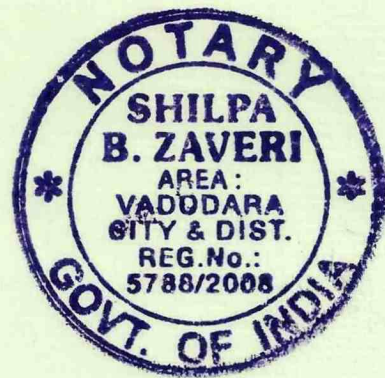


**BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONE BENCH, PUNE**

ORIGINAL APPLICATION NO. 02 OF 2025(WZ)



IN THE MATTER OF:

Shri Ashutosh Kumar

: Applicant

V/s

Gujarat Fluorochemicals Ltd. & Ors.

: Respondents

REPLY ON BEHALF OF THE RESPONDENT No. 06: CENTRAL POLLUTION CONTROL BOARD (CPCB)

1. That, Hon'ble NGT (PB) vide order dated 18.03.2025 has sought reply of respondents (CPCB is Respondent No. 06) in the instant matter. Thereby, the submission is made in following paragraphs.
2. That, CPCB has been constituted under Section 3 of the Water (Prevention and Control of Pollution) Act, 1974 (hereinafter referred to as "Water Act, 1974"). It performs the functions under the Water Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981 (hereinafter referred to as "Air Act, 1981") and the Environment (Protection) Act, 1986 (hereinafter referred to as "E (P) Act, 1986") and the rules made therein. State Pollution Control Board/ Pollution Control Committee in every state and Union Territory constituted under Section 4 of the Water (Prevention and Control of Pollution) Act, 1974 and Section 6 of the Air (Prevention and Control of Pollution) Act, 1981 in the respective State/ Union Territory and are responsible for implementation of the provisions of both the Acts.

PRELIMINARY SUBMISSIONS

3. The matter is related to an incident of gas leak on dated 28.12.2024 in the CMS (Chloro Methane Substance) plant of M/s Gujarat Fluorochemicals Ltd. (Hereinafter referred as M/s GFL), GIDC Dahej, District Bharuch, Gujarat causing death of 04 people. The applicant has mentioned about the accident incidents in industries of Gujarat during the year 2020 to year 2024 including in a unit operated by M/s GFL itself in Panchmahal district of Gujarat. The applicant has also mentioned about the harmful chemicals released by the Respondent No. 1 i.e. M/s GFL in the environment during the aforementioned incident, which may continue to pollute and degrade the environment for a long time, the pollutants being non-degradable in nature and prone to bio magnification and become a huge public health hazard later on.
4. The applicant has prayed for an inquiry/investigation of the gas leak accident and constitute an Expert Committee to investigate into the circumstances which led to the gas leak in the factory of Respondent No. 1 at Bharuch, Gujarat on 29.12.2024 and to determine the causes of the leak and the environmental damage resulting therefrom.

REPLY:

5. That, it is humbly submitted that Consolidated Consent and Authorization (CCA) and health & safety related permissions are issued and dealt by the state authorities.
6. That, as per the CCA granted by Gujarat Pollution Control Board (GPCB), the said unit is engaged in production of various chemicals, predominantly fluorine based organic chemicals, liquid Chlorine, Caustic Soda, Chloromethane compounds, Calcium Chloride,





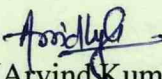
CO₂, refrigerants (R-22) etc. The industry is a red category industry as per the Classification of Industrial Sectors into Red, Orange, Green, White and Blue Categories by Central Pollution Control Board (CPCB).

7. That, it is humbly submitted that CPCB has obtained status of investigation and action taken in the matter from the GPCB. The information provided by GPCB through e-mail is summarized below.
 - i. The unit has obtained CCA from GPCB for production of refrigerants, various chemicals, predominantly fluorine based organic chemicals. The CCA is valid up to 15.02.2027. GPCB has issued amendment in CCA vide order dated 07.11.2023 wherein few of the conditions related with production quantity of some products, freshwater consumption & wastewater generation quantity, fuel consumption, hazardous waste generation quantity, permitted in original CCA have been amended.
 - ii. M/s Gujarat Fluorochemicals Limited was visited by a team of GPCB officials on **29.12.2024** at 11.30 AM to investigate the incident and the investigation report mentions that the incident took place in the unit on **28.12.2024** at 7.40 PM. Following information is gathered from the inspection report;
 - a. As per the inspection report, leakage of crude Chloro Methane Substance (CMS) gas occurred from isolation valve near auto valve XCV-2209 of CMS-1 plant. This isolation valve (near auto valve XCV-2209) is installed in the pipeline carrying Crude CMS (Gaseous form) from the Recycle Column (T2202) to Crude CMS Tank (V2204) at Approx. 9 kg/cm² pressure. The Crude CMS contains the mixture of Chloroform, Methylene Dichloride and Carbon Tetrachloride. CCTV footages of the incident reveals gaseous cloud for 15 minutes between 07.40 PM to 7.55 PM on 28.12.2024.
 - b. The inspection report mentions that, the gas cloud was formed in the entire CMS-1 plant area, Control Room area and further dispersed in the plant area.
 - c. The inspection report mentions that, four persons namely: 1. Shri Mundrika Yadav (Contract Worker), 2. Shri Mahesh (Contract Worker), 3. Shri Suchit Kumar (Contract Worker), & 4. Rajesh Magnadia (Company Employee) were deceased due to this incident and two persons were kept in medical observation.
 - d. GPCB issued Closure Direction for CMS-1 plant of the unit on **03.01.2025** and imposed an interim Environment Damage Compensation (**EDC**) of Rs. One Crore on the unit. The unit was directed by GPCB to carry out safety audit / Hazard and Operability (HAZOP) study and root cause analysis for the accident that shall include environmental aspects. Copy of Closure Direction is attached as **Annexure-1**.
 - e. GPCB again inspected the unit on **16.01.2025**. The inspection report mentions that unit has replaced the isolation valve near auto valve XCV-2209 of the CMS-1 Plant, where earlier gas leakage incident had occurred. The inspection report mentions that the two persons injured during the accident are discharged from the hospital and joined the duty.
 - f. The inspection report mentions that the unit has submitted reports for HAZOP study, safety audit and root cause analysis. The unit has also submitted notarized undertaking to GPCB vide letter dated 10.01.2025 to implement recommendations of HAZOP study for adequate safety measures. The unit has submitted compliance report w.r.t. the Directions dated **29.12.2024** issued by Directorate of Industrial Safety and Health (DISH); and closure Directions revocation order dated **13.01.2025** was issued to the unit by DISH. Unit has submitted **EDC** of Rs. One Crore to GPCB.
 - g. Considering the action taken report submitted by M/s GFL, GPCB has revoked closure direction vide order dated **17.01.2025**.
8. That, the safety audit report of the unit shows that audit was carried out through third party agency during 07.07.2023 to 08.07.2023. The safety audit report highlighted some important findings with respect to structural stability issues, absence of leak emergency plan, blockage of escape route, storage of hazardous waste along internal roads (point No. 88), faulty fire alarm in CMS area (Sr. No. 112), reason for trip bypass in CMS-1 and



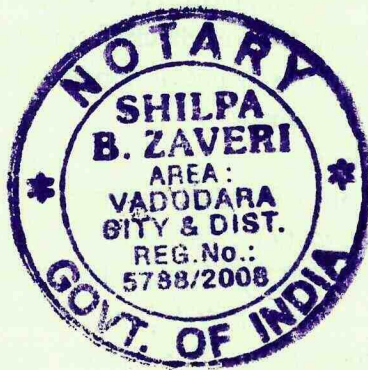
CMS-2 plant is not recorded (Sr. No. 113), poor housekeeping in CMS plants (Sr. No.116), etc. The Safety Audit Report also highlighted non-compliances like unavailability of PPEs, absence of safety mock drill for process upsets, etc. Copy of Safety Audit Report is attached as **Annexure- 2**.

9. That, Rule 10 (4), 10 (5) and 10 (6) of The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (amended) stipulates that after the commencement of the Rules, the occupier of both the new and the existing industrial activities shall carry out an independent safety audit of the respective industrial activities with the help of an expert, not associated with such industrial activities ; and the occupier shall forward a copy of the (safety) auditor's report along with his comments to the concerned Authority within 30 days after the completion of such audit ; and the occupier shall update the safety audit report once a year by conducting a fresh safety audit and forward a copy of it with his comments thereon within 30 days to the concerned Authority.
10. That, the Root Cause Analysis report carried out internally by the industry and shared by GPCB to CPCB mentions two probable reasons namely embrittlement and metallurgical failure as cause of incident. However, it has not mentioned whether leakage testing, seal/gasket inspection and torque check frequency are defined and same is evaluated as part of root cause analysis or not. It appears that the HAZOP study is based on Piping and Instrumentation Diagrams (P&ID) of plant supplied by the industry to the HAZOP study agency. HAZOP Report and Root Cause Analysis report submitted by M/s GFL to GPCB are attached as **Annexure- 3 & 4** respectively.
11. That, Hon'ble NGT vide order dated **13.01.2025** has constituted a Joint Committee (comprising one member each of Gujarat Pollution Control Board, Directorate of Industrial Safety and Health and District Collector, Bharuch, Gujarat) in the matter for inquiry / investigation, suggesting remedial measures and to look into the details of affected person & compensation related aspect.
12. That, the answering respondent craves reply of the Hon'ble Tribunal to file additional reply, in future, if required.
13. That, in light of the above submission, it is respectfully submitted that this answering respondent i.e. CPCB, shall abide by any order(s) or direction(s) passed by this Hon'ble tribunal in the instant OA.


(Arvind Kumar Jha)

Scientist 'E' & RD(Vadodara)
Central Pollution Control Board

डॉ. अरविंद कुमार झा / Dr. Arvind Kumar Jha
क्षेत्रीय निदेशालय / Regional Director
केंद्रीय प्रदूषण नियंत्रण बोर्ड / CENTRAL POLLUTION CONTROL BOARD
(पर्यावरण, वन एवं जलवायु परिवर्तन विभाग, भारत सरकार)
(Ministry of Environment, Forest & Climate Change, Govt. of India)
क्षेत्रीय निदेशालय वडोदरा - 390023, गुजरात.
Regional Directorate, Vadodara - 390023, Gujarat.



Regional Director, Vadodara - 390023, Gujarat
 Ministry of Environment & Forests, Government of India
 (Under the provisions of the Environmental Protection Act, 1986)
 Regional Director, Gujarat Pollution Control Board
 Dr. Arvind Kumar Jha

BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONE BENCH, PUNE

ORIGINAL APPLICATION NO. 02 OF 2025(WZ)

IN THE MATTER OF:

Shri Ashutosh Kumar

: Applicant

V/s

Gujarat Fluorochemicals Ltd. & Ors.

: Respondents

AFFIDAVIT

Regd. No.: 4362
Date: 06/06/2025

I Arvind Kumar Jha, aged 48 years, having office at the Regional Directorate (Vadodara), Central Pollution Control Board (CPCB), Near VMC Ward No. 10 Office, High Tension Road, Subhanpura, Vadodara, 390023, do hereby solemnly affirm, declare on oath and state as under:

1. That the deponent is authorized representative to represent the Respondent CPCB in the present case, and as such, I am well conversant with the facts and circumstances of the present case on the basis of the information derived from the official records, and hence, I am competent and authorized to verify, sign and swear this affidavit on behalf of the Respondent CPCB.
2. That the accompanying reply may be read part and parcel of the present affidavit as I am competent to swear this affidavit.
3. That the accompanying reply has been drafted and filed under my instructions and the contents thereof are true and correct on the basis of the record maintained during ordinary course of business of CPCB and available records and documents and the contents of the same are read over and explained to me and are not repeated herein for the sake of brevity.

Arvind Jha
DEPONENT

VERIFICATION

Verified at Vadodara on this 6th Day of June, 2025 that the contents of the above reply are correct and true on the basis of the record of the cases as mentioned in the day to day affairs of the CPCB. Nothing has been concealed therefrom or mis-stated.
Verified at Vadodara on this the 6th Day of Jun, 2025.

Arvind Jha
DEPONENT



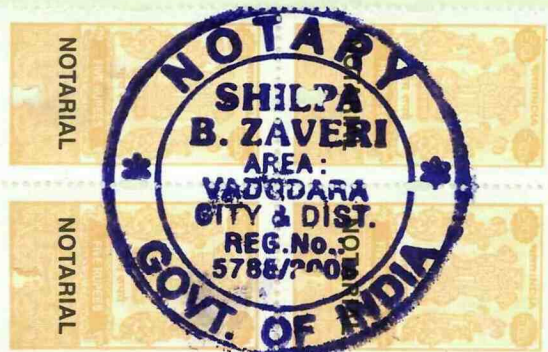
डॉ. अरविंद कुमार झा / Dr. Arvind Kumar Jha
क्षेत्रीय निदेशालय / Regional Director
केंद्रीय प्रदूषण नियंत्रण बोर्ड / CENTRAL POLLUTION CONTROL BOARD
(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार)
(Ministry of Environment, Forest & Climate Change, Govt. of India)
क्षेत्रीय निदेशालय, वडोदरा - 390023, गुजरात.
Regional Directorate, Vadodara - 390023, Gujarat.

My Commission expires on 28-4-2028
SHILPA B. ZAVERI,
NOTARY

Solemnly Affirmed/Declared
Sworn Before me by *Arvind Kumar Jha*

Shilpa B. Zaveri

Shilpa B. Zaveri
NOTARY
6 JUN 2025



GUJARAT POLLUTION CONTROL BOARD

PARYAVARAN BHAVAN, SECTOR 10-A,
GANDHINAGAR - 382010,
(T) 079-23232152

BY R.P.A.D.

DIRECTION UNDER SECTION-31(A) OF THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT-1981 (HEREINAFTER REFERRED TO AS THE "AIR ACT") AS AMENDED FROM TIME TO TIME

WHEREAS you **M/s. Gujarat Fluorochemicals Limited** having an industrial plant at Plot No.: 12-A, E-50/1, Dahej GIDC Estate, Tal.:Vagra, Dist.: Bharuch.

AND WHEREAS you are having CCA No. AWH-129478 valid up to 15/02/2027 for manufacturing activity/operation of industrial plant subject to compliance of conditions mentioned in order of said CCA.

AND WHEREAS during the inspection of your industrial plant on 29/12/2024 by the authorized officer of the Board, it has been observed that:

- (1) On 28/12/2024, gas leakage accident occurred in CMS- 1 plant of unit.
- (2) Leakage occurred from isolation valve near auto valve XCV-2209 of CMS-1 plant leading to leakage of Crude CMS (Chloro Methane Substance). Crude CMS contains mixture of Chloroform, Methylene Dichloride and Carbon Tetrachloride.
- (3) Crude CMS was emitted into atmosphere due to this accident and as per the CCTV footages gaseous cloud was seen for approximately 15 minutes.
- (4) The cloud of the gas was formed in the entire CMS-1 plant area, Control Room area and further dispersed in the plant area as informed.
- (5) Due to this Gas leakage accident, 04 persons were died and 02 persons were injured (under observation). (As per latest information).
- (6) At the time of inspection the isolation valve (near auto valve XCV2209) found damaged and bonnet found displaced.
- (7) Unit has not adopted adequate safety measures.

AND WHEREAS the non-compliances found during the inspection seems severe and may damage environment adversely.

AND WHEREAS Director Industrial Safety and Health (DISH), Bharuch office has issued prohibitory order for manufacturing activity in CMS-1 plant of the unit.

UNDER THE CIRCUMSTANCES, as directed, I M. R. Macwana, Unit Head-Bharuch, Gujarat Pollution Control Board issue the directions under Section 31-A of the Air Act - 1981 as under:

- (1) Unit shall not use/operate CMS-1 plant before obtaining revocation the Board.
- (2) To take all necessary measures to safely remove all remaining in-process material/ intermediate materials considering requisite process safety aspects.
- (3) To ensure safe collection of residues of chemicals / hazardous & other wastes generated from accident and dispose the same as per provisions of the HOWM Rules-2016 under intimation to the Board.

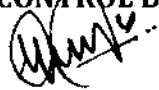
- (4) To take all necessary measures to ensure safety of all reactors, equipment etc. to prevent further mishappening and environmental damage.
- (5) To carry out safety audit/ HAZOP study and root cause analysis for accident that shall include environment aspects at the earliest and submit the same to the Board.
- (6) To submit compliance report of the instructions/directions issued by DISH w.r.t. accident, if any.
- (7) **Unit shall pay Rs. 1 Crore (Rupees One Crore only) as Interim Environment Damage Compensation (EDC) immediately through XGN portal.**
- (8) **To submit Bank guarantee of Rs. 10 Lac (Rupees ten laconly) for compliance assurance at the time of revocation.**

Non-compliance or violation of the aforementioned direction/order will constrain this Board to initiate action as per provision of Section- 37 of the Air (Prevention and Control of Pollution) Act-1981 and amendment thereof.

If you are aggrieved by the aforesaid direction, you may file an appeal under Section 31 of the Air (Prevention and Control of Pollution) Act, 1981 before Appellate Authority (Forests & Environment Department, Government of Gujarat) within thirty days from the date of this order.

This order is issued with the approval of competent authority of the Board.

**FOR AND ON BEHALF OF
GUJARAT POLLUTION CONTROL BOARD**


**(M. R. MACWANA)
UNIT HEAD**

NO: GPCB/BRCH/CCA-1080(25)/ID-15136/

Date: /01/2025

Issued to:

M/s. Gujarat Fluorochemicals Limited
Plot No.: 12-A, E-50/1, Dahej GIDC Estate,
Tal.: Vagra, Dist.: Bharuch

Copy To:

- **Regional Officer,**
Gujarat Pollution Control Board,
Regional Office, Bharuch..... for monitoring & verification.



GUJARAT FLUOROchemical LIMITED
SITE-A, DAHEJ

THIRD PARTY SAFETY AUDIT
(AS PER IS 14489-2018)
JULY, 2023

PREPARED BY



VERSATILE ENGISAFE PRIVATE LIMITED

A-504, SAIDHAM RESIDENCY, NR. ABC CIRCLE, BHOLAV,
BHARUCH, GUJARAT, INDIA

PH: 02642-228151, +91-94263-58787

Table of Contents

DOCUMENT DETAILS.....	3
AUDITOR'S REPORT	4
AUDIT CERTIFICATE	5
1: EXECUTIVE SUMMARY	6
2: INTRODUCTION & COMPANY PROFILE.....	8
3: ON SITE OBSERVATIONS & RECOMMENDATIONS	25
4: OBJECTIVES, SCOPE AND METHODOLOGY	43
5: APPLICABLE LAWS AND STATUTORY COMPLIANCE	48
6: IS: 14489-1998 – SAFETY AUDIT QUESTIONNAIRE	53
END OF REPORT	150

DOCUMENT DETAILS

TITLE	Third-Party Safety Audit		VERSATILE ENGISAFE PVT. LTD. A-504, Saidham Residency, Nr. ABC Circle, Bholav, Bharuch, Gujarat, India. Ph.: 02642-228151, Mo.:+91-94263-58787 Email: info.versatileengisafe@gmail.com
FOR	GUJARAT FLUORO-CHEMICAL LIMITED, SITE-A, DAHEJ Plot No: 12/A, Industrial Estate Dahej, Tal: Vagra, Dist.: Bharuch, Gujarat		
AUDIT SESSION	Date: 07 th & 8 th July, 2023		
	Place: GUJARAT FLUORO-CHEMICAL LIMITED, SITE-A, DAHEJ		
DOC. NO.	TPSA/MOL/2324/1003	AUDITOR	Mr. Sanjay Masrani Mr. Anil Shah Mr. Sunil Dave
DATE OF ISSUE	13 th July 2023	SITE COORDINATOR	Mr. Sharad Potghan Mr. Maulik shah Mr. Jikar Malek
REVISION NO.	00		
PREPARED BY	Vishal Patoliya <i>Process Safety Engineer</i>	<i>Signature</i>	
REVIEWED BY	Dharmesh Sankla <i>Director-Technical</i>	<i>Signature</i>	
APPROVED BY	Sanjay Masrani <i>Auditor</i>	<i>Signature</i>	
00	08 th Septembere 2023	Rev.00	No Comments
00	13 th July 2023	Rev.00	Issued for confirmation
REV.	DATE	STATUS	DESCRIPTION

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in MGN on 13/01/2025 16:51:34 from IP No: 172.16.31.15
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AUDITOR'S REPORT

Safety Audit of **M/s GUJARAT FLUOROCHEMICAL LIMITED, SITE-A, DAHEJ** is situated at Plot No: 12/A, Industrial Estate Dahej, Tal: Vagra, Dist.: Bharuch, Gujarat was carried out on 07th & 8th July, 2023 by **M/s. VERSATILE ENGISAFE PVT. LTD., Bharuch**. During the period of audit, field visits and technical discussions were held by Mr. Sanjay Masrani, Mr. Anil Shah and Mr. Sunil Dave & also reviewed the documents and discussed with concern representatives of the plant. Safety Audit is carried out as per **BIS 14489-2018**. The auditor has sincerely tried to adhere to the terminology and methodology of **BIS 14489-2018**. The observations and recommendations are based on information supplied to us by the company & plants visits. Auditor acknowledges the management of **M/s. GUJARAT FLUOROCHEMICAL LIMITED, SITE-A, DAHEJ** for their valuable co-operation & help render for the safety audit.

