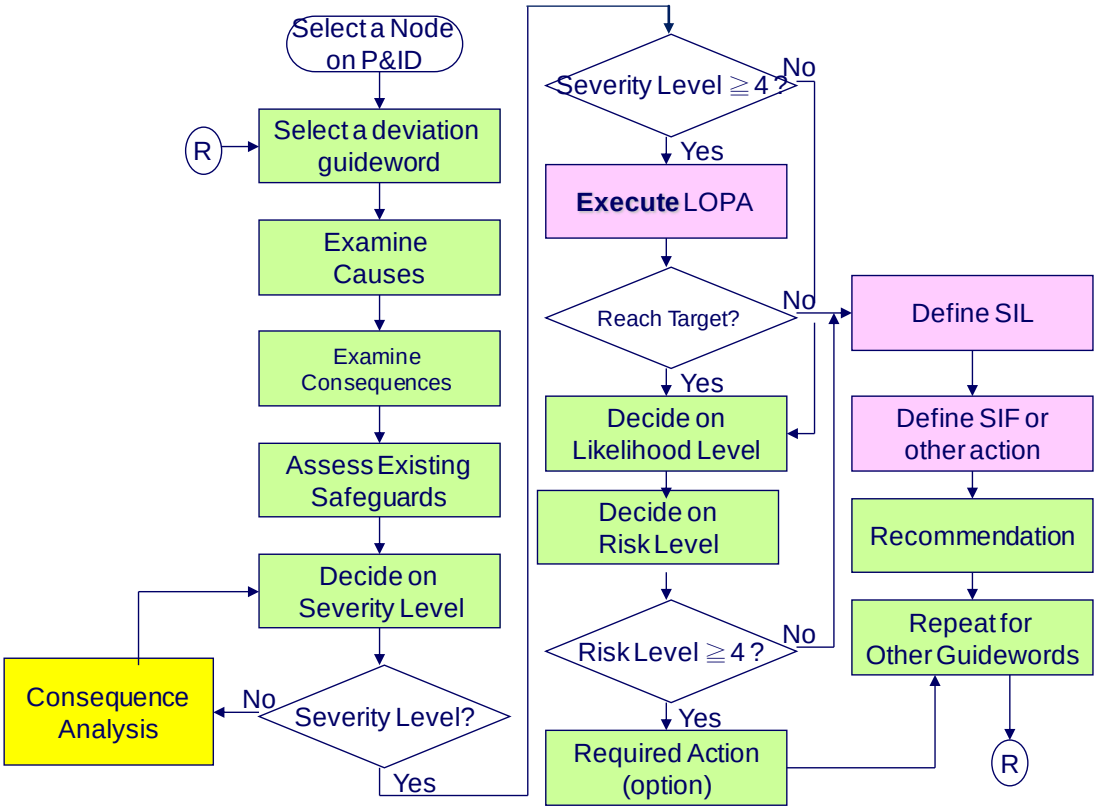


Figure 1 HAZOP/LOPA Assessment Workflow

Table 2 Risk Matrix

| Risk matrix | | Likelihood | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Severity | 7 | 4 | 5 | 6 | 7 | 7 | 7 | 7 | 7 |
| | 6 | 3 | 4 | 5 | 6 | 7 | 7 | 7 | 7 |
| | 5 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 7 |
| | 4 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 7 |
| | 3 | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | 2 | 1 | 1 | 1 | 2 | 3 | 4 | 5 | 6 |
| | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 5 |

Note:

| | **PFDavg** | **RRF** | **Typical implementation** |
|---|---|---|---|
| A1 | No requirement | No minimum | Alarm only |
| A2 | No requirement | No minimum | DCS action |
| SIL1 | 0.01≦PFD＜0.1 | 100≧RRF＞10 | Trip separate from DCS |
| SIL2 | 0.001≦PFD＜0.01 | 1000≧RRF＞100 | Trip separate from DCS |
| SIL3 | 0.0001≦PFD＜0.001 | 10000≧RRF＞1000 | Redundant trip separate from DCS |
| B, SIL4 | | | Single SIF is not sufficient, design other protection layers |

($PFD_{avg}$: Average Probability of Failure on Demand)