Signature of Auditor

 GUJARAT FLUOROCHEMICALS PRAJ LAXMI GREEN CHEMIST	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ DOCUMENT ID IPSA/GFL/2324/1003 REVISION NO. 00	 VERSATILE Empowering the Future

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AUDIT CERTIFICATE

We are pleased to certify that this Occupational Safety and Health Audit of **M/s GUJARAT FLUORO-CHEMICAL LIMITED, SITE-A, DAHEJ**, Plot No: 12/A, Industrial Estate Dahej, Tal: Vagra, Dist.: Bharuch, Gujarat has been conducted by us in the month of JULY 2023.

Safety Audit is a legal requirement Under Rule 12–C, 68–O and 68-J of the Gujarat Factories Rules, 1963 and Rule 10 of the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.

This audit is carried out as per requirements of the above statutes and as per guidelines given in IS 14489: 2018.

We have sincerely tried to adhere to the terminology and methodology of IS 14489:2018 and gone through the maximum details as suggested in Annex B & C thereof.

The observations and recommendations are based on information supplied to us by the company and our plant visits. The detailed observation report is attached herewith.

The Executive Summary is given in the beginning to highlight the significant observations in our audit report. We hope the compliance of audit points suggested in this report will make the company safer and healthier.

The Third-Party Safety Audit is valid for one Year as per MSIHC Rule 1989; hence next Audit will be due in July 2024.

Seal

For, **VERSATILE EngiSafe Pvt Ltd.**

Place: **Bharuch**

Director (Technical)

 GUJARAT FLUORO-CHEMICALS PVT. LIMITED	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ DOCUMENT ID IP/A/GFL/2324/1003 REVISION NO. 00	 Empowering the Future

- Reply to Closure dated 03.01.2025 with annexures Uploaded in MGN on 13/01/2025 16:51:24 from IP No: 172.16.31.15
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1: EXECUTIVE SUMMARY

In order to assess the existence and effectiveness of health and safety system, the management of **M/S GUJARAT FLUORO-CHEMICAL LIMITED, SITE-A, DAHEJ**, Plot No: 12/A, Industrial Estate Dahej, Tal: Vagra, Dist.: Bharuch, Gujarat entrusted M/s Versatile EngiSafe Pvt Ltd. Bharuch, to conduct safety audit in their facilities so as to enable them to take necessary measures to strengthen & improve the Health and Safety Systems.

The report of this safety audit has identified certain areas where some more efforts are needed to achieve higher levels of safety performance.

Good Observations:

1. The occupational safety & health management system is found able to march towards improvement.
2. Statutory compliance of safety aspects including documentation is satisfactory and management is committed to follow statutory and non-statutory safety aspects.
3. ETP is there for environment protection.
4. Housekeeping is well maintained.
5. Public address system is provided for better communication.
6. The employees have been trained for the process operation.
7. The firefighting devices like sand bucket, fire extinguishers, fire hydrant etc. are provided in the process area.
8. The employees have been issued the required personal protective equipment to be worn while on the job.
9. Weekly safety communication meeting by Site leadership with employees and contractor workers is good initiative for employee involvement.
10. On-site emergency plan is well prepared complying the provisions under FA section 41-B and GFR 68-J (12).
11. The mock drills are also scheduled and executed complying the provisions under FA section 41-B and GFR 68-J (12).
12. Environment related legal compliance is carried out meticulously. The work place monitoring is being done in compliance with FA Section 7-A (a) (e) and GFR 12-B.
13. MOC implementation and closing related documentation at all stages were evident at plants and HAZOP was found done.
14. The WP procedure implemented and compliance found visible in field during field visit in all the plants. Work Permit was found with compliance to FA section 64, Part-II, Schedule-XIX and GFR 68-E & GFR 89 to 91.

Area of Improvement:

1. Display of safety policy shall be ensured at strategic location and employees shall be made aware about the safety policy of company.
2. Process as well as emergency shutdown procedure related drills/ table top exercise needs to be conducted and recorded. Employees shall be made aware about such drills.
3. Tank safety is one of the most critical points in PSM. More awareness / training is required for staff.
4. Along with the fire and safety requirements necessary arrangement shall be provided to control the spillage of chemicals. Spill contingency plan is not available to handle tank overflow case.
5. plant operators shall be provided systematic tool box talk on hazards associated and risk while handling the chemicals. Do's and Don'ts and handling procedure shall be displayed at strategic locations.
6. A procedure for the checking, inspection, validation and time frame for with scaffolding are to be kept in the area, keeping escape routes free, etc. shall be part of the SOP prepared. Also inspection of scaffold material, clamps, platform clamps shall be part of SOP.
7. The permit procedure is required to be reviewed and revamped. Confined space atmosphere and isolation shall be checked as per the matrix and in compliance to the requirement of section 36 of 'The Factory Act'.
8. The entry in the license premises shall be restricted. The PESO approved license premises shall have required caution display boards. The area shall be kept under lock and key with defined responsibility.
9. ESO shall be designated as per CEA regulation. The Legal matrix shall be revised and reviewed for including the requirements of CEA regulations.
10. Isolation permit shall be separated and format shall be prepared as per the relevant IS.
11. TREM card shall be prepared for the chemicals transported from site. It shall be given to the driver of the vehicle through with the chemical is transported.
12. No lifting tools and tackles of contractor, without form 10 shall be allowed inside the site.
13. TNI shall be defined for each employee and its monitoring mechanic shall be developed. Roles, responsibilities and duties and notification letter for SO,ESO, Welfare officer and factory manager shall be kept easily accessible.
14. The medical test for drivers and food handlers, height worker shall have specific test to be defined.
15. Contractor safety management system should be developed & implemented. Their working area & hazards must be informed them before giving any job.

2: INTRODUCTION & COMPANY PROFILE

INTRODUCTION

Chemicals and petroleum industries have undergone considerable changes during the last two decades. During this period plants have grown in size, the process has become more complex and interlinked and the inventory of hazardous chemicals increased to meet the demands of the society. These factors have greatly increased the hazard and loss potential both in human and in economic terms. Such loss may occur in various ways. The most obvious is the major accidents, usually arising from loss of containment and taking the form of serious fire, explosion or toxic release of chemicals. With the growing scale and complexity of modern plants the danger of serious large scale incident has been a source of increasing concern. In the interest of accident prevention and the observance of the related legislation it is the responsibility of the occupier to make the plant inherently safe, to provide a safe place of work and operate safe systems of work. Safety audit is an important tool of the management to evaluate the effectiveness of safety and health system. It is increasingly being used by the management of not only the chemical plants but by all concerned to evaluate the strength and weakness of health and safety system in their organization. Safety audit is also an important tool for identifying falling standards, areas of risks or vulnerability, hazards and potential accidents in proposed and existing plants and processes, the action necessary to remove hazards before personal injuries or damage occur; and for ensuring that the whole safety effort of the company is effective, meaningful and the objectives understood.

In view of past accidents in chemical industries in the country over a few decades, a specific legislation covering major hazard activities has been enacted by government of India in 1989 (MSIHC Rules 1989) in conjunction with EPA 1986. One of the important provisions of the MSIHC Rules and of the Factories Act 1948 & the Gujarat Factories Rules 1963 is the preparation and filing of safety audit report by the organization.

With this back ground the management of **M/S GUJARAT FLUORO-CHEMICAL LIMITED, SITE-A, DAHEJ**, Plot No: 12/A, Industrial Estate Dahej, Tal: Vagra, Dist.: Bharuch, Gujarat requested to carry out safety audit of their works.

WHY SAFETY AUDIT?

Various indices for attempting to assess the results of a company's safety activities are well known. They include injury frequency and duration rates estimating financial loss due to fire and other damage accidents and recording the number and types of injuries. All these methods have certain things in common; they are quantitative and because they measure results only, are not always strictly related to the quality of a company's safety effort.

What is needed, there for, is a method which will give a reasonable indication of how well a company's safety programme is working in all its aspects, how hazards are being recognized and controlled, how unsafe acts and conditions are being eliminated. How accidents are being avoided, without using only failures as the yardstick.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ DOCUMENT ID: IPSA/GFL/2324/1003 REVISION NO. 00	

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COMPANY PROFILE

An ISO 9001:2015, ISO 14001:2015, ISO 45001:2018 and SA 8000:2014 certified organisation, GFL is a leading producer of Fluoropolymers, Fluorospecialities, Refrigerants and Chemicals for applications in varied industries. GFL derives its strength from expertise in Fluorine Chemistry, vertical integration from natural minerals to Fluoropolymers and strong R&D, enabling it to provide one of the best quality products meeting all regulatory compliances, to our clientele globally.

The year 1989 marked commencement of Company's commercial operations with India's largest Refrigerant manufacturing unit at Ranjitnagar, Gujarat, India. The site was further expanded to produce Fluorospeciality products catering to the growing demands in global agriculture and pharmaceutical industry. Foraying into new avenues in 2007, with one of the world's most integrated facilities at Dahej, Gujarat, India, GFL now has a diverse portfolio of Fluoropolymers comprising PTFE, PFA, FEP, FKM, PVDF and Fluoropolymer Additives.

With three manufacturing facilities in India, a captive Fluorspar mine in Morocco, offices and warehouses in Europe and USA, and a marketing network spread across the world, GFL is one of the established players in Fluoropolymers and Fluoro specialities markets.

Our Sustainability goals are interwoven with the way we do business all along our value chain. The company is signatory to the United Nations Global Compact (UNGC), and is a member of the Indian Chemical Council (ICC). Our focus on Health, Safety and Environment is reflected in the wellbeing and safety of our people. All-inclusive efforts towards sustainability at various facets make us long-term partners for our customers across geographies..

NAME AND ADDRESS OF FACTORY

M/s Gujarat Fluorochemicals Limited
12/A, Industrial Estate Dahej,
Tal: Vagra, Dist.: Bharuch, Gujarat

NAME AND ADDRESS OF OCCUPIER:

Mr. Sanath Kumar
12/A, Industrial Estate Dahej,
Tal: Vagra, Dist.: Bharuch, Gujarat

NAME AND PHONE NUMBER OF THE FACTORY MANAGER:

Dr. Sunil Bhatt
12/A, Industrial Estate Dahej,
Tal: Vagra, Dist.: Bharuch, Gujarat

NO OF EMPLOYEES

Total Employment: Above 5000

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ DOCUMENT ID : TPA/GFL/2324/1003 REVISION NO. : 00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in MGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15
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PROCESS DESCRIPTION:**A. Chlor-Alkali Plant**

This plant is designed to produce Liquid Chlorine of 337 MT / Day and Caustic Soda of 11400 MT / Month based on state of the art ion-exchange membrane cell process developed by Asahi, Japan. The Chlor-Alkali plant is designed to produce 380 TPD caustic soda based on the Ion Exchange Membrane Technology. In the electrolysis process, hydrogen gas and caustic soda are produced in the catholyte compartments. Chlorine gas is produced in the anolyte compartments. Hydrochloric Acid is manufactured from Cl_2 and H_2 gas generated in the electrolysis process, in hydrochloric acid synthesis unit. The process consists of following sections:

1. Primary brine purification,
2. Secondary brine purification,
3. Electrolysis,
4. De-Chlorination,
5. Caustic Soda Evaporation,
6. Cl_2 gas washing & cooling, drying,
7. Cl_2 gas compression and liquefaction,
8. Cl_2 absorption,
9. H_2 gas washing
- 10 Chlorine Synthesis

The Chlor-Alkali Plant is controlled by DCS to provide an Integrated Plant Control with following associations:

- i. Distributed Control System (DCS)
- ii. Safety Interlock System
- iii Remote Control Panel for rectifiers
- v. Instrument Panel with monitoring and alarm modules, recorder for Cl_2 and H_2 gas Pressure /differential pressure

Brine solution is used as feedstock, and it is purified in order to remove impurities before sending to Electrolysis Unit. Raw salt is dissolved with return brine solution from electrolyzer, and it is sent to Reactor with sodium carbonate, barium carbonate and caustic soda to exchange the calcium, magnesium and other multivalent ions present in the raw brine. After this reaction, brine solution flows into clarifier to settle suspended solids and the clear liquid is sent to Pre-coat type ceramic filters and Ion-exchange column for further purification. Electrolysis Unit is composed of Electrolyzer, Anolyte and Catholyte circulation facilities. Each electrolyzer of 142 cells is designed to produce 385 ton/day of Caustic Soda as 100% at the current density of 6.0 kA/m². The purified brine is supplied to anolyte compartment, where the chlorine gas (Cl_2) is generated and then sent it to Catholyte compartment, where hydrogen gas (H_2) and Caustic Soda are produced. Wet Cl_2 undergoes washing, Cooling, Drying and Compression processes and finally stored in a Liquid Cl_2 Storage tank by

Liquefaction process. Wet H₂ gas from the Electrolysis is sent to H₂ gas Scrubber. The depleted brine from the electrolysis section is pumped to De-chlorination Tank, which is kept under vacuum by Steam Ejector. The dissolved Cl₂ is stripped together with water vapor and is cooled in De-chlorination Cooler. There still remains a small amount of free Cl₂, which is removed by adding Sodium Sulfite solution. Then, the brine is sent to Primary Brine Purification section. Caustic soda solution from Electrolyzer is fed to Caustic Evaporation Unit for purification. Various raw materials required such as NaCl, Flocculent, Sodium Carbonate, Barium Carbonate, Hydrochloric Acid and Sulfuric Acid are stored in separate storage areas. Utilities such as Steam, Nitrogen, raw water and DM water are supplied from the main utility area. Chilled water and cooling water requirement is met by dedicated chilled water and cooling water plants located in the caustic soda plant area. Chilled water consumption in the plant is about 300 m³/hr. and plant capacity is 250 TR. Cooling water consumption in the plant is approximately 2000 m³/hr.

B. Chloromethane Plant

The CMS Plant is designed to produce 310 TPD of Chloromethane which are Methylene Dichloride, Chloroform and Carbon tetrachloride. The process is carried out in two stages:

Hydro-chlorination in which Methanol gas reacts with HCl gas to produce Methyl Chloride (exothermic reaction) and Thermal Chlorination of Methyl Chloride with Chlorine to produce Methylene Dichloride, Chloroform and Carbon Tetrachloride as per the requirement by altering the feed ratios. The main product produced is Chloroform and this is fed as raw material to the existing R-22 Manufacturing. The process consists of following sections:

- i. Hydro Chlorin section Unit.
- ii. Chlorination Unit.
- iii. Product Rectification Unit.
- iv. Hydrogen Chloride Absorption Unit.
- v. Regeneration and Drying Unit.
- vi. Acid and Alkali storage Unit.
- vii. Refrigeration Unit.
- viii. Steam and Condensate Recovery system.

The CMS Plant is controlled by Distributed Control System to provide an Integrated Plant Control with following:

1. Safety Interlock System
2. Remote Control Panel for rectifiers.

The feedstock Methanol (CH_3OH) and Hydrochloride (HCl) react to produce Methyl Chloride in Hydro chlorination unit. This product is sent to Chlorination unit with Chlorine gas (Cl_2). Both of them undergo thermal chlorination and produce a mixture of Dichloromethane, Chloroform (CHCl_3) and Carbon Tetrachloride (CCl_4). This product mixture is rectified in Rectification unit and dried by azeotropic drying. Most of the by-product HCl from chlorination unit is again sent to hydro chlorination unit and the excess HCl is absorbed in HCl absorption unit. This absorbed HCl and process water formed concentrated hydrochloric acid, which is then stripped in the organic stripper to remove organic matters.

The off-gas containing HCl and Cl_2 are neutralized with NaOH and water. The spent NaOH containing Chloromethane (CMS) mixtures and off-specific CMS are collected and re generated through CMS dryer and sent it to product rectification unit. According to process requirements, exhaust condenser in the hydro chlorination unit, chlorination unit and refrigeration unit adopt R-22 evaporation to exchange heat with the process fluids. In addition to that, storage tanks receive and store concentrated sulfuric acid, dilute NaOH and dilute H_2SO_4 as needed in major process units.

Steam and Condensate recovery system is also provided to recover steam condensate from the plant. Various raw materials required such as Methanol, HCL , NaOH and Sulfuric Acid are stored in separate storage areas. Utilities such as Steam, Nitrogen, raw water and DM water are supplied from the main utility area.

C. TFE, PTFE and PT- PTFE Plants

This plant is to manufacture TFE, PTFE, PT-PTFE and DPTFE using captive available R 22 of about 112 MT/day as the feed stock for the production of TFE and to produce PTFE resin. The annual production capacity on the basis of 300 working days per year is TFE of 7,680 TPA and PTFE of 1650 MT/Month.

The PTFE plant is designed to produce 1650 MT/ Month of Poly Tetra Fluoro Ethylene i.e., suspended middle grain and fine grain PTFE resin. The process is mainly carried out in two stages:

- i. Thermal cracking of R-22 with over-heated steam to produced TFE.
- ii. Polymerization of TFE with De-ionized water and reduction – oxidizing system to produce PTFE.

The process consists of following sections:

1. TFE monomer metering.
2. Suspension polymerization.
3. Crushing, washing and drying of PTFE.
4. Air- jet pulverization process.
5. Packing and storage.

The PTFE Plant is controlled by DCS to provide an Integrated Plant Control with following associations:

1. Distributed Control System
2. Safety Interlock System

Fresh and recycled Chlorodifluoromethane (R22) is mixed in a vessel and enters into Steam heating furnace and to the Reactor for cracking. Cracked gas is composed of C₂F₄, HCl, un-reacted R22, excess steam and traces of other cracked products. They enter into a Graphite condenser after rapid cooling in a Quencher. The excess steam and HCl are condensed to form dilute hydrochloric acid and transferred to either neutralization chamber or storage vessel. Uncondensed cracked gas is neutralized and then sent to a buffer tank.

The cracked gas enters into the three-stage compressor unit through a buffer tank, cooler and refrigeration dryer to remove excess moisture. The dry process gas is sent to rectification units for further purification of TFE monomer after de-oxidation process and sent to storage tank through condenser. The un-reacted R 22 from rectification units is recycled to the reaction system. Liquid TFE monomer is sent to Polymerization reactor with de-ionized water after heating, vaporization and compression. The PTFE polymer with mother liquor from reactor is sent for crushing, washing by fresh de-ionized water and drying. Further, PTFE resin is sent, to and dried in the hot air blowing and cold air blowing system and finally it is separated according to its size in a cyclone separator.

post treated PTFE (PT-PTFE) is obtained from following methods depending upon customer requirement. The middle size PTFE resin is fed to air jet mill continuously and smashed by accelerated impact and obtained PT- PTFE's grain size is varying from 10 to 100 Microns. Dry PTFE powder is treated in Heating Ovens at various temperatures to get desired quality of PTFE as per Market requirement. Dry powder is treated in Reactor along with water and Perchloro-ethylene at various temperatures to get the properties of free-flowing PTFE powder.

Various raw materials required are TFE, Aqueous alkali, Disodium hydrogen phosphate, Ammonium per sulfate, Sodium bisulfate, Ferrous sulfate, De-ionized water and Silica gel. Utilities such as N₂, Instrument Air and Process Air, cooling medium (-15oC CaCl₂ Brine, -35oC CaCl₂ Brine, -5oC aqueous Ethylene Glycol), Saturated steam, Electricity 3- phase and Compressed air are supplied from the main utility area.

D. Captive Power Plant

GFL has set up a 26MW Co-generation plant, which represents the combined production of heat and power through a c

This plant is designed to produce electric power for captive power requirement, process steam through waste heat recovery boilers using hot flue gases coming out of the gas turbines. In addition to that the plant has been designed to operate its gas turbines with augmented output by means of reducing the sensible heat and partially reducing the moisture in the combustion air through the Vapor Absorption Machines (VAM) of 330 TR capacity driven by the hot engine jacket cooling water. Fuel is natural gas with Methane number greater than or equal to 70.

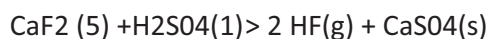
The minimum and maximum gas pressures for operation are 3.5 and 6 bar (g), respectively. Steam is produced at the net rate of 195000 kg per hour and at a pressure of 12.0 kg/cm² (g) and temperature of 191°C. Makeup water is added at 65°C and 4 kg/cm² (g).

E. A & H Plant

Process Description of HCFC R-22 for TFE feedstock

Anhydrous Hydrofluoric Acid, for captive consumption, is manufactured by reacting Fluorspar with a mixture of Sulphuric Acid and Oleum. Wet Fluorspar is fed to the inlet of Flash Dryer. The dry Fluorspar from Cyclone is fed to the Rotary Kiln through the Storage Silo. The Fluorspar, after drying, is fed to the Rotary Kiln along with a mixture of Sulphuric Acid and Oleum, to produce AHF and By-product Gypsum (CaSO₄) as per the following reaction:

Heat



The reaction is endothermic and there is no possibility of any run-away reaction.

The Rotary Kiln is indirectly heated by hot flue gases. The Gypsum from the Kiln is neutralized with Lime and discharged as By-product.

The HF vapor is passed through the Kiln Column. The clean HF from the Kiln Column is condensed in HF condensers by means of Refrigeration. The crude condensed HF liquid is fed to the Distillation Columns through Crude HF Storage Tank. Pure AHF is withdrawn and sent to receiving tank after due Analysis.

The entire HF Plant is kept under negative pressure and there is no possibility of leakages of HF from the equipment to the atmosphere.

Raw Materials Anhydrous Hydrogen Fluoride (AHF) and Organic CHCl₃ for R-22) are fed to Reactor (01). The Reactor contains special Penta chloride Catalyst which is used to catalyze the reaction between AHF and Organic to produce Refrigerant gas as per the following reactions:



The Crude Refrigerant gases from Reactor enter the Stripper (02) to condense and return unconverted Reactants. CHCl_3 to the Reactor.

From Stripper, Crude gas mixture enters HCl Distillation Column (03). Top product of Distillation Column enters HCl Absorption Unit, which consists of Alumina Towers (07, 08), HCl Absorber (09) and Tail

Tower (10). Here, HCl is generated by counter current absorption with water. The bottom product of the Distillation Column (03) enters exchanger where it is mixed with organic and is finally collected into Phase Separator (04). The top layer of the Phase Separator (04) is collected into the AHF Storage Tank (05) and is finally re-fed into the Reactor (01). The bottom layer of the Phase Separator enters Heavies Recovery Column (06). The bottom product of the Heavies Recovery Column (06) is stored into Heavies Tank and is finally re-fed into Reactor (01). The top product of the Heavies Recovery Column enters HF Absorption Column (11) where traces of HF are absorbed into Sulphuric Acid and output of the HF Absorption Column enters into Alkali Towers (12, 13) where the Crude gas is scrubbed with Caustic Soda Trisodium Phosphate. The Crude Gases are then dried in Acid Drying Towers (14, 15) where Moisture, is absorbed by circulating Sulphuric Acid, The bottom product of Non condensable Column enters 1st Distillation Column (20), where R-22 is withdrawn from the top as Final Product, bottom from the Column (20), which mainly contains High Boilers such as R-21 and CHCl_3 is recycled to the Reactor (01), The Finished Product Refrigerant Gases withdrawn from respective Column tops are then sent to the Daily Storage Tanks. After duly approval of the Quality, the R-22 is sent to final storage for TFE feed stock.

The 32 % HCl obtained from the Absorption Unit is taken to the Storage Tank from where it is sold to Customers. The Spent Liquor from Alkali Tower is taken to Effluent Treatment Plant, for suitable treatment and disposal. The Spent Sulphuric Add from Acid Drying Tower (14, 15) is mixed with Oleum to make up the strength (11) is stored Into Sulphuric Storage Tank T-3107A/B and is finally fed to the Kiln.

Equipment reference no. is mentioned in block diagram of Plant-H.

F. Recovery Plant -1

In the manufacturing of PTFE, TFE is polymerized in DI water with the help of Initiators. Fluoro surfactant is present as the dispersing medium. This Fluoro surfactant remains in the Latex coming from the reactor. This Fluoro surfactant has to be removed from the Product before it is sent to the market. For this following process is followed.

- a. First secondary surfactant (Tegretol) is mixed in this Latex. So that the product becomes stable. This Tegretol is Non-Fluorinated surfactant and can remain in the product as a stabilizer for the product

- b. So, after Adding this secondary surfactant the primary surfactant is removed by passing this liquid through ion exchange columns. Where the primary surfactant is captured by ion exchange resin and final product without Primary surfactant goes for further concentration and packaging of the product.
- c. Now the resin contains this primary surfactant which has to be removed and to be recycled back to the process.
- d. For removing the surfactant from resin solution of Ammonium Chloride 2%, Methanol 70% and water 28% is passed through this column. So, the surfactant get transferred to the is solution
- e. This solution now contains mixture of following:

1. Surfactant
2. Methanol
3. Water
4. Ammonium Chloride

Methanol is separated by distillation under vacuum so that the se can be separated and all can be re used and

can be recycled back to process. The methanol recovered has concentration of around 70 to 80 % which cannot be used in the process.

F. CaCl_2 Plant

Calcium chloride is one of the most versatile of the basic chemicals. It has been produced commercially for well over the years. The properties and characteristics of Calcium chloride make it useful in a large number of applications. Commercially Calcium chloride is produced in following forms. Liquid Calcium chloride is manufactured in concentrations of 20% to 45% and it is also available as 32% food grade formulation.

The object this plant is to utilize of Hydrochloric Acid by neutralizing it with Calcium Carbonate. The Calcium Chloride is produced by the reaction of Calcium Carbonate (CaCO_3) with 32% Hydrochloric Acid in a Reactor. The resulting 35% Calcium Chloride solution is produced & further it is neutralized with lime to make it free from any acidity. It is also Clarified/ filtered to remove all suspended impurities. The clear Calcium Chloride solution is then can be transferred for further use in evaporation or granulation plant to make anhydrous/ solid material. The Calcium Chloride in the form of powder / granules / flakes are easily transportable & salable in the market in India & abroad.

Process- Calcium Chloride

The Calcium Chloride is mainly produced commercially by Limestone & Hydrochloric Acid reaction. The other production processes such as recovery from by product or naturally available forms are not covered here.

Limestone-Hydrochloric Acid Process

Limestone can be treated with hydrochloric acid to form calcium chloride and carbon dioxide:



If concentrated (32%) hydrochloric acid is utilized, the concentration of CaCl_2 in the produced solution will be approximately 32% and further evaporation is only needed when flakes/granules are produced. The purification of the product is mainly accomplished by adding $\text{Ca}(\text{OH})_2$ as described in the natural brine process.



The high purity of the produced carbon dioxide (CO_2) makes it suitable for applications within the food and pharmaceutical industries e.g., in the production of carbonated soft drinks. Extremely pure calcium chloride products can be obtained using this process if the purity of the hydrochloric acid is sufficient. Hence, the process is well suited for producing food grade products. It is also an environmentally friendly method to utilize by-product hydrochloric acid.

Design Basis

The design of the process is based upon the following steps: neutralization of hydrochloric acid with limestone to produce a 35% calcium chloride solution. If required, concentration of the CaCl_2 Solution to more than 50% using a double effect evaporation system, production of flakes using the flaker, calcinations of the flakes in a rotary calciner to further concentration & packing. Alternatively, 35% calcium chloride solution directly fed to Spray Dryer / Granulation Plant.

Neutralization of HCL

The neutralization of HCL with limestone is carried out as explained above to produce CaCl_2 and CO_2 as by product. The CaCl_2 solution which contains un-reacted solids (impurities from the limestone) settled down in bottom of the Reactors which can be removed by drain Valves / manhole periodically to settling pits. The CaCl_2 solution which contains un-reacted solids, free acid and Chlorides of other undesirable metals like Magnesium etc. (impurities from the limestone) flows by gravity to Clarifier through retention tank. Milk of Lime Solution is dosed in Reaction Tank wherein the Milk of lime reacts with free acid and other metallic chlorides. The Calcium Chloride solution becomes neutral and other metallic chlorides converted in to metallic hydroxides which are insoluble in water.

Clarification / Filtration:

The neutralized Calcium Chloride Solution impurities get settled down in Clarifier which is continuously containing insoluble impurities. The Flocculent is added in the Solution overflowing from Retention Tank to Clarifier. The undissolved solids get settled down at the

bottom of Clarifier which are intermittently discharged into settling pit. The overflow from Clarifier is discharged into Calcium Chloride Solution Storage Tank. The neutralized clear solution Calcium Chloride can be filtered by Inline Polished Filter and transferred for further process of Concentration and granulation. The sludge is filtered in a separate filter Press where the cake builds up on the filter cloth. The filtrate is collected in filtrate tank and the solids are discharged.

CO₂ Washing and Cleaning

The CO₂ gas is transferred to CO₂ Liquefaction Plant for further processing. At CO₂ Plant it passes through the Scrubber & demister free of the droplets. The Washed CO₂ is then discharged to further processing for Liquefaction & Dry Icing Plant or vent off to the atmosphere.

G. CO₂ Plant

Purifying system

Two lines of CO₂ gas is mixed in buffer tank (V0101) then transferred to washing tower (T0101) to remove the HCl. The washing tower has two stages for washing. First, to wash with circulation water by washing pump (P010A/B), then to purify with primary water, so to ensure HCl content can satisfy requirement. Washing pump is one in run one stand-by. The washing tower level is automatically controlled and can control the washing effect by controlling the level. After washing, the gas goes into separator (S0101) to separate saturate water, and then it is compressed by compressor(C0101A/B).

CO₂ gas is compressed to 2.4~2.7 MPa and dehumidified by dehumidifier (E0101), to remove part of water by decreasing temperature, so to increase molecular sieve adsorbing time and enhance the adsorption effect. Dehumidifier (E0101) is cooled by utilizing the vent gas from reflux tank (V0102) and distillation tower (T0105)

Outlet gas from dehumidifier (E0101) is dried by dryer (T0102A/B), inside which we use 3A molecular sieve, and the dryer is one in run one stand-by. When the moisture of molecular sieve is 15ppm, the dryer shall be switched and regenerated. The air is heated by electrical heater (F0101) then blown by a blower (P0102). Hot air passed from the bottom of molecular sieve layer and takes the moisture away. The outlet temperature is 2000C, when the outlet temperature T10102 reaches 1200C or complete regeneration after 30min over 1000C, then stop regeneration process. To cool down the dryer, we use vent gas from dehumidifier (air is not allowed for cooling). To finish the cooling process when the T10102 temperature is ambient, then slightly open the outlet valve of dryer to press and then close for standby.

Dried gas is transferred to pre-rectifying tower (T0103) reboiler (E0102) for heating, part of the inlet gas before reboiling (E0102) goes into bottom of distillation tower (T0105) and heated, then gather with the gas and from the bottom of distillation tower, goes into pre-rectifying tower, where to remove the heavy component in gas. T0103 is cooled and washed

by using the liquid from reflux tank (V0102). We control the outlet temperature TICA0106 as - 150C by controlling the liquid level, then the gas pass through absorber (T0104A/B) Absorber (T0104A/B) can remove the heavy component which cannot be removed by pre-rectifying tower (T0103), and it is one in run one stand-by. Absorber regeneration shall be as per gas component data. Adsorbed is cooled by using the vent gas from dehumidifier (E0101). If insufficient, open the line PG0107A. (Air is not allowed for cooling). The process and parameter is the same as dryer regeneration operation.

Gas from absorber (T0104A/B) is transferred to liquefier (E0103), then to reflux tank (V0102) for primary gas liquid separation. Liquid Co2 in reflux tank divides into two parts, one goes to pre- rectifying tower (T0103) by reflux pump (P0103) and one goes into distillation tower (T0105). Co2 is controlled in distillation tower by level.

The distillation tower is heated by bottom coil; light part is vent from top and high purity liquid Co2 comes out from bottom. After testing, qualified Co2 liquid is transferred to storage tank for filling.

Refrigeration system

The low pressure NH3 gas from liquefier (E0103) goes into NH3 compressor (C0201A/B) and compressed to high pressure, high temperature NH3 gas. Then it is transferred to evaporative condenser (E0201) and changes to normal temperature, high pressure NH3 liquid. The liquid NH3 goes into siphon tank (V0202) and then to storage tank (V0202), and goes back to E0103 for evaporation, repeating the cycle.

Oil is cooled by Liquid NH3 in NH3 compressor (C0201A/B). LNH3 is from the bottom of siphon tank (V0202), GNH3 return to V0202 and then goes into evaporative condenser (E0201), repeating the cycle.

Storage

Liquid CO2 from storage tank is filling into truck by filling pump, to reduce loss in this process and truck gas line can be connected with storage tank gas line (VT0302), to make the gas return to storage tank, further goes back to compressor (C0101A/B).

H. FKM Plant

Hexafluoro propylene and Vinylidene fluoride are the main monomers for producing FKM 2,6 rubber. These two monomers in gas form taken in 02 nos. monomer mixing tanks among which one is dedicated for reactor pressurization and the other is for polymerization. The composition of these tanks is different and maintained as per recipe. After preparation of gas mixture, it is fed to Polymerization reactor by the gas compressor. Reaction pressure and temperature maintained as per recipe value. After feeding the recipe amount of monomer mixture feed is cut off and the reactor is vented till the pressure

comes to atmospheric pressure. During this venting process reactor is also cooled to 30°C by cooling water circulation through reactor jacket. After that latex formed in the reactor is discharged to degassing tank where degassing done by evacuation and nitrogen flushing simultaneously and the latex temperature is further cooled down to 20-25°C. Then after checking viscosity of the latex it is transferred to latex storage tank. It is stored there till the downstream is ready. Then this latex is coagulated in coagulator by adding coagulant into coagulator. By this process polymer gets separated from the latex and it is transferred to washing tank where vigorous washing is done of the polymer. Washing continued till the wash water effluent pH comes above 6.0. Then the material is dumped on to a rubber tank from where the material is loaded on trays after dewatering of the polymer. The trays are then placed inside the tray dryer in which drying of the polymer takes place for 24hrs at 95°C. After drying material is weighed and packed in PPCP drums. These drums are then taken in the close mixer where additives are added for pre compounding and thereafter the material is turned into a sheet in a two-roll mill. After that sheet is cut and placed on trays for cooling (cooling is required as the material is heated up during the process of mixing and sheeting). When the sheet temperature brings down to ambient temperature then this sheet is packed in the packing boxes as per requirement.

I. ETFEE Plant

Manufacturing of E-TFEE Product Using Reaction Between 18% Ethanolic-KOH Solution & TFE Gas. The process for the ETFEE production consists of 3 steps:

- 1) Unloading of the Raw material into storage tanks: One of the raw materials used in the manufacturing of ETFEE is 18% KOH in Ethanol. This will be supplied to the plant by tankers which are to be unloaded into tank in an approved tank farm area.
- 2) Reaction: The Ethanolic KOH reacts with TFE to give the ETFEE at a temperature of $50 \pm 2^\circ\text{C}$. The process steps involve
 - Pumping a fixed quantity of the Ethanolic KOH into the reactor.
 - Cooling the mass and qualifying the reactor to make it oxygen free.
 - Feeding the required quantity of TFE at a fixed rate and allowing the reaction to take place in controlled conditions.
 - Post completion of the reaction, water addition for solid dissolution, cooling the mass and evacuating the residual gases safely. Typical batch cycle time is 8 hours.
 - After evacuation, the batch is transferred to a hold vessel and thereafter to the designated tank in approved tank farm.
- 3) Loading of Product into tanker: The crude product made in the process is sent via tankers to Ranjit Nagar facility for purification and ethanol recovery.

J. R-125 (Penta Fluor ethane)

The process includes CO removal, raw material metering, reaction, compression, distillation, drying, recovery, HFC-125 metering and storage. Refer to P&ID (BD1601-301~312) for details.

5.2.1 CO Removal

The gas from LV-1 MSU of TFE plant, under normal temperature and pressure of 1.3kg/cm² enter to the pre-buffer tank (V-6801), then it is cooled to 15 °C by pre-cooler (E-6801). It is pressurized to 6 kg/cm² by diaphragm compressor (C-6801), pass through the after cooler (E-6802) cooled to 25 °C, then go into the after-buffer tank (V-6802). The gas enters the CO absorption tower (T-6800) in countercurrent contact with the solvent (acetic acid copper ammonia solution), the tower top gas go to the mixture buffer tank (V-6809) after ammonia removal through ammonia washing tank (V-6830) and the decompression of control valve. The CO- contained liquid after decompression of control valve at the tower go to the upside of reflux regeneration tower (T-6801). The structure of reflux regeneration tower is refluxing section in the upper, regeneration section in the middle and reducer at bottom. After deamination in water washing tank (V- 6805), the CO- contained exhaust gases from reflux section top go to the waste gas tank (V-6825) for pressure stabilization, then it is pressurized by the blower (C-6803A / B) and sent to incineration. The liquid from regenerator is first cooled by cooling water cooler (E - 6806) and then pumped by solvent recycle pump (P- 6801A / B) to solvent cooler (E-6804) cooled up to 15 °C, then go to CO absorption column (T- 6800). If the copper ratio is too high in the solvent, add compressed air to the reducer section to regulate the ratio. If total ammonia is too low in the solvent, add ammonia downstream of cooling water cooler (E-6806). If the total copper is too low, solvent out of the regenerator pass by solvent preparation tank (V- 6803) to adjust the total copper. Set solvent collection tank (V- 6804) collect copper solvent emissions during shut down and maintenance. 5.2.2 Reaction (BD1601-305~306)

5.2.2.1 Catalyst preparation

Add certain quantity of TBA in reactor (R-6841A/B) and start catalyst circulation pump (P- 6844A~C) to make the liquid circulate. Add certain quantity of HF gradually by HF metering pump (P6841A~C) to form complex with TBA and the temperature is controlled by the circulating condensate in jacket. The catalyst is qualified when the mole ratio of HF to TBA reach to 1.5~1.9:1.

5.2.2.2 Reaction TFE gas from TFE distillation tower (T-606) side and bottom in TFE plant and the recovered from downstream distillation system is mixed and continuously fed into the TFE stabilizing tank (V-6844). It is heated and mixed with TBA in TFE heating tower (T- 6841) and then fed into reactor (R- 6841A/B) through TFE buffer tank (V-6845). The AHF is fed into reactor by HF metering pump (P-6841A~C) after metering. Catalyst continuously circulates in reactor through catalyst preparation tank (V-6849A/B). TFE gas monomer and

AHF are continuously fed into reactor to generate crude product HFC-125 under certain temperature and pressure. Crude HFC-125 gas comes out from reactor top and goes through demister cooler (E-6842) to reflux tower (T-6809) to reduce temperature. Then it goes to mixture buffer tank (V-6809) through reflux tower condenser (E-6829) for cooling.

5.2.3 Mixed gas collection, compression, dehydration and deoxidization (BD1601-307 ~310) TFE recovered from D-PTFE through D-PTFE buffer tank (V-6806) and TFE recovered from S-PTFE through S-PTFE buffer tank (V-6807) for pressure adjustment, then go to the mixture buffer tank (V-6809); Other continuous vent raw gas together with recovered gas emissions from distillation system go into the mixture buffer tank (V-6809). All these gas are mixed with crude HFC-125 from reflux tower. The mixture gas is compressed by the compressor (C-6802A/B), first stage outlet gas enters into the dehydrating tower (T-6802A/B) after cooling and dehydration by cooling dehydrator (E-6807A/B). It is cooled to -10 °C by low temperature dehydrating agent and continued dehydrating, then into the secondary buffer tank (V-6810), then go into the compressor for second-stage compression; Second stage outlet gas is cooled by secondary cooler (E-6809) then go into the dryer (A-6801A ~C), silica gel adsorbed water from the gas, make the gas moisture content less than 100ppm. Then it goes to deoxidizing tower (T-6803) remove O₂. If the moisture content of the gas close to 100ppm changes over the dryer, and the block up dryer is activated by steam heating and vacuuming. The polymerization inhibitor terpene via terpene metering tank (V-6813), terpene pump (P-6803A / B) is supplied to the deoxidizing tower (T-6803), Make up terpene to No.1 condenser (E-6812) by terpene make-up pump (P-6804A / B) on a regular interval and quantitative. 5.2.4 Distillation system (BD1601-310~312) Gas from the top of the deoxidizing tower (T-6803), passing through feeding cooler (E-6810), enters No.1 rough separation tower (T-6804). TFE is recovered from sideline to TFE stabilizing tank (V-6844). Distillates from the top of No.1

condenser (E-6812), which contains NCG like R23 is sent to waste gas mixing tank (V-6826). Trace of TFE, R32 and large quantity of HFC-125 left at the tower bottom are continuously sent to No.2 light fraction removal tower (T-6805) by discharge control valve. Light components (including trace of R32, Y3, TFE) with boiling points lower than HFC-125 are rectified from top of No.2 light fraction removal tower (T-6805) passing through the terpene tank (V-6815) and No.2 condenser (E-6815) enter into the waste gas mixing tank (V-6826). HFC-125 from bottom of No.2 light fraction removal tower goes to No.3 distillation tower (T-6806). The side-cut gases HFC-

5.2.4 125 from top of No.3 distillation tower (T-6806) is sent to product metering tank (V-6846A/B) through collection condenser (E-6826). The gas contains HFC-125 and trace of Y3 at No.3 condenser (E-6818) top recycle back to mixture buffer tank (V-6809). Materials at tower bottom intermittently go into recovery tower (T-6808). Higher purity HFC-125 from top of No.5 recovery tower (T-6808) goes back to mixture buffer tank (V-6809). Liquid at tower bottom are high-boiling residues. They are discharged to residue tank (V-6816). The residues

are compressed into steel cylinder at regular intervals and sent out of battery limit to incineration unit for disposal.