Table 3 Likelihood Level

| | Description | Lower limit $10^{-x}$(≤) | Upper limit $10^{-y}$(<) |
|---|---|---|---|
| 1 | Unlikely | 7 | 6 |
| 2 | Very rare | 6 | 5 |
| 3 | Rare | 5 | 4 |
| 4 | Maybe | 4 | 3 |
| 5 | Possible | 3 | 2 |
| 6 | Very possible | 2 | 1 |
| 7 | Frequently | 1 | 0 |
| 8 | Very frequently | 0 | 0 |

Table 4 Severity Classification

| | Description | Personnel Safety | Financial loss/ US dollar | Environmental influence | Tolerable target |
|---|---|---|---|---|---|
| 1 | Negligible | Injury=1 | < 50,000 | Equipment leakage | 0.1 |
| 2 | Moderate | 1 < injury < 5 | 50,000~100,000 | Unit leakage | 0.01 |
| 3 | Highly | Permanent partial disability ≥ 1 or Temporarily disability < 5 | 100,000~1 million | Plant leakage | 0.001 |
| 4 | Significant | 1 death; Permanent partial disability or temporarily disability ≥ 5 | 1 million~10 million | Pollution confined in plant | 0.0001 |
| 5 | Massive | 2~4 death or permanent disability | 10 million~100 million | Regional pollution; >10,000 bbl oil spill | 1E-05 |
| 6 | Severe | 5~29 death or permanent disability | 100 million~1 trillion | National pollution; >100,000 bbl oil spill | 1E-06 |
| 7 | Extremely severe | ≥ 30 death or permanent disability | > 1 trillion | single equipment leakage | 1E-07 |

Table 5　Tolerable Risk Target

| Risk Class | Description | Tolerable Frequency Target (/year) |
|---|---|---|
| 7 | Extremely severe / $C_G$ | $< 10^{-7}$ |
| 6 | Severe / $C_F$ | $< 10^{-6}$ |
| 5 | Massive / $C_E$ | $< 10^{-5}$ |
| 4 | Significant / $C_D$ | $< 10^{-4}$ |
| 3 | Highly / $C_C$ | $< 10^{-3}$ |
| 2 | Moderate / $C_B$ | $< 10^{-2}$ |
| 1 | Negligible / $C_A$ | $< 10^{-1}$ |

**Team Member**

**Leader** –

Wang Shih Huang (consultant for Advanced Control and Information Technology, Inc. (ACIT))，ACIT is a member of CTCI Group)

Mr. Wang has over 24 years of experience in the oil and gas industry in the area of PHA/HAZOP. Prior to joining ACS, he had served as Department Manager for Industrial Safety Technology Department of Industrial Technology Research Institute in Taiwan (ITRI). He has participated in the following projects,

(1) Project leader, RDS2 Process Safety Evaluation in Taoyuan Refinery, Taiwan CPC, 1991~1992
(2) Project leader, Alkylation and Dehydrogenation Process Safety Evaluation, Taiwan Styrene Monomer Corporation, 1992~1996.
(3) Project leader, PP Process Safety Evaluation, Taiwan Polypropylene Inc., 1994~1995.
(4) Project leader, SBR/BR/TPE Process Hazard Analysis and Risk Assessment, Taiwan Synthesis Rubber Corporation, 1995~1998.
(5) Auditor and Advisor, PSM Promotion Program and PTA3 HAZOP Review, CAPCO, 1996~1998.
(6) Project leader, Semiconductor Process Safety Evaluation, Tsmc, 1998~2000.
(7) Project leader, Liquid Chlorine Transportation QRA, Taiwan DuPont Inc., 2004.
(8) Project leader, Earth Covered Tanks Quantitative Risk Analysis, FPCC, 2006~2008.
(9) Project leader, Synlubes Process HAZOP, Cognis Shanghai, 2008.
(10) Project leader, Ammonia ISO Tank Transportation QRA, Praxair, 2010.
(11) Assessor, Nitrous Acid Process HAZOP, Taiwan Fertilizer CO., 2010.
(12) Project leader, Alkylation Process HAZOP and LOPA in Talin Refinery, Taiwan

CPC, 2010~2011.

(13) Advisor, Mr. Safety – Computer-aided HAZOP/LOPA Software Development, Advanced Control & Systems Inc., 2010~2012.

(14) Coach, HAZOP Training Program and Workshop, Dowcorning Shanghai, BP/CNOOC Shenzhen, Conocophillips Beijing, Lanxess Qindao, and CNOOC Zhanjiang/Teinjing, 2004~2011.

(15) Project leader, NO.10 SRU LOPA/SRS, RBI, FMEA/CA in Talin Refinery, Taiwan CPC, 2012~2013.

(16) Project leader, SNG (Substitute Natural Gas) HAZOP in Xinjiang Yi Nan, ECEC, 2012.

(17) Project leader, YUTAI Large Scale Natural Gas Liquefaction Technology Engineering Project HAZOP, CTYC, 2013.

(18) China huaneng Methanol Produce FMTP Process HAZOP, TCC, 2013.

**Scribe** –

Ying Yining、Gao Xiang(ACIT)

**Core Team Members** –

Owner:

Engineering Manager：Mahmood Nasrollahi

Process Engineers: Iradj Memarian、Mohammadreza Hemmati Mahmoudi

Instrumentation Engineer: Mohammad Mehdi Movahedi

Contractor:

Chief Engeer: Lin Binbin

Engineering Manager: Ai Xiaoxin

Deputy Engineering Manager: Gao Zhihui

HSE Engineer: Ji Weiwei、Liu Xianfan

Process Engineers：Xu Hang、Xu Binghao、Li Zhijuan

Instrumentation Engineer: Ma Guoqiang

Expert: Klaus Hallo、Zhou Guixin

**Schedule and Deliverables**

Schedule

| Date and Time | Agenda |
|---|---|
| Jul 11, 2016 | HAZOP LOPA for<br>Node 1001/ Gas station and NG distribution. |
| Jul 12, 2016 | HAZOP LOPA for<br>Node 1002/ Desulphurisation. |
| Jul 13, 2016 | HAZOP LOPA for |

| | |
|---|---|
| | Node 1003/ NG saturating. |
| Jul 14, 2016 | HAZOP LOPA for<br>Node 2001/ Pre-reformer feed and pre-reformer. |
| Jul 15, 2016 | HAZOP LOPA for<br>Node 2002/ Primary reformer. |
| Jul 16, 2016 | HAZOP LOPA for<br>Node 2002/ Primary reformer,<br>Node 2003/ Process oxygen,<br>Node 2004/ Secondary reformer. |
| Jul 17, 2016 | HAZOP LOPA for<br>Node 2004/ Secondary reformer,<br>Node 2005/ Waste heat boiler and HHP steam drum,<br>Node 2006/ RFG cool down and separation. |
| Jul 18, 2016 | Finished 2000 area. Check with TOPSOE engineer. |
| Jul 19, 2016 | HAZOP LOPA for<br>Node 3001/ Synthesis gas compressing,<br>Node 3002/ Methanol reaction,<br>Node 3003/ MP steam drum. |
| Jul 20, 2016 | HAZOP LOPA for<br>Node 3004/ HP separation,<br>Node 3005/ LP separation,<br>Node 5001/ Raw methanol buffer tank. |
| Jul 21, 2016 | HAZOP LOPA for<br>Node 5002/ Stabilizer column,<br>Node 5003/ LP methanol column. |
| Jul 22, 2016 | HAZOP LOPA for<br>Node 7001/ HHP-HP steam control system,<br>Node 7004/ BFW. |
| Jul 23, 2016 | HAZOP LOPA for<br>Node 7002/ MP steam control system,<br>Node 7003/ LP steam control system,<br>Node 5004/ MP methanol column,<br>Node 5005/ Product polisher,<br>Node 5006/ Methanol product buffer tank,<br>Node 5007/ Drain drum. |
| Jul 25, 2016 | HAZOP LOPA for<br>Node 4001/ Methanol tank, |

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|---|---|
| | Node 0501/ Cooling water unit. |
| Jul 26, 2016 | HAZOP LOPA for<br>Node 7005/ Instrument air,<br>Node 7006/ Power system,<br>Node 7201/ Polishing unit. |

Output:

Desulphurisation and Saturation Process Section: HAZOP LOPA analysis – 3 process nodes, 74 process deviations and 10 pcs of P&ID completed;

Reforming Process Section: HAZOP LOPA analysis – 6 process nodes, 131 process deviations and 17 pcs of P&ID completed;

Methanol Synthesis Loop Process Section: HAZOP LOPA analysis – 5 process nodes, 87 process deviations and 7 pcs of P&ID completed;

Methanol Distillation Process Section: HAZOP LOPA analysis – 7 process nodes, 116 process deviations and 19 pcs of P&ID completed;

Methanol Tank Process Section: HAZOP LOPA analysis – 1 process nodes, 20 process deviations and 2 pcs of P&ID completed;

Steam System Process Section: HAZOP LOPA analysis – 6 process nodes, 58 process deviations and 14 pcs of P&ID completed;

Polishing Process Section: HAZOP LOPA analysis – 1 process nodes, 20 process deviations and 5 pcs of P&ID completed;

Cooling Water Process Section: HAZOP LOPA analysis – 1 process nodes, 18 process deviations and 7 pcs of P&ID completed.