5.2.5 Product storage and filling system, and tail gas scrubbing and absorbing system (BD1601- 310~312) When the HFC-125 in product metering tank (V-6846A/B) is qualified after analysis, it can be pumped to product storage tank (V-6847) in tank field for periodical tank wagon and cylinder filling. If the moisture is not qualified, it should pass HFC-125 dryer (A-6841A/B) for drying until the moisture is qualified, then it can be pumped to tank field. If the purity is not qualified, the gas should be recovered back to mixture buffer tank (V-6809). Qualified HFC-125 is pumped by product transfer pump (P-6848A/B) through product storage tank (V-6847) to tank wagon or cylinder. If the moisture is not qualified, it should pass product dryer (A-6842A/B) for drying until the moisture is qualified. The tank wagon and cylinder and related pipeline should be treated by vacuum before filling.

5.2.6 Three waste treatment Liquid waste is discharged to liquid waste pit (V-6820), and regularly sent to ETP for treatment by liquid waste pump (P-6811A/B). (BD1601-313) Liquid at recovery tower bottom are high-boiling residues. They are discharged to residue tank (V-6816). The residues are compressed into steel cylinder at regular intervals and sent out of battery limit to incineration unit for disposal. (BD1601- 312) Waste catalyst in waste catalyst tank (V- 6848) is stored in steel drum and regularly sent qualified third party for treatment. (BD1601- 306) All Fluoro-contained waste gas vent from plant is collected into waste gas mixing tank (V- 6826) and sent to OSBL for incineration. (BD1601-304 The acid gas from HF tanks is washed by scrubber (T-6842) and high vent. The washing liquid is discharged to liquid waste pit.

(BD1601-313) Waste silica gel and molecular sieve are nontoxic and landfill. Condensate is collected from users into condensate collecting tank(V-6819) and mainly sent to reactor(R-6841A/B) jacket for circulation and part is transferred OSBL. (BD1601-313) The heating medium systems is for No.2 reboiler (E-6814), No.3 reboiler (E-6817) and residue tank (V-6816) heating. It contains heating medium tank (V- 6817) and heating medium pump (P-6808A / B) heating medium heat exchanger(E-6843). (BD1601-313) The vacuum system consist of vacuum buffer tank(V-6818), vacuum pump(P-6809A/B). It can be expanded as per actual requirement. (BD1601-309) Where there is a high concentration of TFE, and for equipment or pipeline which is easy to explosive, safety relief facilities must be set.

K. VDF Plant

1. Cracked gas enters the primary buffer tank from atmospheric pressure gas storage after single-stage compression, then dewatered by water calcium chloride tower after drum, then through the mist eliminator and cold removal, and enters the intermediate gas storage. It enters the secondary buffer tank after two-stage compression and reaches the intermediate tank after silica gel absorber drying and pre-/mid-/end cooling.

2. The liquid phase of intermediate tank is discharged into the catcher and enters # 1 tower, low boilers on the top # 1 tower enter acetone absorption tower and then discharged into drum. Tower bottom enters # 2 tower, VDF at the top of tower enters finished product metering tank after liquefaction by collecting condenser. Tower bottom enters # 3 tower to continue fractionating and recover VDF. Liquid at the tower bottom enters # 4, remove low boilers from the tower top. Bottom material enters # 5 tower, F142b at the tower top enters F142b tank after collection, place the bottom liquid into residue tank.

3: ON SITE OBSERVATIONS & RECOMMENDATIONS

SR. NO.	PLANT	OBSERVATION	RECOMMENDATION
1.	AHF PLANT/ Lab/ Chlorine Tonner filling area	PPEs cupboard is available in control room and PPEs are being replaced / added regularly. Register is maintained for monitoring PPEs use. The same was not evident in central laboratory and chlorine tonner filling area.	PPE cupboard and its Matrix shall be ensured in all the area including laboratory, Chlorine tonner filling area etc.
2.	AHF PLANT	Yellow marking in front of panel (at least 1 meter away from operation desk).	It is recommended to keep safe guard distance (Alert) for visitors and non-operational persons from the operation desk.
3.	AHF PLANT	Review of the graphics with respect to interlock and operational logic is not evident.	It is suggested to review all Graphics with respect to logic and interlocks.
4.	AHF PLANT	Process mock drill are not considered so far towards action for emergency preparedness for process upsets.	Process as well as emergency shutdown procedure related drills/ table top exercise needs to be conducted and recorded. Employees shall be made aware about such drills.
5.	AHF PLANT	Policy is nor displayed in corridor. In control room, it is to be displayed at strategic location which can attract the employee / contract staff / visitor attention. It is found that staff is not well aware about policy.	Display of safety policy shall be ensured at strategic location and employees shall be made aware about the safety policy of company.
6.	AHF PLANT	All staircase found without toe guard facility in the pants.	The design of the railing shall be prepared as per the legal requirements and the same shall be ensued at staircase also.
7.	AHF PLANT	Plant storm water channel found full of water / mud.	cleaning of storm water and plant drains shall be ensured to avoid water logging. The flow of mud and other plant material shall be restricted over the roads.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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8.	AHF PLANT	Housekeeping is very poor throughout the plant.	The house keeping shall be maintained in plant area. The material, spares, chemical drums shall be stored at its designated location. For temporary storage of material a SOP and risk assessment shall be carried out.
9.	AHF PLANT	Car seal Open / Close concept is not applicable for the PSV's.	Car seal open/close concept to be applied for all PSVs throughout the plant after due consideration in PSM.
10.	AHF PLANT	AHF leakage scenario is not part of emergency plan evaluation program. to be consider as process mock drill to strengthened the emergency response plan.	AHF leakage scenario is to be consider as process mock drill to strengthened the emergency response plan.
11.	AHF PLANT	No provision of dump tank in the plant area to avoid water logging.	Dump tank – It is suggested to provide permanent facility to remove water from sump.
12.	AHF PLANT	Corrosion / faint colour observed on piping.	Painting of pipe lines shall be carried out at periodic interval.
13.	AHF PLANT	18 KL HF tank – for iso container unloading nitrogen pressure is used. PRV, PCV provided for reducing pressure.	One PSV is suggested to take care of PEV/ PCV malfunction (To avoid excess pressure in iso container). Detailed risk assessment is recommended for interlock and safety device adequacy.
14.	AHF PLANT	Staff is not well aware about MCP locations.	Awareness program is required. More training regarding importance of MCP to be imparted to staff.
15.	AHF PLANT	Escape route are found blocked, not approachable in many areas.	Escape route to be marked in corridor and plant area. The routes shall be kept clear and approachable all the time.
16.	Fluouro Intermediate	Operating staff is not well aware about tank safety.	Tank safety is one of the most critical points in PSM. More awareness / training is required for staff.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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17.	Fluouro Intermediate	4 atmospheric tanks with nitrogen blanketing are provided for storage of different product / by product. One smoke detector provided.	Along with the fire and safety requirements necessary arrangement shall be provided to control the spillage of chemicals. Spill contingency plan is not available to handle tank overflow case.
18.	Fluouro Intermediate	NFPA diamond provided on tanks. MSDS of the chemicals is found missing at many locations.	It is suggested to provide display board showing information about NFPA diamond. It is recommended to prepare COSHH manual. Awareness sessions on chemical safety needs to be conducted as a part of class room as well as tool box sessions.
19.	Fluouro Intermediate	Tank dyke capacity and its reach seems to incapable of handling the spills with in the dyke.	The dyke design shall be reviewed for its capacity and arresting the spills within the dyke with reference to the available Indian standards and statutory requirements.
20.	CaCl ₂ 1/2/3/4	Housekeeping is very poor; it is unsafe to enter operating area.	Housekeeping to be maintained.
21.	CaCl ₂ 1/2/3/4	Chute 10 Nos for plant 1 & 3 AND Chute 10 Nos for plant 2& 4 are provided. Extremely unsafe operation being carried out to drain out unreacted lime stone – Bottom man hole is opened to drain out lime stone when chute is full.	This is one of the most dangerous and highly risky (non-tolerable) activity being carried out without proper risk assessment. Required modification is suggested to staff to make it safer.
22.	CaCl ₂ 1/2/3/4	Structural stability seems to be poor to be checked on top priority.	It is recommended to check the structural stability of buildings, critical plant equipment and foundations.
23.	CaCl ₂ 1/2/3/4	Acid proof tiling found damaged for all 20 Chutes.	Acid resistance tiles shall be ensured at all such locations where ever it is found damaged.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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24.	CaCl ₂ 1/2/3/4	D-160 tank dyke modification work was in progress. Dyke capacity to be cross checked with design capacity required.	The dyke design shall be reviewed for its capacity and arresting the spills within the dyke with reference to the available Indian standards and statutory requirements.
25.	CaCl ₂ 1/2/3/4	Spill contingency plan is not made to handle tank over flow / leakage case.	Spill contingency plan shall be prepared and same shall be a part of ERDMP.
26.	CaCl ₂ 1/2/3/4	Lime solution tank rubber lining is physically checked internally.	It is recommended to be cross verify the mechanical integrity of tank and rubber lining through external competent agency / CES as per the guidelines of agency who provided rubber lining.
27.	FKM Plant	It is found that staff is not well aware about policy.	Safety policy shall be displayed at strategic location for awareness.
28.	FKM Plant	Escape route to be marked in corridor and plant area.	Escape route to be marked in corridor and plant area. The routes shall be kept clear and approachable all the time.
29.	FKM Plant	Process mock drill are not considered so far towards action for emergency preparedness for process upsets.	Process drill shall be performed as a table talk exercise and evaluated for preparedness.
30.	FKM Plant	All staircase found without toe guard facility in the pants.	To be provided to avoid accidents – A step towards achieving zero accident target.
31.	FKM Plant	It is found that the awareness about chemical safety is not to the required standard.	It is suggested to provide extract of hazards associated with product-on product label. COSHH manual shall be prepared.
32.	SPTFE, PFA, PTFE plants	During interaction with HOD, it is found that targets/goals clearly marked and circulated to staff with responsibility and action plan. Progress is also measured and noted clubbed with performance of individual.	Good practice



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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33.	SPTFE, PFA, PTPTFE plants	All three plants housekeeping is very good with compare to others units visited.	Good practice
34.	SPTFE, PFA, PTPTFE plants	Staff is aware about PSM requirement. Still scope is available for improvement.	Area of improvement.
35.	SPTFE, PFA, PTPTFE plants	20 numbers of pressure vessels are used in the process. The records of inspection as per the PESO requirement is not evident.	To be inspected as per PESO requirement.
36.	SPTFE, PFA, PTPTFE plants	The product being handle in PV is explosive by nature, gas sensor is provided after RD provision to detect leakage.	1. It is suggested to provide pressure transmitter with low range as a second layer of pressure safety to sense leakage due to RD rupture due to over pressure / RD failure due to aging effect. 2. Flame arrestor on vent line to avoid back fire to system.
37.	SPTFE, PFA, PTPTFE plants	There is no level safety (weight) provided except flow control valve cut off facility.	It suggested to provided second layer of level safety. It is suggested to think about providing non-contact type (Radar) LT.
38.	SPTFE, PFA, PTPTFE plants	In PTPTFE plant risk assessment checked. Guidance given to how same can be used for tool box talk / table talk .	plant operators shall be provided systematic tool box talk on hazards associated and risk while handling the chemicals. Do's and Don'ts and handling procedure shall be displayed at strategic locations.
39.	FAM Plant	Staff is not aware about equipment (e.g., Extruder) safety.	More technical training is required to improve operation knowledge resulting in improvement in mechanical integrity.
40.	FAM Plant	Escape route to be marked in corridor and plant area.	Escape route to be marked in corridor and plant area. The routes shall be kept clear and approachable all the time.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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41.	VDF Plant	Electrical furnace operation and hazards associated were discussed in field.	1. It is suggested to provide personal protective insulation on outer cell to avoid burn injury. 2. Arrangement of flame arrestor on vent line going to open vent.
42.	VDF Plant	Compressor operation discussed. Staff gave satisfactory answer to query raised.	Good practice
43.	VDF Plant	VDF storage – Water sprinkler system auto operation is clubbed with fusing of quartzite bulb.	It is suggested to interlocked auto operation with gas detectors (2 numbers) which are already provided in plant.
44.	FE Plant	Furness operation discussed.	1. Staff is aware of operation but more technical training is required to enhance knowledge. 2. Flexible hose is used to connect FG line to burner assembly – Only hard piping with suitable MOC to be used. 3. Gas detector to be provided for each furnace at ground level to detect FG leakage. 4. Furnace is being operated but efficiency is not monitored. 5. Auto operation of Furness (various parameters like draft, out let temperature etc.) to be think about to increase efficiency resulting in energy saving. 6. Check point to be prepared for start-up of furnace for field staff – Not fully aware start-up of furnace
45.	HR	Training needs identification is SAP based but base and training topics are not standardized.	Training need procedure for individual employee / contract employee need to be established. Targets for the training duration for all the employees shall be prepared and monitored. The statutory requirements



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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			like requirement of Factory act, CEA regulations, outcome of various programs shall be considered for developing TNI. Training for the HODs, critical positions like safety head, plant HOD's shall be defined.
			Behaviour aspect training shall be part of top to bottom.
46.	Safety Observation system	Safety observation rounds are carried out.	It is recommended to conduct safety rounds with specific requirements like PTW noncompliance, noncompliance to licence area conditions, etc...
47.	Scaffolding management	Scaffolding are found erected through at various locations. Some are found to be prepared since long and the same has been to be used as platforms in plant area. The platform plates are found tied using wires.	A procedure for the checking, inspection, validation and time frame for with scaffolding are to be kept in the area, keeping escape routes free, etc. shall be part of the SOP prepared. Also inspection of scaffold material, clamps, platform clamps shall be part of SOP.
48.	On road	At many locations the drain water channel covers are found damaged or missing	The damaged / Missing covers shall be replaced.
49.	On road	Storm water channels were found blocked causing water logging at many places	As a pre monsoon process all the storm water channels shall be cleaned.
50.	CPP	EOT crane installed is having valid Form-10. No SOP available to what is to be checked and what test are to be carried out for critical cranes.	For critical lifting equipment like EOT crane, it is recommended to have SOP for checking all the limit switch operations, Brake (Slip) checking, Deflection test and hook integrity checking frequency.
51.	CPP	It is found that the confined space permit is approved by the plant in charge. It is not authorized by the competent	The permit procedure is required to be reviewed and revamped. Confined space atmosphere and isolation

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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		person. Also matrix for checking the gas and atmosphere inside the confined space is not evident.	shall be checked as per the matrix and in compliance to the requirement of section 36 of 'The Factory Act'.
52.	CPP	It was found that while hot work activity in plant the Fire extinguishers are being taken from the site locations. One such fire extinguisher was found taken and was not placed back to its location after completion of job.	Exclusive fire extinguishers shall be provided during hot work instead of removing the extinguisher from its location. SOP for the hot work and contract documents shall be reviewed and amended accordingly.
53.	CPP	One Temporary electric distribution supply board was found lying in the cooling tower area. The board was placed in open area exposed to rain water. The ELCB of the board was not operational. (permit no. 228394)	A robust SOP shall be prepared for inspection of temporary supply. Design of the temporary distribution board shall be reviewed by providing weather shed.
54.	CPP	The eye wash shower placed in the cooling tower area was found damaged but the same is not highlighted in SOA round or inspection rounds.	Specific inspection of emergency equipment shall be conducted and any damaged, missing or obstructed equipment shall be tagged and replaced/ repaired.
55.	CPP	Assembly point near nitrogen plant (utility) has not approach not having space to assemble.	Assembly points shall be reviewed for assess ability and space for assembling in case of emergency.
56.	CPP	The gate of Nitrogen plant (Licence premises was found open and not restriction to unauthorized entry. The same is applicable at almost all the License premises - PESO. The required Caution display are not provided in the license premises.	The entry in the license premises shall be restricted. The PESO approved license premises shall have required caution display boards. The area shall be kept under lock and key with defined responsibility.
57.	CPP	The chain driven conveyors are having its chain exposed at inner side.	Chain shall be provide 360 degree machine guarding.
58.	Substations and switch yard	There is no Electrical safety officer (ESO) designated as per the requirement of CEA regulation. The forms required to be filled by ESO are not evident. CEA regulation is not considered in the legal matrix of the organization.	ESO shall be designated as per CEA regulation. The Legal matrix shall be revised and reviewed for including the requirements of CEA regulations.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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59.	Substations and switch yard	Single line diagram, rescue rod , Ambu bag are not provided in switch yard panel room.	SLD, Rescue rod and Ambu bag shall be ensured in the panel room.
60.	Substations and switch yard	The discharge and Earthing procedure is known to operator but the same is not documented.	Bus Discharge and Earthing procedure shall be documented and communicated to all.
61.	Substations and switch yard	While inspecting the insulated hand gloves used in electrical work out of three gloves checked all were found having manufacturing date beyond one year (2019/ 2021)	The hand gloves used in electrical work shall not be used beyond its expiry date. Procedure for discarding the expired hand gloves shall be in place.
62.	Substations and switch yard	The gate of switch yard (66KV) were found open and contractor employee were found inside the switch yard and its panel room (scaffolding & Housekeeping work). Also fence of switch yard is found damaged at many locations. No provision of danger notice at switch yard fence/ gate / panel room.	Entry in electric panel room shall be restricted and only authorized person shall be allowed to entry in the restricted area. Provision of danger notice as per relevant IS shall be provide at panel room and switch yard. Damaged fence shall be repaired.
63.	Substations and switch yard	out of two Fire extinguisher inside the panel room, one was placed on floor and approach of other extinguisher was blocked by the material placed.	Approach to fire extinguisher shall be kept clear. Fire extinguishers shall be mounted on wall as required in GFR.
64.	Substations and switch yard	Electrical Isolation permit is not as per the relevant Indian standard. It is part of the general work permit.	Isolation permit shall be separated and format shall be prepared as per the relevant IS.
65.	Substations and switch yard	Bus coupler panel is not provided with distinct colour.	Bus coupler panel shall be provided with distinct colour.
66.	Substations and switch yard	Fire suppression system is not provided in the panel.	fire suppression system shall be provided in the electric panel.
67.	Chlorine Tonner filling station	Tonners are lifted using the hook of two legged chain sling.	Appropriate lifting clamps shall be used for lifting chlorine tonners. Lifting using tip of the hook may result in damage to hook.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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68.	Chlorine Tonner filling station	The Airline respirator and BA set are available in the premises and may get exposed to gas in case of gas leakage.	Risk assessment shall be conducted and based on outcome the location of the BA set and Airline respirator shall be reviewed.
69.	Chlorine Tonner filling station	Seating arrangement of operators is found just besides the chlorine tonners stacked in three layered.	The sitting arrangement shall be relocated. The stacking height of the tonner shall be reviewed as per the Gas cylinder rules.
70.	Chlorine Tonner filling station	In case of heavy leakage the use neutralizing pit is not clear to all working in the area.	SOP for emergency handling shall be displayed in the area.
71.	Permit 276410, Near V919	The hot work was in progress at height. Spatter were falling on the floor. Fire extinguisher was not available at site. The safety harness being used was having its clamps in damage condition. The seal of shock absorber was damaged. Tool box talk was not evident. Plastic material was not cleared from the area below. All thing were marked clear in the permit.	Review the permit format. Awareness on permit management needs to be improved for the permit issuer and acceptor. Procedure for inspecting the PPE used by contractor shall be prepared and implemented.
72.	Fork lift management	One fork lift GJ 16 BS1380 was found with registration number place of two distinct colours - Black and yellow in front and black and white on rear. SWL was not displayed on the fork lift. The spark arrestor provided on the silencer is not checked for its integrity. seat belt was found in damaged condition.	inspection procedure for the forklift shall be strengthened. A check list shall be used for fork lift inspection to fix accountability.
73.	Central Lab	Gas cylinders are found placed outside the Lab without proper securing and no warning sign or MSDS is displayed in the area. No means of unauthorized entry in the manifold area.	Gas cylinder manifold area shall be provided with appropriate warning signs, Display of Do's and Don'ts, handling procedure and restricted entry shall be provided. MSDS shall be displayed in the area.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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74.	Central Lab	Fumes cup board inside the lab are found with damaged door. The air velocity checking for fume hood is not in place.	Fume cup board shall be providing with proper door. The fume extractors air velocity shall be checked and recorded.
75.	Central Lab	PPE matrix is not available for handling chemicals - use of respiratory PPE and hand gloves and face shield.	PPE matrix shall be displayed.
76.	Central Lab	Person working in Lab is unaware about the emergency procedure in case of fire.	Person shall be made aware about the emergency procedures to be followed in their area.
77.	Central Lab	Procedure for disposal of hazardous waste generated in the lab is not known to person working in Lab.	Person working in the lab shall be made aware about the waste disposal procedure.
78.	Central Lab	Provision of ELCB is not evident for the equipment used in Lab.	Provision of earth leakage protection device shall be made in the circuit.
79.	Sulphuric Acid storage area & HCL storage area (T3101 tank & T4222D)	Standard Danger notice is not evident in tank farm for sulphuric acid.	Standards danger notice shall be displayed in the acid storage area (refer GFR).
80.	Sulphuric Acid storage area & HCL storage area (T3101 tank & T4222D)	The vent pipe/ over flow pipe of the tanks are not diverted through scrubbers. The length of pipe is not appropriate. The acid proof tiling is not evident on the foundation of the tanks.	The vent pipe of the tank shall be diverted to scrubber. Pipe of appropriate length to avoid splashing shall be ensured at vents and over flow. Acid proof layer shall be ensured on the top portion of tank foundation.
81.	Sulphuric Acid storage area & HCL storage area (T3101 tank & T4222D)	The capacity to the dyke and dyke design to handle the spillage from tanks is not appropriate.	The dyke capacity and dyke wall distance shall be reviewed and revised to handle leakage in acid tank.
82.	Sulphuric Acid storage area & HCL storage area (T3101 tank & T4222D)	The pumps in the area has missing coupling guards.	A survey of coupling guard shall be conducted and missing guards shall be provided.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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83.	Sulphuric Acid storage area & HCL storage area (T3101 tank & T4222D)	Flange guard are found missing on many flanges in acid line	Flange guard shall be ensure on all the flanges of the acid line.
84.	MDC filling area	It is found that the sitting arrangement for truck driver is not available. Key are placed in operator cabin and driver of one of the truck was not found in the vicinity.	The sitting arrangement / location for the truck drivers shall be fixed. The key location shall be so provide that it can be access immediately in case of emergency situation.
85.	MDC filling area	TREM card is not provide for the chemical filled and transported from the site.	TREM card shall be prepared for the chemicals transported from site. It shall be given to the driver of the vehicle through with the chemical is transported.
86.	MDC filling area	The area is not provided with Do's and Don'ts, loading and unloading procedure.	Proper display of Do's and Don'ts and loading & Unloading procedure shall be provided.
87.	MDC filling area	Drums are found placed on road without proper barrication, no MSDS, NO spill control arrangement.	Chemical drums (filled) shall be stored at its designated location with proper hazard warning and spill control management.
88.	CMS1	It is found that the hazardous waste is placed on road outside its storage area.	Hazardous waste and scrap material shall be stored at its designated location.
89.	On road	One hydra (GJ 16 BS2404) is having form 10 for vehicle but slings along with the hydra are not having form 10	No lifting tools and tackles of contractor, without form 10 shall be allowed inside the site.
90.	Filling station - R 125)	Three tankers were placed inside the premise. The connected hose has no identification. Display of Do's and Don'ts and loading & Unloading procedure not evident in the area. The drain point is not having blind.	The SOP for tanker loading unloading shall be prepared and displayed. Number of tankers to be placed inside the premises shall be marked. Hose management procedure shall be prepared for its life, tagging and compatibility.
91.	Canteen	Deep cleaning of canteen was in progress at the time of food preparation.	Deep cleaning of the canteen area is to be carried out after the food preparation is over.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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92.	Canteen	Roti are going on floor from roti maker.	Roti collection vessel at roti maker machine needs to be reviewed.
93.	Canteen	Fly catcher machine were found not operational in the food preparation area.	Fly catcher machine shall be kept connected and ensured in ON condition in kitchen area.
94.	Canteen	Semi cooked food was insufficiently covered.	Proper covering shall be ensured on cooked and semi cooked food.
95.	Canteen	ELCB not available in the electrical equipments and gas valves with lot of dust.	ELCB shall be provide in the circuit. Gas valves shall be cleaned for easy operation.
96.	Canteen	Dish are manually washed and no SOP for dish cleaning.	Procedure shall be prepared for washing Dish.
97.	Canteen	Hygiene survey of canteen is not evident.	Hygiene survey shall be carried out for the canteen and hygiene audit of canteen and its staff shall be conducted at periodic interval.
98.	HR	TNI, Roles and responsivities and duties of the key position, Notification for SO, ESO, Welfare officer and Factory manager is not evident.	TNI shall be defined for each employee and its monitoring mechanic shall be developed. Roles, responsibilities and duties and notification letter for SO,ESO, Welfare officer and factory manager shall be kept easily accessible.
99.	Medical examination	Medical examination test for the employees shall be defined based on their job.	The medical test for drivers and food handlers, height worker shall have specific test to be defined
100.	Safety Observation system	Safety observation system needs to be strengthened	Safety observation rounds shall be schedule for specific inspection also.
101.	Training and awareness	Awareness on emergency preparedness, permit to work system, Chemical safety, Legal matrix needs to be improved.	Systematic plan of Training needs are to be identified and plan to cover all the concerned employees shall be prepared and implemented.
102.	General	PPEs matrix not found.	PPEs Matrix should be decided related to all plants/operations & boards should be displayed in each plant area.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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103.	General	Emergency awareness found poor among employees.	Emergency scenarios & required actions should be discussed in plant with all employees & refresher trainings should be provided. Emergency siren coding boards should be displayed in each plant area & ensure audibility of siren in each plant. All assembly points should be given identification number & also same to be marked on emergency evacuation plan. Well-equipped emergency control centre should be established.
104.	Permit to work system	Work permits found in one format for all type of work & makes difficult/erratic selection of Applicability of Criteria's for different type of work. Risk assessment also found poor & less hazards considered.	Work permit system should be strengthened & criteria for each work should be separated/listed. All type of hazards/risks should be considered for risk assessment before starting any job. The work environment should be monitored by competent person for confined space entry as well as hot work jobs.
105.	House keeping	Overall poor housekeeping observed in plant area.	5's System should be implemented & Scrap management should be improved.
106.	Traffic management	Overall Road safety found poor. Vehicle movement & parking of cranes/trucks/tankers found on road causing road block.	Traffic management plan should be prepared & implemented.
107.	Fire System	Fire alarm monitoring system found in fire dept. Office.	Toxic gas monitoring system should also be integrated along with the fire alarm system.
108.	Structural Stability	As the factory is situated near seashore and humid environment, corrosion rate will be higher. Corrosion observed on structure in plant area.	Structural integrity survey should carried out frequently as plant also hands corrosive chemicals.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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109.	On road	Spill contingency plan is not evident to control spills and leaks of the chemical drums stored on road.	A plan should be developed prior to every operation for handling spills of all components with regard to compatibility and disposal of associated waste utilizing Reactive Chemicals data.
110.	Emergency preparedness	ERT members list shall be displayed at main gate.	ERT members list should be displayed at main gate with their contact no's & availability in factory.
111.	CMS -1 & CMS-2 Plants, Control room	"Trouble' Fault observed on fire alarm panel.	It should be rectified.
112.	CMS -1 & CMS-2 Plants, Control room	No checklist found in first aid box & list of first aider present in shift.	First aider lists should be displayed & Checklist of first aid box items should be kept & filled on monthly basis.
113.	CMS -1 & CMS-2 Plants, Control room	Trip-Bypass register found prepared & maintained.	Reason for bypass should be mentioned. After attending it, what action taken should be recorded together with dates & by whom. List of interlocks should be maintained in control room with status (Active or Not).
114.	CMS -1 & CMS-2 Plants, Control room	SOPs found well prepared & documented.	SOPs should be updated to include emergency scenario in concern section & actions should be taken in specific manner in sequence in detail indicating equipment/valve with tag no's. Table-top exercise should be done for each emergency scenario for increasing awareness & immediate action.
115.	CMS -1 & CMS-2 Plants	NO PPEs matrix & emergency siren coding board found displayed.	Both should be displayed.
116.	CMS -1 & CMS-2 Plants	Poor Housekeeping observed.	Housekeeping should be improved.
117.	CMS -1 & CMS-2 Plants	V-2205 tube bundle found being boxed up. Cold work permit No.273976, dated 07/07/23 found issued. Only	This job also includes fall, trip, hook failure, strike to, uneven flooring hazards & should be considered

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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		'Cut' hazard found considered in risk assessment before doing job.	during risk assessment & appropriate control measures should be taken/mentioned. .
118.	CMS -1 & CMS-2 Plants	Contractor staff found sitting in chloroform tanker unloading area along with one argon cylinder kept on simple trolley. No work found in progress. New chloroform dryer line connection work was planned in CMS-2 Plant.	Contractor safety management system should be developed & implemented. Their working area & hazards must be informed them before giving any job.
119.	CMS -1 & CMS-2 Plants	Chloroform dyke area drain valve found closed but no drain pit found.	Drain pit should be made & connected with ETP.
120.	CA (Caustic Alkalies), Control room	"CPU failure' Fault observed on fire alarm panel.	It should be rectified.
121.	CA (Caustic Alkalies)	SOPs found well prepared & documented.	SOPs should be updated to include emergency scenario of hydrogen leakage on main hydrogen header in plant area. & actions should be taken in specific manner in sequence in detail indicating equipment/valve with tag no's. Table-top exercise should be done for each emergency scenario for increasing awareness & immediate action.
122.	CA (Caustic Alkalies) Plant area	No pipeline colour coding board found displayed in plant area.	Pipeline colour coding board should be displayed in plant area & strictly followed.
123.	ETP	No acid proof tiles found on flooring of dyke area of acid storage tanks.	Acid proof tiles should be provided.
124.	ETP	No fume absorber found on HCL storage tank.	Acid fume absorber should be provided.
125.	ETP	Electrical Earthing found on fan cover of motor for caustic feed pumps.	Electrical Earthing should be provided on motor body.
126.	CU (Common Utilities)	No smoke detectors found installed in MCC room.	Smoke detectors should be installed & linked with fire alarm panel.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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127.	TFE-1 & R-125 Plant, NG station	NG station inlet header vent valve found closed but end flange not blinded.	Blind should be provided to prevent leakage of NG in case of minor passing of Valve.
128.	TFE-1 & R-125 Plant, NG station	NG station PCV-8301 downstream strainer flange jumper found in damaged condition.	Jumper should be attended & periodic testing should be carried out.
129.	TFE-1 & R-125 Plant, Control room	"CPU failure' Fault observed on fire alarm panel.	It should be rectified.
130.	TFE-1 & R-125 Plant, Control room	Emergency scenario ERP-S7 - Leakage of R-22/TFE from tower T-604 identified & one cause for leakage is Condenser top vent valve FCV-6013 failure.	The cause should be written clearly i.e. failure of valve itself & leaking or stuck close can lead to over pressurization of tower. Corrective actions to be taken during this emergency should be mentioned in details specifically in ERP for all causes leading leakage of TFE from tower. HFP leakage from tonner in storage shed should be considered & corrective actions should be mentioned in ERP/SOP.
131.	TFE-1 & R-125 Plant, Control room	Trip-Bypass register found prepared & maintained.	After attending it, what action taken should be recorded together with dates & by whom.
132.	TFE-1 & R-125 Plant	HFP full cylinders found kept upright without chain support & stand. HFP tonners found kept/lying on floor.	Gas cylinders should be stored with proper chain support & stand. Full & empty cylinders should be stored separately with display boards. HFP cylinders should be stored on roller support to hold securely in place & resist corrosion.
133.	TFE-1 & R-125 Plant	E-608 Dehydrator tube side leakage observed & was being attended.	Process incident should be studied in detail as per PSM needs. PSM should be implemented. MOC should be reviewed from mechanical integrity point of view.
134.	PVDF Plant	27G0101 Diaphragm type compressor motor Earthing found fan cover.	Earthing should be provided on motor body.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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135.	APTFE / DTPFE plants	GI-5023 near monomer metering tank V-502J found faulty.	It should be rectified.
136.	APTFE & DTPFE plants	DI water storage tank V-5102H high level interlock found with XV to fill/make up the tank.	80% level indication should be considered for normal make up & closing XV. 85% level indication for high level alarm if XV fails to close.
137.	DTPFE Plant	No display emergency siren coding & audibility of emergency siren.	Both should be implemented & ensured.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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4: OBJECTIVES, SCOPE AND METHODOLOGY

OBJECTIVES

The overall objectives of the Safety Audit are as under:

- To carry out a systematic critical appraisal of all potential hazards Involving personal, plant, services and operation method.
- To evaluate work practices and procedure followed in the plant and their effectiveness.
- To ensure that OS&H system fully satisfy the legal requirements and those of the Company's written safety policies, objectives and Progress.
- To examine and evaluate accident investigation & prevention.
- To examine safety management and accountability systems
- To carry out a systematic, critical appraisal of all potential hazards involving personnel, plant, services and operation method; and
- To ensure that OH & S system fully satisfies the legal requirements and those of the company's written safety policies, objectives and program.

AUDIT GOALS

Audits are normally designed to achieve one or more of the following goals:

- To provide the auditee with an opportunity to assess its own OH & S system against a OH & S system standard and identify areas for improvement;
- To determine the conformity of the implemented OH & S system with specified requirements and identify areas for improvement; and
- To meet regulatory requirements.
- To increase Health, Safety and Environmental awareness.
- Enhance Company image

SCOPE

The scope of the safety audit was limited to the safety and health of workers employed in the manufacturing processes and operations and also the safety of the plant and equipment used in the factory. A few aspects of environmental management systems were also audited.

"Management Systems" audit was done to assess the management's involvement and commitment towards promoting safety and health system at work. Management system audit provided scope of examining and evaluation of safety policies and procedures and their review, hazard communication system, dissemination of information and hazard awareness programme, training and motivation of employees, etc.

Besides management systems audit, technical aspects of plant activities namely, storage and handling of hazardous substances, process and operational safety review, transportation safety, testing and examination of plant and equipment, housekeeping, waste disposal system, fire protection and control, etc. were also audited.

The following elements of management systems and technical aspects were audited:

1. Health and Safety policy
2. Safety Organization and functions
3. Safety Committee
4. Safety Budget
5. Accident Reporting, Investigation and Analysis
6. Safety Inspection
7. Safety Education and Training
8. Safety Communication/Motivation/Promotion
9. First Aid
10. First Aid Centre (Occupational Health Centre)
11. House Keeping
12. Noise
13. Ventilation
14. Illumination
15. Hazard Identification and Control
16. Fire Protection and Control System
17. Personal Protective Equipment
18. Waste Disposal system
19. Emergency Preparedness
20. Material Safety Data Sheet (MSDS)
21. Safe Operating Procedure (SOP)
22. Work Permit System
23. Plant Layout and Area Classification
24. Static Electricity
25. Pressure Vessels (Fired & Unfired)
26. New Equipment Review
27. Lifting Machines and Tackles
28. Maintenance systems
29. Tank Storage Vessel Area
30. Transportation Hazard
31. Statutory Compliance

METHODOLOGY

Methodologies applied for conducting safety audit were as follows:

- i) Preliminary information was collected from the factory during pre-audit survey in respect of its employment, production process and target, storage system and capacity of hazardous material storage, safety engineering and management, features of the plants and processes, emergency and disaster management plant and processes, emergency and disaster management plan etc. A set of questionnaires specifically designed for the factory was used for collection of information during the audit.



- ii) An opening meeting was held with the senior management personnel of the plant by VEPL Team to get familiarized with the plants and processes and the built-in safety redundancy systems available in different plants; and also to appraise safety philosophy of the management in terms of accident prevention programme and disaster control plan. The audit team also informed the management personnel regarding the scope and objectives of the audit and methodologies that will be followed.
- iii) The audit team made site inspections to different plants with critical observations in respect of safety and occupational health to identify and assess hazard potential in the plants. Deviations from safe working conditions and practices and defects in the plants and equipment observed during such visit were analyzed and documented for their corrective actions.



- iv) All documents pertaining to the safety and health system namely the accident intimation register, accident register, accident investigation report, safety equipment register, inventory of firefighting and their inspection and maintenance schedule, inspection and maintenance of plant record, training of personnel etc. were perused by the audit team.
- v) Deficiencies observed in the plants and processes and health and safety systems were discussed with the management at the end of the audit.
- vi) Finally, a report was made on the basis of the information collected and observations made during the audit.

STANDARDS

The audit was conducted with the following standards and codes of practices on safety and occupational health:

- i) Indian Standard on Codes of practices for Occupational Safety & Health Auditing (IS 14489:1998)
- ii) Statutory requirements (Factories Act, Explosive Act, other related Acts & Rules made there under.
- iii) Codes of practices prepared by National and International Organizations (e.g. BIS, ICMA, NSC, LPA, etc.)
- iv) Current Safe Practices, Prevalent in the factory.

AUDIT FREQUENCY

The need to perform an audit is determined by the client, taking into account specified or regulatory requirements and any other pertinent factors. Significant changes in management, organization, policy, techniques or technologies, and products that could affect the OH & S system, or changes to the system itself and the results of recent previous audits, are typical of the circumstances to be considered when deciding audit frequency. It is desirable that organizations have a combination of external and internal OH & S audit system. While the external audit in respect of organizations may be conducted once in two years, or as specified by any statute, the frequency of internal audit may be set once in every year. Records of accidents and dangerous occurrences should be examined and used to identify high-risk areas and activities and consequently the frequency of internal audit may be increased.

ACTION FOR IMPLEMENTATION OF OH & S AUDIT REPORT

The auditee is responsible for determining and initiating corrective action on audit recommendations. The auditee should prepare an action plan for implementation of audit report; specifying action by concerned departments and time limits for completion. This may be in consultation with the auditing organization or client. The time limit for completion may be decided considering the importance and safety implications of the recommendation.

One of the most important follow-up actions is the communication of the content of the audit report to appropriate personnel in the auditee organization. The agreed recommendations for action with target dates for implementation of the recommendations should also be conveyed to implementing agency. Where no action is proposed to be taken (although it may have been recommended in the course of the audit) the reasons for this decision should be documented. If it is not feasible to implement some of the recommendations of the audit team, then the auditee should inform about such recommendations to the client specifying reasons. This information may also be conveyed to the auditor.

The auditee should develop a monitoring system for implementation of the recommendations and periodically assess the implementation status of the audit report. If needed a follow-up audit can be conducted to review implementation of the audit recommendations.