Deliverables:

HAZOP Worksheet, please refer to Attachment 2.

**Recommendations**

| Serial # | Risk | Recommendation | Accept | Not accept | Alternative/ Comment | Follow up |
|---|---|---|---|---|---|---|
| 1001.1 | 1 | 1.Add FI-1915/1925 high flow alarm.<br>2.PCV-1916/1926 regulation loop manual valve add LOCK OPEN on P&ID.<br>3.USV-1915/1925 should be trunnion ball valve and for HH flow shut off. | Y | | | TCC |
| 1001.3 | 2 | Add CSC for vent to atmosphere(gas station). | Y | | | TCC |
| 1001.3 | 3 | Take note at D-1001 bottom: open gate valve fully and then slowly open 1" globe valve for draining the liquid and closing do reverse and make sure the drain line is fully closed after the drain. | Y | | | TCC |
| 1001.8 | 3 | Check the capacity of synthesis loop purge gas control valve FV-3169(for Nitrogen content of feed increase to 7%). | Y | | | TCC |
| 1001.15 | 3 | D-1001 equipped with 2oo3 high level protection and shut off the ball valve same as 1001.18 recommendation. | Y | | | TCC |
| 1001.17 | 3 | Same as 1001.18 recommendation. | Y | | | TCC |
| 1001.18 | 4 | 1.Add 14"fire safe pneumatic ball valve(USV according to API2218) and 2" by pass valve(LC) for isolation before gas station package.<br>2.Cancel out HV-1003.<br>3.Move PG-1002,PI-1002,TG-1002,TI1001,FI-1006 and manual block valves to the BL, but keep one manual block valve and blind plate for isolating gas station and D-1001.(1001.18 recommendation) | Y | | | TCC |
| 1002.1 | 2 | 1.Soft ware limitation for changing set point value not more than 5%, must be consider.<br>2.AIA-1045 high sulphur alarm and proper SOP is considered in operating and personnel training is also considered. | Y | | | TCC |
| 1002.2 | 3 | 1.Manual valve add LOCK OPEN on P&ID(1000-PID-003).<br>2.Consider a L.C. for the bypass of FV-2150 to prevent H2 backflow. | Y | | | TCC |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1002.5 | 1 | Same as high concentration 1001.8. | Y | | | TCC |
| 1002.20 | 2 | Add TIA-2229/2154/2155 high temperature alarm. | Y | | | TCC |
| 1003.5 | 3 | PIC-6025 add low pressure alarm. | Y | | | TCC |
| 1003.6 | 5 | 1.Add LL level interlock by using LT-6034 1/2 signal to shut off FV-6081 and USV-6081, SIF should be meet SIL 2. | Y | | | TCC |
| 1003.12 | 3 | Add a note in operation manual : operator to check the temperature change of R-2003, TICA-2253,TIA-2268,TIA-2154~2265 and detect deactivation of catalyst. | Y | | | TCC |
| 1003.16 | | Design pressure of T-6001 1/2 steam side should have to be considered for full anti-vacuum design due to PT/PIC/PV-6025 abnormally closed and MPS condense in T-6001 1/2 shell side. | Y | | | TCC |
| 1003.20 | 2 | Add a note in operation manual : operator to check the temperature change of R-2003, TICA-2253,TIA-2268,TIA-2154~2265 and detect deactivation of catalyst. | Y | | | TCC |
| 1003.32 | 3 | PIC-6025 add high pressure alarm. | Y | | | TCC |
| 2001.16 | 2 | FT-3001 failure (cause high pressure or not)(Ask from steam turbine vendor). | Y | | | Hold for GE |
| 2002.1 | | To be confirmed by ITT(about high flow of air). | Y | | | Hold for ITT |
| 2002.2 | 2 | Add FIC-2061 high flow alarm. | Y | | | TCC |
| 2002.3 | 4 | Flame failure to cause explosion (H-2001 fuel gas high flow). (To be checked with ITT) | Y | | | Hold for ITT |
| 2002.7 | 4 | SOP should add that in normal operation the nitrogen line block valve closed(for H-2001). | Y | | | Owner |
| 2002.10 | 3 | Select PDT-2283 to show minus value too (reverse polarity). | Y | | | TCC |
| 2002.13 | 1 | Add SOP for planned inspection for air intake filter of F-2002. | Y | | | Owner |
| 2002.30 | 2 | Add TIA-2229/2154/2155 high temperature alarm. | Y | | | TCC |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2003.6 | 4 | 1.Before the start-up all the O2 pipe must be chemical clean according to procedure(to be approved by owner).<br>2.During the design step all the sharp edge must be avoided.<br>3.Proper design, material, procedure considered and qualified vendor shall supply the filter according to O2 service standard/practice. | Y | | | TCC |
| 2004.12 | 1 | O2 burner vendor should check the length of the flame and prevent catalyst top surface damage. | Y | | | Topsoe |
| 2004.13 | 4 | Manual valve of synthsis gas compressor inlet should be LO. | Y | | | TCC |
| 2005.1 | 3 | Add LSAH-2372(2oo3)high level trip IS-03,SIF should be meet SIL 2. | Y | | | TCC |
| 3001.1 | 3 | 1.C-3001/3002 overspeed trip, SIF should be meet SIL 1.(Check with GE)<br>2.Ask from compressor vendor for the proper safeguard about liquid droplet in compressor. | Y | | | Hold for GE |
| 3001.2 | 4 | 1.Ask from compressor vendor for the proper safeguard about liquid droplet in compressor.<br>2.C-3001/3002 circulator inlet pressure decrease, outlet pressure decrease(for recycle gas high flow).(Check by GE) | Y | | | Hold for GE |
| 3001.3 | 3 | 1.High vibration trip, SIF should be meet SIL 1.(Check with GE)<br>2.Ask from compressor vendor for the proper safeguard about liquid droplet in compressor.<br>3.Ask and confirm from GE about SIL level. | Y | | | Hold for GE |
| 3001.4 | 3 | High vibration trip, SIF should be meet SIL 1.(Check with GE) | Y | | | Hold for GE |
| 3001.9 | 3 | Check by GE for effect of (cause, consequence, safeguard) changing the molecular weight of synthesis gas. | Y | | | Hold for GE |
| 3001.10 | | Check by GE for effect of (cause, consequence, safeguard) changing the molecular weight of synthesis gas. | Y | | | Hold for GE |