5: APPLICABLE LAWS AND STATUTORY COMPLIANCE

All activities are to be subjected to the present safety audit. For this inspection was carried out and this was also aimed to promote contact with the individual workers. This helped to achieve the company's interest and concerns, to gain worker involvement, to encourage comments and suggestions relating to safety and to invite co-operation in discovering conditions which need correction so that the company's safety standards are in line with that of approved safety standards. Based on the above criteria and discussion, the scope of safety audit was limited as given below:

Looking to the above chemicals, their storage quantity & process parameters, applicability of some safety laws is discussed below: -

Applicable Laws & Statutory Compliance

Sr No.	Work Area/ Document/Title	Statutory Requirement as per	Observation	Recommendation
1.	Occupier	Section 2 (n) of the Factories Act (FA)	Mr. Sanath Kumar	-
2.	Factory Manager	Section 2 (n) of the Factories Act (FA)	Dr. Sunil Bhatt	-
3.	Factory License No.	Under Section-6 of FA.	Licence No: 15074 Valid up to 31 st December 2025	-
4.	Approval of Plan.	Under the Sub-Section (1) of Section-6 and Rule-3, 3(A) and 3(B) of GFR.	Approved.	-
5.	Stability Certificate in Form no 1-A.	Under the Sub-Section (1) of Section 6 and Rule-3 (C) of GFR	Available.	-
6.	Work Place Monitoring.	Under the Section 7-A (a) (e) & Rule 12-B of GFR.	Form No. 37 Maintained. Carried out by Third Party.	-
7.	Pollution Control.	Under the Water Act-1974 & Air Act 1981 and Solid Waste Management 1986	GPCB consent order No. CCA : AWH-118244 Valid up to: 15/02/2027	-
8.	Dust & Fumes	Section 14 of the Factories Act (FA)	Scrubber Systems is provided.	-

9.	Cleanliness	Section 11 of FA 1948	Housekeeping maintained.	-
10.	Ventilation & Temperature	Section 13 of FA 1948	Effective measures are taken	-
11.	Overcrowding	Section 16 of FA 1948	No room found overcrowded.	-
12.	Lighting	Section 17 of FA 1948	Proper lighting found in work area.	-
13.	Drinking water	Section 18 of FA 1948	Water quality checked regularly & Records are maintained.	-
14.	Fencing of machinery	Section 21 of FA 1948	Maintained properly	-
15.	Centrifuge.	Section 23 of FA 1948 & Under the Rule-54, Schedule-V of GFR.	Not Available.	-
16.	Hoist & Lifts.	Under the Section-28 & Rule-58 of the GFR.	Test date & Safe load marking done at all places.	-
17.	Lifting Tackles and Lifting Machines.	Under the Section-29 of FA & Rule-60 of GFR.	Test date & Safe load marking done at all places.	-
18.	Pressure Vessels and Gas Holder.	Under the Section 31 of FA & Rule 61, 61 A of GFR.	Tested & records are maintained.	-
19.	Floors, Stairs & Means of Access	Section 32 of FA 1948	Maintained properly	-
20.	Pits, Sumps, Openings in floors	Section 33 of FA 1948	Storm water channels are covered to prevent entry of spilled chemicals.	-
21.	Protection of eyes	Section 35 of FA 1948	Periodical Inspection & record are maintained	-
22.	Precautions against Dangerous fumes and gases etc.	Section 36 of FA 1948	Dust Masks are made available. Work Permit system is there.	-

23.	Precautions regarding use of portable light	Section 36 (A) of FA 1948	Electrical equipment's are provided with ELCB.	-
24.	Explosive & inflammable Dust, Gas etc.	Section 37 of FA 1948	Effective enclosure & safe venting system are installed.	-
25.	Lighting Arrestor.	Section 37 of the Factories Act 1948.	Available.	-
26.	Earthing for Static Electricity.	Section 37 of the Factories Act 1948.	Provided.	-
27.	Safety of Building & Machineries	Section 40 of FA 1948	Maintained.	-
28.	Maintenance of Buildings	Section 40 (A) of FA 1948	Stability Certificate Available.	-
29.	Appointment of Safety Officers	Section 40 (B) of FA 1948	Safety department is available at site with 10 Nos of Qualified safety professional.	-
30.	Personal Protective Equipment.	Section 41 of FA 1948 & Under the Rule 68B & Schedule XIX of Rule-102 of GFR 1963.	Provided.	-
31.	Thermic fluid heater.	Section 41 of FA 1948, Under the Rule- 68D of GFR.	Tested & records are maintained.	-
32.	Driers & Ovens.	Section 41 of FA 1948, Under the Rule -68G of GFR.	N/A	-
33.	Wind Indicator.	Section 41 of FA 1948, Under the Rule -68J of GFR.	Provided.	-
34.	Compulsory Disclosure of information by occupier	Section 41-B of FA 1948	It is in line with requirements.	-

35.	Accident/Incident & Occupational Disease Record.	Under the Section 88, 88-A & 89 of the FA 1948.	Well Maintained.	-
36.	Onsite/Offsite emergency plan.	Under the Section 41-B & Rule 68-J (12) of GFR. & Rule-13 of MSIHC Rule 1989.	Prepared.	-
37.	Onsite Emergency Plan Mock Drill.	Under the Section 41-B & Rule 68-J (12) of GFR & Rule-13 of MSIHC Rule 1989.	Mock drill Conducted & Record is maintained.	On-site plan to be review once in a year.
38.	Safety Report.	Under the Rule 68-J (9) of GFR & Rule 10 of MSIHC Rule 1989	Safety report is prepared as per schedule 8 of the law.	
39.	Standard Operating Procedure.	Under the Section-41 (B) (7)	Prepared & available.	It Shall be made available at plant area offices.
40.	Safety Manual.	Under the Rule 41 (B)	Available.	
41.	Health & Safety Policy.	Under the Section 41-B & Rule 12-C / Rule 68-O of the GFR.	Prepared & displayed.	-
42.	Safety Committee.	Under the Section-41 (G) and Rule 68 (F&Y) of GFR	Safety committee formed. Quarterly meeting conducted	-
43.	Specific responsibility of occupier in relation to hazardous process	Section 41-C of FA 1948	It is in line with requirements.	-
44.	Periodic medical examination to prevent occupational diseases.	Section 41-C of FA 1948 & Under the Rule 68 T & 102 of GFR 1963.	Form no 32 & 33 maintain regularly Conducted & Records are maintained.	-
45.	Emergency Standards	Section 41-E of FA 1948	OSEP Prepared. ECR (ECC) developed.	-
46.	Workers Participation in Safety Management	Section 41-G of FA 1948	Safety Committee consists of workers representative &	-

			management representatives.	
47.	Safety Audit/Risk Assessment / Hazop Study.	Under the Rule 12-C/Rule 68-O of GFR & Under MSIHC Rules 2000, Rule 10.	Conducted and records were checked during the visit.	
48.	Public Liability Insurance.	Under the Public Liability Insurance Act 1991	Available.	-
49.	Storage of petroleum products & Explosives	Under the Explosive Act & Rules.	License No. S/HO/GJ/03/1778 (S73093) Storage valid up to 30/09/2025	--
50.	Boilers	Under the Boilers Act & Rules.	05 (Hydrogen Boiler, HRSG-2, AFBC-2)	-
51.	Food & Drug License.	Under the Food & Drug Act & the Food Safety & Standard Act for Solid Sulphur Storage	Not applicable	-
52.	Poison License.	Under the Poison License Act, 1919	NA	-
53.	NOC of DG. Set.	Under Electricity Act.	02 DG (1010 + 500 KVA)	-
54.	Ambulance Van.	Under the Rule 68-V of GFR 1963.	Mutual Agreement with Nearby Hospital	-
55.	Transportation of hazardous material.	Under the Motor Vehicle Act.	Rented vehicles.	-
56.	Workman Compensation detail.	Under the Workman Compensation Act.	Insured with insurance company.	-

6: IS: 14489-1998 – SAFETY AUDIT QUESTIONNAIRE

C-1 OH & S MANAGEMENT

C-1.1 OH & S Policy

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Does the organization have OH & S policy?	YES	Prepared as per the factory act requirement and it is available.	YES	Complied.
b	Who has signed the OH & S policy?	YES	OH & S policy is signed by CEO	YES	Complied.
c	Whether the OH & S policy is per guidelines of the statutory provisions?	YES	Yes, It is prepared as per factory act 1948	YES	The OSH policy is prepared as per GFR guidelines.
d	When was the OH & S policy declared and adopted?	YES	OH & S policy declared and adopted on dated: 1 st January 2022.	YES	Complied.
e	Whether the OH & S policy reviewed periodically?	YES	Yes, reviewed. Dated: 1 st January 2022.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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f	Whether the OH & S policy is available in local language and made known to all?	YES	Yes, it is only available in English language.	YES	Policy should be available in Hindi- Local Language.
g	What was the last date of updation?	YES	1 st January 2022.	YES	Complied.
h	Does the policy find a place in the annual report?	Yes	Yes. Record is available.	Appreciable.	-

C-2 OH & S ORGANIZATIONAL SET UP

C- 2.1 Safety Department

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	AUDITEE REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Does the factory have a safety department and what is strength of safety department?	YES	Safety department is available at site with 10 Nos of Qualified safety professional.	YES	Complied.
b	Whether the strength and qualifications of Safety Officers are as per the statutes?	YES	Yes, As per the requirement of factory act	YES	Complied.
c	Does the head of safety department report to the Chief Executive?	YES	Yes, reporting to the CEO / Factory Manager	YES	Complied.

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	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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d	How often are the safety officers retrained in the latest techniques of total safety management? What is the frequency of retraining?	YES	As per requirements	YES	-
e	What additional duties the safety officer is required to do?	YES	No additional duties	Safety staff should concentrate mainly on safety duty.	There is no any additional duties done by safety officer
f	What is the power of safety officer vis-a-vis unsafe condition/unsafe act?	YES	To stop any dangerous operation. If there are any unsafe conditions or acts, these will be brought to the notice of the concerned HOD and in the case of imminent danger, the job stopped until unsafe conditions/ act were removed / corrected.	YES	Safety officer have power to stop any activity which is unsafe.

C-2.2 Safety Committee(s)

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Does the factory have a safety committee(s)? What are the types,	YES	Plant Safety Committee, Central Safety Committee	YES	Complied.

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	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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	structures and terms of reference of the committees				
b	Is the constitution of the safety committee(s) as per the statute?	YES		YES	Safety committees constituted As per Statutory compliance.
c	How are the members of safety committee(s) selected? (elected / nominated	YES	Nominated	YES	50-50% of management and worker side.
d	How often are the meetings of safety committee(s) held?	YES	PSC: Monthly, CSC: Quarterly	YES	MOM is circulated to committee members & records are maintained.
e	Are the recommendations of the committees(s) implemented?	YES	The recommendations were implemented by action plan by respective department In-charge.	YES	Complied.
f	Are the minutes of the safety committee(s) meetings circulated among the members?	YES	Minutes of safety committee's meetings circulated through e-mail	YES	Complied.
g	Are the minutes forwarded to the trade union(s) and chief executive and occupier?	YES		YES	Circulated & Records are maintained.
h	Whether the management and trade union play their active roles in supporting and accepting the committee(s) recommendations?	YES	Always	YES	

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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i	How are the safety committee(s) members apprised of the latest development in safety, health and environment?	YES	Yes Regular training and video presentation at every meeting	YES	Safety committee(s) members shall be apprised of the latest developments in safety, health & environment and also sent to other units to share the information & gain practical experience.

C-2.3 Safety Budget

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What is the annual safety budget?	YES	As & when demands, provides approval for safety compliances	YES	Budget is provide based on the requirements for new and for AMC it is based on approval.
b	How much percentage is this budget of the total turnover of the company?	YES	As per Standard use to provided amount	YES	No such capacity decided.
c	How much budget has been utilized till date?	YES	As requirement.	YES	-
d	Is the safety budget adequate?	YES	Adequate.	YES	-
e	How is the safety budget arrived at?	YES	From past budgets.	YES	Based on activity planned.
f	What is the pattern of expenditure for the last five years?	YES	Data available at HSE department.		In increasing trend. Expenses including Training, PPEs,

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	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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					preventive maintenance of firefighting equipment, testing and examination expenses, inventory of emergency arrangements. Dedicated Cost controller reviews the trend/track on pattern of expenditure.
g	What are the approved sanctions for the expenditure in this budget?	YES	Expenses related to SHE	YES	-
h	Does this budget get reflected in the annual report of the company?	YES	As per Standard include the Annual report	YES	-

C-3 SAFETY MANUAL

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	What is the periodicity of updation / review of safety manual?	YES	As per requirement or Every three years	YES	Complied.
b	Does the safety manual adequately address all the hazards in the plant?	YES		YES	Complied.
c	Are the employee made aware of safety rules / instruction mentioned in the safety manual?	YES	Training given.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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C-4 STANDARD OPERATING PROCEDURES (SOP)

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are written Standard / safe operating procedures available for all operations and processes?	YES	Records Available at respective department	YES	Complied.
b	Whether the written Standard / safe operating procedures are displayed or made available and explained in the local language to the workers?	YES		YES	Display are provided at site.
c	Whether concerned section and safety department prepares standard / safe operating procedure jointly?	YES	Concerned section and safety department jointly prepared Procedure/SOP.	YES	Complied.
d	Are standard / safe operating procedures reviewed and updated?	YES		YES	Complied.
e	Have the workers been informed of the consequences of failure to observe the standard / safe operating procedures?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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C-5 PLANT MODIFICATION PROCEDURES

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What is the system for effecting any change in the existing plant, equipment or process?	YES	MOC (Management of change) Procedure Available	YES	Complied.
b	Whether the P & I diagrams and other related documents are updated accordingly?	YES	P & ID updated, Records are available	YES	Complied.
c	Whether hazard assessment done before implementation of modification?	YES		YES	Complied.

C-6 WORK PERMIT SYSTEM

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What types of work permits exist in the factory?	YES	Total 8 work permit available. Like- Hot work, Confined Space, working at Height work, Excavation & General Work		Isolation permit to be implemented properly.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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b	Are the necessary forms detailing required safety precautions have been prepared and used for each type of work-permit?	YES	Work permit system in place for each type of work.		Each work permit considers their appropriate hazard.
c	Is the responsibility assigned to authorize person for issuing of safety work permit?	YES	Work Permit Authorization system available		Complied.
d	Is the copy of safe work permit sent to safety officer before execution of the job?	YES	Filing system followed	YES	Safety officer ensures that working condition is safe before execution.
e	Is validity period specified in the safety work permit?	YES	Mentioned in work permit also	YES	
f	Are the records of work permit available and maintained in proper order?	YES	Records available	YES	Work permit is maintained properly by yearly sequence number.

C- 6.1 Control Measures for Work at Height

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Is adequate safe access provided to all places where workers need to work?	YES		YES	Height work controlled by PTW.

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	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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b	Are all such access in good condition?	YES		YES	Complied.
c	Are all scaffolds are properly designed and erected?	YES			Complied.
d	Are scaffolds inspected every day before work begins?	YES	Visually inspected daily	YES	Complied.
e	Are ladders securely clamped or lashed in place?	YES		YES	Complied.
f	Are planks in good condition?	YES		YES	Complied.
g	Are scaffold walkaways, platforms, runs or stairs free of debris, grease, any unnecessary obstruction and projecting nails?	YES	Free from obstruction	YES	Complied.
h	Are the scaffolds higher than 20 m.? If yes, is a netting or intermediate railing provided between toe-boards and hand railings?	YES		YES	Verified.
i	Are folding stepladders properly used?	YES		YES	Complied.
j	Are ladders set up at the proper slope of about 1:4?	YES		YES	Complied.
k	Do workers use hand lines to lift tools or materials?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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l	Are proper ladders used around electrical hazards?	YES	Electrical ladder used	YES	Complied.
m	On sloping roofs, are crawling boards, lifelines, safety belts and edge protection provided where needed?	YES		YES	Complied.
n	Whether the weak spots, skylights, or deteriorated asbestos-cement boards through which a worker might fall while working in the roof has been identified and safety net provided appropriately?	NO	No any situation available in site	NO	Complied.
o	Are the workers being medically examined for their fitness to work at height?	YES	Medical examination done	YES	Complied.

C-6.2 Work in Confined Space

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is work permit system followed for working in confined space?	YES	Confined space work permit in place and followed.	YES	Complied.

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b	Whether monitoring of the atmosphere inside the confined space is carried out and ensured that there is no flammable or toxic gas in the area?	YES	Yes, O ₂ , LEL level & in confined space entry work permit	YES	Complied.
c	Whether the person entering the confined space is using suitable personal protective equipment (PPE)?	YES	All required PPEs are used during confined space work.	YES	Complied.
d	Is rescue team available in case of any emergency?	YES	In case of any emergency, team are available	YES	Complied.

C-7 CONTRACTORS' SAFETY SYSTEM

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is there any system for selection of contractors?	YES	System available	YES	Procedure/SOP for contractor Safety Management prepared & implemented.
b	Are there any guidelines on contractor's safety and training?	YES	L1 training given by HSEF Team	YES	Procedure/SOP for contractor Safety Management prepared & implemented.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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c	Whether contract document includes necessary safety and welfare clauses as per statutes?	YES	Yes Follow during pre qualification	YES	Procedure/SOP for contractor Safety Management prepared & implemented.
d	Is there any programme to ensure use of PPE by contractors personnel?	YES		YES	Procedure/SOP for contractor Safety Management prepared & implemented.
e	Do the contractors have their own safety organization?	YES	Contractor wise safety supervisor available	YES	Procedure/SOP for contractor Safety Management prepared & implemented.
f	Are the contractors reporting all accidents and injuries?	YES		YES	Procedure/SOP for contractor Safety Management prepared & implemented.
g	Are contractor workers trained to observe safety at work place?	YES	L2 Job specific Training given by	YES	Procedure/SOP for contractor Safety Management prepared & implemented.
h	Whether contractor workers are engaged in process / operations? If yes, are they aware of safe operating procedures?	YES	No, contractor workers were engaged in plant process & operation.	YES	Procedure/ SOP for contractor Safety Management prepared & implemented.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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C-8 PLANT DESIGN AND LAYOUT

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether hazardous operations in the plant are segregated?	YES		YES	Complied.
b	Whether occupational health & safety aspects are considered during the design?	YES		YES	No such supportive document
c	Are all the equipment provided with adequate space for working, maintenance etc.?	YES		YES	At present material stored on road and ground floor causing obstruction. Keeping free access
d	Are the storage tanks provided with enough space/ clearance between them?	YES		YES	Complied.
e	Whether the plant layout has taken care of the movement of firefighting equipment and emergency exits?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-9 MEDICAL MANAGEMENT OF ACCIDENTS

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are medical facilities available with trained first aid staff and equipment in round the clock shift for all including contractors?	YES	FMO in First and Second shift, Two male nurse and two ambulance drivers in each shift and one female nurse in general shift.	YES	Complied.
b	Is the ambulance van available for round the clock basis with the dedicated driver?	YES	02 ambulance available with drivers	YES	Complied.
c	Is there any mutual aid scheme available with the nearest hospitals to manage and treat injuries during emergency?	YES	Mutual aid scheme available	YES	Complied.
d	Are the workers / contractor workers aware of emergency medical facilities?	YES	Training available	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-10 MANAGEMENT OF EMERGENCIES (NATURAL / MAN-MADE)

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Does the system exist to detect and control these Emergencies?	YES	Emergency Response Plan is in place	YES	Periodical On-site emergency Action Plan awareness training to be done.
b	Are the employees aware of the measures to be taken during emergencies?	YES	The employee aware through Mock Drill & OSEP Training on regular basis.	YES	Verbal interview, Mock drill.

C-11 EMPLOYEES SELECTION AND PLACEMENT

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether norms are available for selection of different category of employees?	YES		YES	Job Description should be available with HR.
b	Whether pre-employment medical examination is being conducted for employees?	YES	Form No. 33 of all employee is available	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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THIRD PARTY SAFETY AUDIT

c	Is there any procedure to evaluate safety awareness and record of the employees during their promotion?	YES		YES	Complied.

C-12 SAFETY CULTURE

C-12.1 Attitudes of Managers

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Do the managers follow the plant safety rules at all times?	YES		YES	Complied.
b	What are their attitudes towards safety reviews and audits?	YES	Positive attitudes towards safety review and audit	YES	Behavior Base Safety awareness training to be done for all the employees.
c	What is the response of management to safety violation?	YES	CSR Policy available	YES	Complied.
d	Whether safety related decisions are taken in consultation with the workers?	YES		YES	Complied.
e	What is the attitude of the managers towards non-use of personal protective equipment?	YES	They fully use Mandatory PEES	YES	

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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C-12.2 Attitudes of Workers

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether workers are aware of the consequences of their wrong actions?	YES	workers are aware of the consequences of their wrong actions and Violation.	YES	Complied.
b	Are laid down safe working procedures followed strictly?	YES	Training given to all workers.	YES	Complied.
c	What is the attitude of the workers towards their own mistake, which can prejudice safety?	YES	Safety observation tour data available.	YES	Appreciated.
d	Do the workers report near miss incidents and suggest safety improvements?	YES		YES	Complied.
e	Are the workers aware of the system of rewards and sanctions relating to safety matters?	YES		YES	Rewards and recognition during safety week.
f	What is the attitude of workers towards use of personal protective equipment?	YES	Positive attitudes towards use of personal protective equipment.	YES	Non-compliance to use of PPE was not observed during audit.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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			All workers used personal protective equipment.		

C-13 STATUTORY LICENSES, APPROVALS AND RECORDS

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether all the safety related Acts / Rules (with latest amendments) applicable to your organization identified, informed to all employees and complied?	YES	Legal aspect register is prepared & responsibilities are identified.	YES	Training to be provided on safety rules and act.
b	Whether the licenses have been validated?	YES		YES	Verified all the licenses.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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C-14 MOTIVATIONAL AND PROMOTIONAL MEASURES FOR OH & S

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Does the factory have occupational health and safety suggestion scheme?	YES	HSE department has prepared occupational health and safety suggestion scheme.	YES	Verified.
b	Are occupational health and safety contests organized in the factory?	YES	During safety month celebration	NSD 4 th March celebrates & organized contests	NSD week to be celebrated with organized various contests & report to be submitted to DISH Office.
c	Does the factory participate in National Awards?	YES		YES	Complied.
d	Has the factory been awarded during last five years?	NO		NO	
e	Does the organization publish safety bulletin / newsletters?	YES	Published by mail	YES	Periodical Safety Bulletin /newsletters will increase the knowledge & awareness among employees
f	Whether the safety bulletins are widely distributed?	YES		YES	Periodical Safety Bulletin /newsletters to be widely distributed
 THIRD PARTY SAFETY AUDIT – GFL, DAHEJ DOCUMENT ID TPSA/GFL/2324/1003 REVISION NO. 00 					

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g	How is the occupational health and safety information including accident statistics disseminated in the factory? (Bulletin boards, Newsletter etc.)	YES	Through Bulletin boards, Newsletter, Mail	YES	Occupational health and safety information including accident statistics disseminated in the factory at Main Gate & each plant
h	What are the activities conducted during National Safety day / week?	YES	External training, First aid training, Safety quiz, safety slogan quiz, safety poster quiz etc.	YES	Complied.
i	What is the percentage of Workers participating in the various safety promotional activities?	YES	Majority Workers participating in the various safety promotional activities.	YES	Complied.

C-15 HAZARD IDENTIFICATION AND JOB SAFETY ANALYSIS

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Was an initial process hazard analysis (PHA) completed?	YES		YES	Complied.
b	What are the stages of PHA? Whether a dedicated group is identified for PHA?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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c	Was the PHA appropriate for the complexity of the process and identify, evaluate, and control the hazards involved in the process?	YES	Records available	YES	Complied.
d	Does the hazard evaluation use one or more of the following PHA methodologies: What-If Analysis, Process Checklist, Hazard and Operability Study (HAZOP), Failure Mode and Effects Criticality Analysis (FMECA), Fault Tree Analysis (FTA) or any other appropriate equivalent methodology?	YES	Process Checklist, Hazard and Operability Study (HAZOP), for hazard evaluation	YES	Complied.
e	Does PHA assures addressing issues of inherent safety features with respect to material and their properties?	YES		YES	Complied.
f	Does the PHA address the hazard identify incidents history, consequences of failures (engineering and administrative controls), human factors, and consequent analysis with respect to	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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	possible safety and health effects of failure of controls?				
g	What are the stages of PHA? Whether a dedicated group is identified for PHA?	YES	PT & PHA Subcommittee, PSM Subcommittee, PSM coordinators from each process plant.	YES	Complied.
h	Does the system exists to promptly address findings and recommendations of PHA?	YES	Tracking of data by PT&PHA Subcommittee	YES	Complied.
i	Are the PHA's updated and revalidated at least every five years by a qualified team to assure that the PHA is consistent with the current process?	YES	Last Completed by DSS and Small section HAZOP by Quality Engineering Services	YES	Complied.
j	Whether the activities requiring Job Safety Analysis have been identified?	YES	Initiated recently	YES	Verified.
k	Whether the identified jobs for Hazard Identification have been carried out by trained and experienced persons?	YES	Hazard Identification have been carried out by trained and experienced persons. Records are maintained.	YES	Complied.
l	Whether the checklists have been prepared on each Job Safety Analysis	YES	Records available	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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THIRD PARTY SAFETY AUDIT

	and are being used while carrying out the job?				

C-16 PRODUCT SAFETY

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether hazards arising from use of the products are identified?	YES	Register is prepared for all activities and counter measures are provided.	YES	MSDS are available.
b	Whether material safety data sheet prepared for the products?	YES	MSDS is available with respective departments.	YES	-
c	Are all the products labeled and packed appropriately?	YES	products are labeled and packed appropriately.	YES	-
d	Whether safety instructions are given along with products?	YES	Safety instructions are given along with products.	YES	-
e	Whether policy exists for recall of products?	YES	-	YES	-

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-17 SAFETY TRAINING

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether training needs have been identified?	YES	Training calendar Excel based available for HSE training / at E&T department	YES	Training needs have been identified for each employees & implemented
b	Is there any programme of induction training, its duration and topics covered?	YES	Duration for induction training: 02 Hrs	YES	Induction training Should be provided to employees; Visitors & hazardous material transporting Drivers.
c	Whether the assessment of the trainees has been carried out?	YES	Records available	YES	Assessment of the trainees to be carried out by Question paper.
d	What are the infra-structural facilities available for training?	YES		YES	Dedicated Conference Room and training Hall available.
e	Whether training is conducted by qualified person?	YES		YES	
f	Whether trainers are being re-trained from time to time?	YES		YES	Train the trainers program to be conducted
g	Whether proper records of training program conducted are maintained?	YES			Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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h	How training programs are evaluated?	YES	By written and practical exam.	YES	Complied.
i	Whether schedule for training on occupational health and safety is available and maintained?	YES	Training calendar available.	YES	Verified.
j	Whether the training Programmes are reviewed?	YES	Training Programmes are reviewed on regular basis.	YES	Verified.
k	Are all the employees periodically trained / retrained and what is the frequency of such training?	YES	Yearly.	YES	Complied.
l	Are the retraining needs identified whenever a new process / products and change in existing process introduced?	YES	Training Programmes are reviewed on regular basis.		Procedure /SOP prepared for Safety Training need identification. & training frequency.
m	Whether training covers top management?	NO	-	NO	Top management to be provided with the training.
n	How many hours of safety training is given to different employees?	YES	About 3 man days internally conducted.	YES	Verified.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



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THIRD PARTY SAFETY AUDIT

C-18 CHANGE MANAGEMENT

C-18.1 Management of Change

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Are there written procedures for managing change to process chemicals, technology, equipment and procedures and changes to facilities that affect the plant process / system operation?	YES		YES	Verified.
b	Do the procedures assure that the technical basis for the proposed change addressed prior to any change?	YES	They were ensured with technical team for the proposed change addressed prior to any change and maintained the record.	YES	Verified.
c	Do the procedures assure that the impact of the change on safety and health addressed prior to any change?	YES		YES	Complied.
d	Do the procedures assure that modifications to operating procedures are addressed prior to any change?	YES		YES	Complied.
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e	Do the procedures assure that the necessary time period for the change is addressed prior to any change?	YES		YES	Complied.
f	Do the procedures assure that the authorization requirements for the proposed change are addressed prior to any change?	YES		YES	Complied.
g	Are employees involved in operating a process, and maintenance and contract employees whose job tasks will be affected by change informed of, and trained in, the change prior to the start-up of process or affected part of process / operations?	YES	Training given to operators for Process Change.	YES	Complied.
h	Is the safety information is reviewed and updated on changes?	YES		YES	Complied.
i	Are the operating procedures or practices updated?	YES	SOP updated	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-18.2 Mechanical Integrity

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Does the mechanical integrity program include for all mechanical equipment including pressure vessels and storage tanks, piping and components, relief devices and vent systems, emergency shutdown systems, pumps, control systems?	YES	MIQA committee	YES	Complied.
b	Are there written procedures to maintain the on- going integrity of process equipment?	YES	SOP available	YES	Complied.
c	Whether training been provided to each employee involved in maintaining the on-going integrity of process equipment?	YES	Training record available	YES	Verified.
d	Are inspections and tests performed on each item of process equipment included in the program?	YES	Records available	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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e	Does the inspection and test frequencies meet the manufacturer's recommendation and good engineering practice?	YES	Records available.	YES	Complied.
f	Are inspections and tests performed more frequently if determined necessary by operating experience?	YES	PM record available & frequency defined.	YES	Complied.
g	Are deficiencies in equipment that are outside limits corrected before further use so as to assure safe operation?	YES		YES	Complied.
h	In the construction of new plants and equipment, whether quality assurance programme is implemented to ensure that equipment fabricated is suitable for the process?	YES		YES	
i	Are appropriate checks and inspections made during equipment installation stage?	YES		YES	
j	Are the suitability of maintenance materials, spare parts and equipment ensured during maintenance?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-19 PHYSICAL HAZARD

C-19.1 Housekeeping

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are all the passages, floors and the stairways in good condition?	YES		YES	Complied.
b	Is glass door taped or otherwise marked to make it visible to workers?	YES		YES	Complied.
c	Do you have the system to deal with the spillage?	YES	Dry sand, spill kit, absorbent	YES	Verified.
d	Do you have sufficient disposable bins clearly marked and whether these are suitably located? Are containers of refuse (waste) and trash emptied at the end of every day or soon after they are full? Are the containers or bins regularly cleaned?	YES	Disposable bins were placed in prominent places clearly marking for different categories of wastes like metallic, plastic, wooden etc.	YES	Verified.
e	Are drip trays positioned wherever necessary?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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f	Do you have adequate localized extraction and scrubbing facilities for dust, fumes and gases? Please specify	YES		YES	Complied.
g	Whether walkways are clearly marked and free from obstruction?	YES		YES	Complied.
h	Do you have any inter-departmental competition for good housekeeping?	NO		NO	Inter-departmental competition for good housekeeping to be introduced.
i	Has your organization elaborated good housekeeping practices and standards and made them known to the employees?	NO		NO	Good housekeeping practices and standards and made them known to the employees.
j	Are there any working conditions, which make the floors slippery? If so, what measures are taken to make them safe?	YES	Which will spill and soil the floor, were cleaned with suitable material spill kit available.	YES	Complied.
k	Does the company have adequate measures to suppress polluting dust arising out of materials stored on the roadside?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-19.2 Machine and General Area Guarding

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether machinery and equipment which can cause physical injuries to operator have been identified?	YES		YES	Complied.
b	Are all moving parts and point of operation of machinery adequately guarded?	YES	Moving parts and point of operation of machinery are adequately guarded.	YES	Goods lift rope drum guard not available
c	Are all fixed guards securely bolted in position and in good condition?	YES	fixed guards are securely bolted in position and in good condition.	YES	Complied.
d	Are all interlock guards for prevention of physical injury in good condition?	NO		NO	Interlock guards for prevention of physical injury to be maintained.
e	Are all emergency stop buttons effective and clearly labeled?	YES	Emergency stop buttons are effective and clearly labeled.	YES	Complied.
f	Are the operators for machines having moving parts aware of the danger of working with loose clothing?	YES	Training provided	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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g	Are the openings where there is free fall hazard covered or fenced securely?	YES	All the openings where there is free fall hazard are covered with railing and toe guard.	YES	Complied.

C-19.3 Material Handling

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are adequate equipment available for handling materials?	YES		YES	Complied.
b	Are the workers aware of the hazards associated with material being handled?	YES	Training provided	YES	Complied.
c	Where manual handling is necessary, are the workers been trained? Do they practice this? Are workers warned for lifting of excessive weight? (Maximum weight of material for adult male and female are 55 Kg and 30 Kg respectively)	YES	Training and TBT given on regular basis.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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d	Do workers follow safe procedures for storage of materials?	YES		YES	Complied.
e	Do workers follow safe procedures for storage of materials?	YES		YES	Complied.
f	Are all the statutory examinations and tests carried out and certified by competent person(s)?	YES	Form 9 Form 10 available	YES	Complied.
g	Are the operators of crane, lifts, hoists and other mechanized operations adequately qualified?	YES		YES	Complied.
h	Is the safe working load clearly marked?	YES		NO	Goods lift not having marking for SWL.
i	Has the person employed to operate crane, forklift, or to give signals to crane been medically examined for eyesight and color vision?	YES		YES	Medical clinical examination test matrix with OHC.
j	Is the frequency of eyesight and color vision examination as per the latest rules?	YES		YES	Complied.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-19.4 Electrical Safeguarding

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are licensed electricians available for electrical work?	YES	Available	YES	
b	Whether area classification for electrical equipment has been carried out?	YES		YES	Complied.
c	Do the electrical fittings conform to area classification for electrical equipment?	YES		YES	Complied.
d	Is a ground fault current interrupter system (ELCB) in use?	YES	ELCB, MCB & RCB being used wherever required.	YES	Complied.
e	Are all connections made by using appropriate plugs, receptacles or enclosures? Are fuses provided?	YES	Industrial plugs being used.	YES	Complied.
f	Are there any make shift connection bare wires or damaged cables?	NO		NO	Complied.
g	Is there a system of ensuring periodical inspection of hand tools, extension boards used for electrical work?	YES	Monthly schedule available	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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h	Do the workers use proper types of PPE during the working on live line?	NA	No employee is allowed to work on live wires, Full energy isolation is required to perform and job on machine and maintenance job is done only by authorized electrician	NA	Complied.
i	Is the separate work permit issued for working on high voltage line?	NA	No employee is allowed to work on live wires, Full energy isolation is required to perform and job on machine and maintenance job is done only by authorized electrician	NA	Complied.
j	Whether the process(s) and equipment that generate and accumulate static charge have been identified?	YES		YES	Complied.
k	Whether all such equipment including pipelines for flammable materials are properly bonded and earthed?	YES	All such equipment including pipelines for flammable materials are properly bonded and earthed.	YES	Complied.
l	Whether earth pit resistance is measured and the record maintained?	YES	Yearly inspection by electrical department , record maintained	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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THIRD PARTY SAFETY AUDIT

m	Whether lightning arrestor has been installed and is adequate?	YES		YES	Marking of earth pit to be improved.

C-19.5 Safety in Storage and Warehousing

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether the Material Safety Data Sheet for all chemicals is available?	YES		YES	Same to be made available at storage area, control room and respective plant.
b	Are the chemicals stored as per their hazardous properties including the incompatibility?	YES	All material stored as per their compatibility.	YES	Compatibility matrix not available. Material stored on road and Ground floor of plant.
c	Are all containers clearly, indelibly labelled? Are all chemicals stored as per safety regulations?	YES	All containers clearly, indelibly labelled. All chemicals stored as per safety regulations.	YES	Complied.
d	Whether all racks and steel cages have sufficient load bearing capacity?	YES		YES	Complied.
e	Is adequate natural ventilation provided to store room? Is there any emergency exit?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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f	Whether adequate firefighting arrangement existing in flammable chemical storage?	YES	Fire Hydrant, Hose reels, sand Bucket, Fire Monitors all available at chemical storage area.	YES	No network in ETP area. Fire sprinklers are not evident. Need to conduct fire adequacy study and comply accordingly.
g	Whether methodology for handling spillages of hazardous chemical available along with the equipment required handling the spillage?	YES	SOP available for spillage handling.	YES	Verified.
h	Whether aisles are marked and emergency exits displayed?	YES		YES	Complied.

C-19.6 Hazard Assessment for New Equipment

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What is the system for effecting any change in the existing plant, equipment?	YES	MOC System followed for change control	YES	MOC procedure with format available.
b	Is there system for evaluating hazards from new equipment?	YES		YES	

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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c	Whether the P and I diagrams and other related documents are updated accordingly?	YES		YES	P&ID needs to be updated immediately after the change is implemented
d	Is any Job Hazard Analysis (JHA) carried out after installation of new equipment?	YES		YES	Complied.

C-19.7 Hazards from Radiation Sources

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether licenses have been obtained for storage / handling of radioactive material?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
b	Whether approved Radiological Safety Officer appointed?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
c	Whether appropriate PPEs are used against radiation hazards?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

d	Is the flooring of the radioactive material handling area amenable for proper decontamination?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
e	Is the storage room of radiation source as per the license condition?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
f	Are all persons working in the facility have radiation safety training?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
g	Is the operators handling devices using radioactive materials qualified and possess the necessary certificate?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
h	Is the periodical radiation monitoring carried out?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
i	Are the records of inventory of radioactive material maintained in the standard format and submitted to the competent authority as per the period specified?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
j	Are emergency handling tools available?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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THIRD PARTY SAFETY AUDIT

k	Are the personnel monitoring badges (TLD, Pocket dosimeter etc.) assigned and worn by each radiation worker?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-
l	Are the radiation symbol and red light displayed as required?	NOT APPLICABLE	No Radioactive material being used.	There are no any radiation sources using in Industry	-

C-20 CHEMICAL HAZARD

C-20.1 Transportation of Hazardous Substances

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What potentially hazardous materials are transported to or from the site (including wastes)	YES	List of Hazardous material transported available with Department	YES	Check list of truck/Tanker to be update (To check TREM CAD & EIP CODE on tanker
b	What mode of transport are used? 1) Road, 2) Rail, or 3) Pipelines	YES	Road	YES	Check list of truck/Tanker to be update (To check TREM CAD & EIP CODE on tanker

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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1 Road					
a	Does the company employ licensed vehicle of its own / outside sources?	YES	Outside sources vehicle are use.	YES	
b	Are the loading / unloading procedures in place and safety precautions displayed?	YES		YES	Loading / unloading procedures SOP to be displayed at area.
c	Is there a provision to check the healthiness of road tanker with respect to explosives rules?	YES	Physically checked at gate	YES	Healthiness of Road tanker should be as per explosives rules.
d	Are loaded tankers or trucks parked in a specific area on-site?	YES		YES	Procedure/SOP to be prepared & Implement
e	Do all truck and tanker drivers carry transport emergency (TREM) card or instruction booklet?	YES		NO	Check list of truck/Tanker to be update (To check TREM CAD & EIP CODE on tanker
f	Do all truck and tanker drivers get training in handling emergencies during transport?	YES	Training record available	YES	Complied.
g	Are all the tankers marked for proper Hazchem code?	YES		YES	Check list of truck/Tanker to be update (To check TREM CAD & EIP CODE on tanker

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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2 Rail

a	What hazardous materials are transported by rail?	NO		NO	-
b	Does the company have a direct siding on site?	NO		NO	-
c	Are tankers or other wagons used in transportation?	NO		NO	-

3 Pipelines

a	What materials are transported to and from the site by pipelines?	NA		NA	
b	Are the pipelines underground or over ground?	NA		NA	
c	Are corrosion protection measures employed in pipelines?	NA		NA	
d	Whether intermediate booster pumps are used?	NA		NA	

**THIRD PARTY SAFETY AUDIT – GFL, DAHEJ**

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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e	What is the maximum, minimum and average transfer rates?	NA		NA	
f	Are the pipelines extended in the public domain?	NA		NA	
g	Are the pipelines dedicated for each type of chemicals?	NA		NA	
h	Are the pipelines fitted with safety equipment such as leak detectors, automatic shut-off valves etc.?	NA		NA	
i	What is the frequency and method of testing of the pipeline?	NA		NA	
j	Is there written procedure for tackling leakages in pipeline?	NA		NA	

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-20.2 Handling of Hazardous Substances

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What are the hazardous substance handled in the factory?	YES	Methanol, H ₂ , VDF etc..	YES	Verified.
b	Whether quantity of hazardous substances is above the threshold limit specified in the Manufacture, Storage and Handling of Hazardous Substances Rule, 1989? If yes, then required documentation is available as per the rule.	YES	Required documents are available.	YES	Well documented and all licenses updated.
c	Whether written procedure for handling the hazardous substance is available and operators are trained for handling such substances including actions required in case of leakages and spillages?	YES	Do's and Don'ts displayed & SOP is available, Training provided	YES	SOP for handling to be displayed at site

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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THIRD PARTY SAFETY AUDIT

d	Are the employees aware of the hazards arising from hazardous substances and safety precautions to be taken during handling of these?	YES	Training provided	YES	Verified.

C-20.3 Material Safety Data Sheets (MSDS)

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Are the material safety data sheets available for all the chemicals handled, used and manufactured in the factory?	YES	MSDS for all chemical used in plant are available.	YES	Complied.
b	Whether the latest MSDS are displayed at strategic locations?	YES	Available & displayed at respective department	YES	Verified.
c	Is it available in local language?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-20.4 Spill Control Measures

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether spill control procedure is available?	YES	SOP, MSDS, Do's and don'ts available	YES	Verified.
b	Whether spill collection pit / sump is available at the workplace?	YES		YES	Complied.
c	Whether methodology for recovery / disposal of collected material has been established?	YES	SOP available for collected material	YES	Complied.

C-20.5 Storage of Hazardous Substances

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether storage vessels are identified with the capacity as required under MSIHC, Rules 1989.	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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b	What are the storage pressure and temperature?	YES	Data available	YES	Complied.
c	Whether vessels are above ground / underground?	YES	above ground	YES	Complied.
d	If any of the tanks storing flammable material, whether electrical equipment and fittings are as per electrical area classification?	YES		YES	Complied.
e	Is the bunded area takes into account the total quantity of the largest tank?	YES		YES	Complied.
f	Whether the bund perimeter takes into consideration of trajectory of leak from tank?	YES		YES	Complied.
g	Are the vessels properly bonded and earthed and whether periodically checked and record maintained?	YES	Record available	YES	Complied.
h	Are the vessels fitted with remotely controlled isolation valves?	YES	As per requirement	YES	Complied.
i	Are vessels provided with emergency vent, relief valve, bursting disc, level indicator, pressure gauge, overflow line?	YES	Vessels are provided with emergency vent, relief valve, bursting disc, level indicator, pressure gauge, overflow line as required.	YES	Vents available with wire mesh.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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j	Where do such vents discharge?	YES	In atmosphere	YES	Complied.
k	Are the vessels provided with alarms for high level, high temperature and high pressure?	YES	Vessels are provided with alarms for high level, high temperature and high pressure as required.	YES	Complied.
l	Are standby empty tanks or any other alternate systems provided for emptying / transfer in case of emergencies?	YES		YES	Complied.
m	What are the provisions made for firefighting / tackling emergency situations around the storage vessels?	YES	Fire-fighting system available	YES	Sprinkler system to be reviewed. Holes in pipe instead of standard sprinkler.
n	Has any consequence analysis for loss of containment been carried out?	YES		YES	Complied.
o	Whether the vessels are tested as per statute?	YES	Form 11 maintained	YES	Verified.
p	Whether log sheets are filled up on daily basis for recording the parameters of these vessels?	YES		YES	Verified.
q	Whether monitors for detection of leakage of flammable / toxic material installed?	YES		YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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r	Whether the chemicals stored are as per their compatibility?	YES		YES	Complied.