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| 3001.14 | 3 | C-3001/3002 package high temperature alarm and trip, SIF should be meet SIL 1.(Check with GE) | Y | | | Hold for GE |
| 3002.1 | 1 | 1.Ask from GE about cause, consequence and safeguard(for process gas high flow).<br>2.Compressor capacity control system. (Check by GE) | Y | | | Hold for GE |
| 3003.3 | 1 | Add a proper SOP to operating manual to check leakage from HV-3087/3090/3093. | Y | | | Owner |
| 3003.6 | 1 | AP-3054 for checking concentration of phosphate and proper SOP in operating manual. | Y | | | Owner |
| 3003.7 | 1 | AP-3054 for checking concentration of phosphate and proper SOP in operating manual. | Y | | | Owner |
| 3004.10 | 2 | Low pressure alarm in compressor.(Check by GE) | Y | | | Hold for GE |
| 3004.16 | 3 | 1.Selection of cooling tower electrical equipment from explosion proof type.<br>2.Gas detection.(TCC specify tag number) | Y | | | TCC |
| 3005.8 | 3 | Gas detector is necessary in D-3002 area. | Y | | | TCC |
| 4001.3 | 3 | 1.Add an Automatic Recirculating Valve (ARV) in the discharge of each pump, in stead of check valve.<br>2.Change FV-4022 control valve and bypass to remote control (HIC valve). | Y | | | TCC |
| 4001.10 | 3 | 1.Delete isolating vavle on pressure feedback impulse line of PCV-4025/4027.<br>2.Change PSV-4001/4002 inlet manual valve from LC to LO.<br>3.Add PI-4005/4006 high pressure alarm.<br>4.Gas detector.(TCC specify tag number)<br>5.Thermoresistive heat detector.(TCC specify tag number) | Y | | | TCC |
| 4001.11 | 3 | Add PI-4005/4006 low pressure alarm. | Y | | | TCC |
| 4001.12 | 2 | 1.PCV-4026 shall be equipped with a PG to show pressure inside D-4001 and distance between this PCV and top surface of ground of installation position of D-4001 shall be less than 1.5 meter, otherwise an individual PG shall be dedicated to D-4001. | Y | | | TCC |

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| 4001.14 | 3 | Thermoresistive heat detector.(TCC specify tag number) | Y | | | TCC |
| 4001.16 | 3 | Gas detector.(TCC specify tag number) | Y | | | TCC |
| 4001.19 | 2 | 1.PCV-4026 shall be equipped with a PG to show pressure inside D-4001 and distance between this PCV and top surface of ground of installation position of D-4001 shall be less than 1.5 meter, otherwise an individual PG shall be dedicated to D-4001. | Y | | | TCC |
| 4001.20 | 2 | Gas detector.(TCC specify tag number) | Y | | | TCC |
| 5001.6 | | Solid NaOH have to be supplied from high quality and low impurity type. | Y | | | TCC & Owner |
| 5001.7 | 3 | Proper SOP shall be added to operation manual(for TK-5050). | Y | | | Owner |
| 5001.10 | 3 | 1.Gas detector.(TCC specify tag number)<br>2.Thermoresistive heat detector.(TCC specify tag number) | Y | | | TCC |
| 5001.13 | 3 | 1.Gas detector.(TCC specify tag number)<br>2.Thermoresistive heat detector.(TCC specify tag number) | Y | | | TCC |
| 5002.17 | 2 | Add sampling point at E-5024 1/2 shell side outlet. | Y | | | TCC |
| 5002.20 | 2 | 1.Gas detector.(TCC specify tag number)<br>2.Thermoresistive heat detector.(TCC specify tag number) | Y | | | TCC |
| 5003.17 | | Proper design, material, procedure considered and qualified vendor shall supply the exchanger (for E-5002 1/2/3/4). | Y | | | TCC |
| 5004.7 | | Supply pure chemical from qualified vendor and check the quality in each purchase(for solid NaOH). | Y | | | TCC & Owner |
| 5004.17 | 2 | Add sampling point at E-5023 shell side outlet. | Y | | | TCC |
| 5004.18 | | Choose a qualified and high quality vendor(for E-5003 1/2). | Y | | | TCC |
| 5005.2 | 1 | Position of AP-5382 should be change to X-5001A outlet and also a same analytic point to X-5001B shall be added. | Y | | | TCC |
| 5006.2 | 3 | TCC study the relocating of TK-5003 to area 5003. | Y | | | TCC |

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| 5007.4 | 1 | 1.PCV-5701 shall be equipped with a PG to show pressure inside D-5011 and distance between this PCV and top surface of ground of installation position of D-5011 shall be less than 1.5 meter, otherwise an individual PG shall be dedicated to D-5011. | Y | | | TCC |
| 7001.2 | 3 | Ask GE for safeguard in compressor package.(in case of cause1) | Y | | | Hold for GE |
| 7001.4 | 1 | Possibility of using import steam instead of HPS and preventing shutdown of plant. (owner to check with DMPC) | Y | | | Owner & DMPC |
| 7001.5 | 4 | Total /partial blockage of HP from turbine shall be prevented. (This subject shall be check with GE ) | Y | | | Hold for GE |
| 7001.10 | 2 | 1.Add high alarm to PI-7021.<br>2.Effect of higher pressure HPS to DMPC shall be checked(owner to check). | Y | | | 1.TCC<br>2.Owner & DMPC |
| 7001.13 | 2 | Add low alarm to PI-7021. | Y | | | TCC |
| 7001.14 | 3 | HH temperature trip in FT-3001 package.(TCC check with GE) | Y | | | TCC & GE |
| 7001.16 | 2 | Potentially exceeding design temperature in downstream.(owner to check with DMPC) | Y | | | Owner & DMPC |
| 7001.17 | 1 | Ask from GE for safeguards (for low temperature(HHPS))(TCC to check). | Y | | | TCC & GE |
| 7004.4 | 3 | Add flow indicator in BFW pump outlet line. | Y | | | TCC |
| 7004.7 | 3 | 1.Add check valve on 10"-LPC-70-116-B24-H1and 6"-LPC-70-113-B24-H1 to prevent reverse flow to E-5003 and P-5011A/B(during start-up).<br>2.Change bypass of LSV-5070 from gate to globe valve. | Y | | | TCC |
| 7004.9 | 1 | Supply chemical from well known vendor and check the quality before purchase. | Y | | | TCC & Owner |
| 7004.12 | | 1.The volume of TK-7060 shall be increased to 3.6 m3.<br>2.Increased the capacity of ammonia pump P-7060A/B from 17 L/h to 40 L/h. | Y | | | TCC |
| 7004.14 | 1 | TCC study and find safeguard for bad effect of high pressure on separation of O2 (for Deaerator). | Y | | | TCC |

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| 7004.15 | 1 | Add silencer for vent of warm up HPS line to FT-7001A/B. | Y | | | TCC |
| 7004.19 | 4 | Develop and implement of a suitable level control philosophy(for Deaerator ). | Y | | | TCC |
| 7005.2 | 3 | 1.A total shut down (IS-1) have to be added from low low or no pressure . Based on this requirement, a 2oo3 voting system is necessary so 2 more PT shall be add too.<br>2.Add an emergency N2 line which tie-in to 3"-IA-70-101-B50-N before PT's with regulator, solenoid valve (FO) and manual valve (LO) for keeping available and stable pneumatic function in case of low pressure instrument. | Y | | | TCC |
| 7006.1 | 3 | A shut down command (IS-1) shall be added for "total power failure". | Y | | | TCC |
| 7201.7 | 1 | Supply chemical from well known vendor, with high quality and test before use in plant. | Y | | | TCC & Owner |
| 7201.8 | 2 | Consider two individual ARV for discharge line for each line. | Y | | | TCC |
| 7201.14 | 2 | Two pH indication in discharge line of each ion exchanger shall be considered. | Y | | | TCC |
| 501.3 | 3 | Develop SOP for proper adjusting CW distribution in case of two pumps running and low plant loading situation. | Y | | | Owner |
| 501.5 | 3 | Add AT-0511 low pH alarm and interlock to auto-stop H2SO4 injection pump. | Y | | | TCC |
| 501.9 | 3 | Add AT-0511 low pH alarm and interlock to auto-stop H2SO4 injection pump. | Y | | | TCC |
| 501.10 | 2 | TCC to check: relation between ClO- and Cl- concentration and relevant reactions(for NaClO dosing in CW). | Y | | | TCC |
| 501.12 | 3 | Add high alarm to PIA-0514. | Y | | | TCC |
| 501.13 | 2 | 1.Add TE-0511 low temperature alarm.<br>2.Add PT-0511 low pressure alarm. | Y | | | TCC |
| 501.17 | 3 | 1.Tag number of F-5020A/B shall be modified to F-5020 1/2.<br>2.Lines from each filter to PD-5020 for discharge of CSW shall be sloped down towards PD-0502. | Y | | | TCC |

*In the name of God*

## Minutes of Meeting

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|---|---|---|---|
| **Date** | 2016/7/26 | **MOM Ref. No.** | |
| **Venue** | 0304 | **Recorded by** | Yin Yining |
| **Pages** | | **Attachments** | |
| **Subject** | **Confirmation of HAZOP recommendations** | | |
| **Attendees** | | | |
| | **Name** | **Title** | **Distribution** |
| **OWNER** | Mahmood Nasrollahi | Engineering Manager | |
| | Iradj Memarian | Process Engineer | |
| | Mohammadreza Hemmati Mahmoudi | Process Engineer | |
| | Mohammad Mehdi Movahedi | Instrumentation Engineer | |
| **CONTRACTOR** | Lin Binbin | Chief Engineer | |
| | Ai Xiaoxin | Engineering Manager | |
| | Gao Zhihui | Deputy Engineering Manager | |
| | Ji Weiwei | HSE Engineer | |
| | Xu Hang | Process Engineer | |
| | Xu Binghao | Process Engineer | |
| | Ma Guoqiang | Instrumentation Engineer | |
| | Liu Xianfan | HSE Engineer | |
| | Li Zhijuan | Process Engineer | |
| **SUB-CONTRACTOR** | Wang Shihuang | Chairman | |
| | Zhou Guixin | Expert | |
| | Klaus Hallo | Expert | |
| | Yin Yining | Scribe | |
| | Gao Xiang | Scribe | |
| | | | |
| **Note :** | | | |

**OWNER – Project Manager**

for M. Nasrollahi

**SUB-CONTRACTOR – PROJECT MANAGER**

S. H. Wang

**CONTRACTOR – Project Manager**