C-20.6 Gas Cylinders

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	What are the various gas cylinders used in the plant?	YES	Hydrogen, Air, Argon, Oxygen etc.	YES	Complied.
b	Are valid licenses available for storing all these cylinders?	YES		YES	Verified.
c	Are the cylinders stored and segregated as per their compatibility?	YES	Cylinders are stored and segregated as per their compatibility.	YES	Complied.
d	What are the measures taken for combating any emergency in the cylinders storage area?		SCBA set, Fire hydrant system, fire extinguisher	YES	Complied.
e	Whether integrity test certificates are obtained from the suppliers of the cylinders?	YES	Records available	YES	Verified.
f	Are the cylinders chained and secured properly along with the valve caps and proper identification colour code?	YES	Cylinders are chained and secured properly along with the valve caps and proper identification colour code.		

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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g	Are the cylinders protected from heat or sun and rain?	YES	Cabinet provided	YES	Verified.
h	Whether monitors for detection of leakage of flammable / toxic gas installed?	YES	Fixed GDS	YES	Verified.

C-20.7 Labeling and Color Coding

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are all the containers, vessels and storage tanks labeled for its content and capacity?	YES	All the containers, vessels and storage tanks are labeled for its content and capacity.	YES	Complied.
b	Whether the pipelines are colour coded as per IS 2379?	NO		NO	
c	Is any plant specific colour code followed?	YES		YES	Complied.
d	Whether the colour codes are displayed conspicuously in the working areas?	YES	Display boards available for colour coding	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-20.8 Hazardous Waste Management

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is identification done for various types of hazardous wastes?	YES	Identification done As per GPCB Norms	YES	Complied.
b	Are these quantities less than those specified by the Hazardous Wastes (Management & Handling) Rules, 1989?	YES	Quantities are less than those specified by the Hazardous Wastes (Management & Handling) Rules, 1989, As per GPCB Norms	YES	Complied.
c	What are their disposal modes?	YES	Processing, Co-processing etc. As per GPCB Norms	YES	Pass book and agreement copy with TSDF.
d	What are the systems / measures adopted for controlling air / water / land pollution?	YES	Full fledge ETP , form 37 maintained, Storm water drain is available not connected to process line.	YES	Complied.
e	Whether the solid waste like combustibles, plastic, metals etc. segregated?	YES	Segregated as per GPCB Norms	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 16:53:10 from IP No: 172.16.31.15.

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C-21 FIRE AND EXPLOSION HAZARD

C-21.1 Organizational Set-up for Fire Fighting

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	What is the total strength of fire station and fire crew?	YES	24	YES	Complied.
b	How many fire crews are available in each shift?	YES	08	YES	Verified.
c	Is there fire squad identified in each shift?	YES	Trained ERT member list is displayed at main gate.	YES	Regular periodical ERT training to be done & record to be maintained.
d	Standing fire order is available with latest revision	YES		YES	Covered – in Training
e	How is the communication with fire station?	YES	Through Phone	YES	Complied.
f	Does fire safety inspections carried out?	YES	Records available	YES	Verified.
g	Does emergency procedure available for leakage or combustion of flammables?	YES	On-site emergency plan available & reviewed and update periodically.	YES	Complied.
h	What measures are available to control the fire load in the plant area?	YES	Hydrant, sprinklers fire extinguishers available, Fire Monitor & Hose reel.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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i	Whether technical knowledge and skills of the manager and staff responsible for overall fire safety of the plant is adequate?	YES		YES	Complied.
j	How many major and minor incidents / fires were there in the factory during the last five years? Give department / plant wise.	YES	Data available with Safety department	YES	Verified.
k	Have all the fires / incidents been investigated and corrective actions taken? Give break-up.	YES	Data available with Safety department	YES	Verified.
l Resources:					
a	Adequacy of protective clothing (coat, trouser, gloves, boots and helmets);	YES		YES	Adequate.
b	Availability of SCBA for firefighting operations and spare cylinders (at least 2 for each SCBA);	YES		YES	Complied.
c	Adequacy of hose, nozzles, ladders, lighting equipment and pumps; and	YES	Inspection done on regular basis, Record available	YES	Fire pumps installed in fire station only.
d	Communication facility at fire station, walkie talkie sets during firefighting.	YES	Mobile and Walkie talkie	YES	Security control room is common control room. No fire stations.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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					Mobile and land line phones are means of communication.

C-21.2 Built in Safety in Civil Design and Construction

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether the two safe means of escape available? Are they in separate directions?	YES	Safe means of escape available & they are in separate directions.	YES	Complied.
b	Is emergency exits provided to the building handling flammables?	YES	Where flammable material being handled.	YES	Complied.
c	Whether emergency lights are provided?	YES	Emergency lighting provided in Plant & marked. Records available.	YES	Complied.
d	Whether fire / smoke detectors are installed in fire prone areas?	YES		YES	Complied.
e	Whether fire call points are provided in different areas?	YES		YES	Complied.
f	Whether Fire hydrants are provided near the buildings?	YES	Fire hydrants are available and regular inspection done.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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g	Is ventilation system in plant handling flammables is adequate to prevent formation of flammable mixtures?	YES		YES	Complied.
h	Is adequate separation is provided between combustible / flammable materials and other material to restrict the fire growth?	YES		YES	Complied.
i	Access routes for firefighting operations is available for areas having high fire load	YES	Access routes for firefighting operations is available.		Verified.
j	Whether building changes interferes with fire detection and / or fire suppression systems?	YES		YES	Complied.
k	Whether building changes cause unreasonable fire loading / openings in the fire rated walls?	NO		NO	--

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-21.3 Built in Safety in Electric Circuits and Equipment

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are the electrical equipment in areas where flammables mixture is likely to be present of flame-proof type?	YES		YES	Regular periodical Inspection of earthing jumpers & flame roof electrical fittings & equipments are carried out & records are maintained
b	Are lightning arrestors are provided to the buildings / structures storing flammable materials?	YES		YES	Complied.
c	Whether adequate bonding and grounding of electrical equipment / pipelines provided?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-21.4 Explosive Substances

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether necessary license / approval taken from concerned statutory bodies?	YES	Necessary license / approval taken from concerned statutory bodies.	YES	Storage capacity tank wise not provided.
b	Whether systems for explosion suppression, high speed fire detection with deluge, sprinklers, explosion venting etc. are provided?	YES	Fire hydrant sprinklers MCP, Fire monitor.	YES	Only hydrant system is available. Sprinkler system in storage tank area is in manual mode.
c	Whether explosion resistant walls or barricades are provided around explosive storage?	YES		YES	Complied.
d	Whether explosive substance storage areas are restricted for entry?	YES	Explosive substance storage areas are restricted for entry	YES	Complied.
e	Whether only trained persons are handling explosive substances?	YES	Training data available.	YES	Records Verified.
f	Whether explosive substances are stored and transported in approved containers only?	YES	Documents verified as per explosive rules	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine. IP is depends upon the Internet Service Provider.

g	Whether electrical fixtures in areas handling explosives are explosion proof type?	YES	Regular periodically inspection of flame proof electrical fixtures is carried out & records are maintained	YES	Verified.
h	Whether adequate measures are taken to prevent any sources of ignition where explosive substances are handled?	YES		YES	Complied.

C-21.5 Fire Safety in Handling Flammable and Explosive materials

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether emergency procedure is available for control of leakage?	YES	OSEP available	YES	Verified.
b	Whether emergency measures are displayed locally in case of accidental spillage / leakage?	YES	Safety Board are displayed.	YES	Complied.
c	Whether facility is provided for safe drainage of combustible or flammable liquids in case of leakages?	YES	Collection pit available	YES	Complied.
d	Whether highly flammable liquids are stored under inert atmosphere?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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e	Whether flammable storage tanks are provided with flame arrestors?	YES		YES	Complied.
f	Whether suitable PPEs are provided?	YES	Suitable PPEs are provided.	YES	Complied.

C-21.6 Fire Detection and Alarm System

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What type of fire detection and alarm system provided?	YES		YES	Complied.
b	Whether all fire prone areas of the plant are covered with fire detection system?	NO		NO	Complied.
c	Whether fire detection equipment and smoke alarms in good operating condition?	YES		YES	Complied.
d	Whether the number of fire call points are adequate and free from obstruction?	YES		YES	Complied.
e	Whether regular inspection / maintenance / testing of fire detection and alarm system carried out and records maintained	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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f	Whether any atmospheric monitoring is carried out for explosive mixture of gases or vapors?	YES			Complied.
g	Whether emergency power supplies are provided to fire detection and fire alarm system?	YES		YES	Complied.
h	Whether smoke detectors are located considering ventilation pattern?	YES		YES	Complied.
i	Whether annunciation of fire is local or in the control room or in both places?	YES		YES	Complied.
j	Whether fire panel is constantly attended?	YES		YES	Fire control room is at security control room.



THIRD PARTY SAFETY AUDIT – GFL, DAHEJ

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

C-21.7 Passive and Active Fire Protection System

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What are the passive fire protection measures available? (Barriers, doors, dampers etc.)	YES		YES	Complied.
b	Are the areas requiring fire barriers identified?	YES		YES	Complied.
c	Whether the fire barrier provided is of adequate ratings?	YES	Adequate rating fire barriers is provided.	YES	Complied.
d	Whether ventilation ducts in flammable areas have been provided with isolation dampers of suitable fire rating?	NA	We don't have process that required isolation dampers in flammable areas	NA	-
e	Whether sprinklers / deluge are installed wherever necessary?	YES	Storage Area	YES	Verified.
f	Whether regular inspection / maintenance / testing of fire protection system carried out and records maintained?	YES	Record maintained	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-21.8 Fixed Fire Extinguishing System

SR. NO.	ATTRIBUTE	AUDITEE INPUTES	AUDITEE REMARK	AUDITOR INPUTES	AUDITOR REMARK
a	What are the sources of firewater and whether they are dedicated to the fire extinguishing system?	YES	GIDC water	YES	Complied.
b	Whether the capacity of dedicated water reservoir is adequate to supply to hydrants for minimum 2 h?	YES		YES	Complied.
c	Whether un-interrupted power supply is provided to the firewater pumps?	YES	D.G Set provided	YES	Complied.
d	Whether the extinguishing medium selected is appropriate to the class of fire (water, gaseous, foam, dry powder)?	YES	Extinguishing medium selected is appropriate to the class of fire.	YES	Complied.
e	Whether fire hydrants layout is available?	YES	Fire hydrants layout is available.	YES	Complied.
f	Whether additional (over minimum requirement) fire hoses, nozzles are available?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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g	Whether the hydrants lines are kept pressurized?	YES	7 kg/cm2 pressure maintained in fire hydrant line.	YES	Complied.
h	Whether regular inspection / maintenance / testing of fixed fire extinguishing systems carried out and records maintained?	YES	Maintenance, Inspection and testing carried out by Third party. Record available	YES	Verified.

C-21.9 Portable Fire Extinguishing System

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Whether suitable type and numbers of fire extinguishers provided?	YES		YES	Complied.
b	Whether the fire extinguishers are located at conspicuous position and easily accessible? Are they fully charged and tagged?	YES	Inspection done on regularly basis ,records available	YES	Complied.
c	Whether fire extinguishers periodically inspected, tested, refilled and records maintained?	YES	Inspection done on regularly basis ,records available	YES	Complied.
d	Whether defective / unchecked fire extinguishers present at site?	NO		NO	Follow IS 2190

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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e	Whether additional fire extinguishers are available?	YES		YES	Complied.

C-21.10 Fire Fighting Equipment and Facilities

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether fire tenders (water / foam) are available?	YES		YES	Fire Tender and Fire hydrant system is available.
b	Whether the fire-fighting system and equipment approved, tested and maintained as per relevant standard?	YES	Firefighting system tested and maintained by third party.	YES	Complied.
c	Whether the SCBA / fire suit provided to firefighting team for immediate action?	YES		YES	Complied.
d	What is system for maintenance / recharge of SCBA?	YES	Inspection done on regularly basis ,records available	YES	Out sourced.
e	Is proper access available for firefighting equipment?	YES	Proper access available for firefighting equipment.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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f	Whether fire hose cabinets are in good condition, easily visible, and accessible?	YES	Inspection done on regularly basis ,records available	YES	Hose reel found damaged in alpha plant.
g	Whether drill tower is available? Are fire personnel carrying out regular fire drill?	YES		YES	Wet drill performed at regular interval.
h	What is the communication facility at fire station? Is it adequate?	YES	Telephone Mobile phone, Walky Talky	YES	Complied.

C-21.11 Fire Drill

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether mock fire drills are conducted? What is the frequency of drills?	YES	Every Month	YES	Records verified.
b	Whether fire drills are also performed in night shift	YES		YES	Drills in odd hours to be documented.
c	Whether feedback of fire drill is documented?	YES	Always maintain all the document	YES	Documents Verified.
d	What is the system of mutual-aid scheme?	YES	Records Available.	YES	Documents Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-21.12 Fire Fighting Training

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether there is a system of providing fire- fighting training to plant personnel?	YES	fire- fighting training to plant personnel is provided monthly. Records are available.	Monthly	Complied.
b	What is the frequency and duration of such training? Whether training records are maintained?	YES	2 Hrs./month	YES	Complied.
c	Whether fire squads are identified for different areas for first-aid firefighting and rescue, and suitably trained?	YES	Details available at SHE	YES	Complied.
d	Are all personnel conversant with the fire prevention and protection measures?	YES	Training provided	YES	Complied.
e	Whether the fire staff are sent for refresher / advanced training courses?	YES		YES	Internally trained.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-21.13 Static Electricity and Lightning

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether all vessels and pipes are provided with suitable bonding and grounding?	YES	Regular inspection done.	YES	Complied.
b	Whether arrangement has been made for grounding the tanker containing flammable liquid during loading / unloading?	YES		YES	Complied.
c	Whether spark resistant tools are provided?	YES		YES	Complied.
d	Whether lightning protection is provided and is adequate?	YES		YES	Complied.
e	Whether antistatic clothing, hand gloves and footwear are provided?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-21.14 Pressure Relief System

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether the listing of all 'pressure plants' [as defined under Factories Act] has been done?	YES	Form 11 Maintained.	YES	Records verified.

C-22 INDUSTRIAL HYGIENE / OCCUPA- TIONAL HEALTH

C-22.1 Ventilation, Illumination, Noise, Vibration, Heat stress and Non-Ionizing Radiations

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
C-22.1.1 Ventilation					
a	Whether any ventilation study has been carried out?	YES	Ventilation study is carried out by 3rd party agency.	YES	
b	Whether natural ventilation is adequate or not?	YES	ADEQUATE	YES	Complied.
c	Whether dust / fumes / hot air is generated in the process?	YES		YES	Dust Extraction system is available.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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d	Is there any exhaust ventilation system in any section of the plant?	YES	Ventilation duct provided	YES	Verified.
e	Is periodic / preventive maintenance of ventilation system carried out and record is maintained?	YES	Record maintained	YES	Verified.
f	Does any ventilation system re-circulate the exhausted air in work areas?	NO	No ventilation system re-circulate the exhausted air in work areas.	NO	Complied.
g	Is the work environment assessed and monitored for chemical and physical hazards?	YES	Form-37 maintained	Environment monitoring is done.	Records verified.
h	Whether PPE are provided to workers exposed to dust / fumes and gases?	YES	Dust mask	YES	Complied.

C-22.1.2 Illumination

a	Whether illumination study has been carried out for the assessment of illumination level?	YES		YES	Complied.
b	Is there any system of periodical cleaning and replacing the light fittings / lamps in order to ensure that they give the intended illumination levels?	YES	Regular inspection done.	YES	Complied.

**THIRD PARTY SAFETY AUDIT – GFL, DAHEJ**

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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c	Are the workers subject to periodic optometry tests and records maintained?	YES		YES	Verified.
d	Are emergency lighting available at first aid center.	YES		YES	Complied.
C-22.1.3 Noise					
a	Whether any noise study conducted?	No		No	Noise study to be carried out.
b	Are there any machines / processes generating high-noise?	YES	DG set, Compressor, Blower	YES	Complied.
c	Whether engineering and administrative controls been implemented to reduce noise exposure below the permissible limits?	YES		YES	Complied.
d	Is there a system of subjecting all those employees to periodic audiometric test who work in high- level noise areas?	YES	Record maintained at OHC	YES	Complied.
e	Whether the workers are made aware of the ill effects of high noise?	YES	Training provided	YES	Records verified.
f	Whether ear muffs / plugs are provided and used?	YES	Ear muffs / plugs are provided and used in high level Noise area.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-22.1.4 Vibration

A	Are there equipment which contribute excess level of vibrations and whether they are identified?	NO		NO	No such equipment identified.
b	Whether any vibration study has been carried out?	NO		NO	Vibration study to be carried out.
c	Are the measures taken to combat vibration to acceptable levels?	NO		NO	Vibration study to be carried out.
d	What is the frequency for measurements of vibration?	NO		NA	
e	Are the records of measurements and maintenance of equipment / system maintained?	NO		NA	

C-22.1.5 Heat Stress / Cold stress (Extremes of Temperature)

a	Are there sources from equipment increasing the heat load in work places?	YES	steam line	YES	Complied.
b	Whether evaluation of heat stress is carried out?	NA	-	NA	-
c	Whether natural ventilation is adequate to minimize the heat stress in work environment?	YES	Adequate.	YES	Complied.
d	Are resources available to deal	YES	Drinking water, lined	YES	Complied.

**THIRD PARTY SAFETY AUDIT – GFL, DAHEJ**

DOCUMENT ID

TPSA/GFL/2324/1003

REVISION NO.

00



- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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	with very hot or very cold conditions (drinking water, lined gloves, insulated boots)?		gloves available to deal with hot conditions.		
e	Do workers know the symptoms of heat cramps / heatstroke or frost bite / hypothermia?	YES		YES	Complied.
f	Are the personal protective equipment suitable for reducing the effects of heat stress available?	YES		YES	Complied.
C-22.1.6 Non-Ionizing Radiations					
a	Does the work involve likely exposure to non-ionizing radiations (ultraviolet, infrared, radiofrequency, microwaves, lasers, etc.?)	YES	Welding & Gas cutting operations.	YES	Complied.
b	Whether risk assessment have been done for all work areas involving presence of non-ionizing radiations?	YES		YES	Complied.
c	Are the work areas displayed with relevant safety signs?	YES		YES	Complied.
d	Are the employees aware about the hazards of non-ionizing radiations?	YES	Training provided	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

THIRD PARTY SAFETY AUDIT

e	Does written procedures exists for working in non-ionizing radiations?	YES		YES	Complied.
f	Is the work environment monitored periodically for physical hazards and control measures initiated whenever deviation from permissible values is observed?	YES		YES	Complied.
g	Whether suitable personal protective equipment are provided to workers exposed to non-ionizing radiations?	YES		YES	Complied.

C-22.2 Work Place Monitoring for Hazardous Chemicals

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Whether the dust, fumes, smoke aerosols and mist are monitored as per statute and records maintained?	YES	Form 37 maintained.	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

b	What are the types of detectors used for monitoring concentration of hazardous chemicals?	YES	Smoke, Chlorine, Hydrogen, beam types	YES	Complied.
c	Is any alarm system installed for any leakage of hazardous chemicals?	YES	Chlorine, Hydrogen	YES	Complied.
d	Are antidotes available for toxic chemicals?	YES	Listed in OSEP	YES	Verified.
e	Are control measures initiated whenever deviation from permissible values is observed?	YES		YES	Complied.

C-22.3 First Aid Facilities and Occupational Health Centre (OHC)

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Are adequate numbers of first aid boxes provided? Give location details?	YES		YES	Complied.
b	Are qualified / trained first aiders available in each shift?	YES		YES	Trained first aiders available in each shift.
c	How many qualified / trained first	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

	aiders are available at each plant / department?				
d	How many persons are trained / given refreshers training in first aid in a year?	YES	As per requirement	YES	Certified Refreshers training in first aid in a year to be conducted.
e	Whether occupational health center is provided?	YES	Full fledged OHC is available.	YES	Complied.
f	Does OHC conform to the provisions of the existing statutes?	YES	OHC is built as per requirement of GFR.	YES	OHC facility should be verified GFR 1963 Rule 68U.
g	Are the Medical Attendants / Doctors available in each shift?	YES		YES	Complied.
h	What facilities are available for transportation of the injured to hospital?	YES	One ambulance with driver and tie up with Hospital at Ankleshwar.	YES	Complied.
i	Are the names of the trained first aiders displayed?	YES	Digital boards displayed with ERT members.	YES	Complied.
j	Are the name of nearest hospitals and its telephone number available in OHC?	YES		YES	Name of nearest hospitals and its telephone number should be available in OHC.
k	Does the plant have any special preventive medicine program?	YES		YES	Complied.
l	Is ambulance posted in proper place and is it available whenever required?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine. IP is depends upon the Internet Service Provider.

m	Are sufficient numbers of anti-dotes available in case of any emergency?	YES	Sufficient numbers of anti-dotes available in case of any emergency in OHC.	YES	Complied.
n	Are fire safety measures provided in fire aid Centre?	YES		YES	Complied.
o	Are emergency lighting arrangements available at first aid Centre?	YES		YES	Ensure emergency lighting is provided in first aid centers to be periodically inspected & tested & record to be maintained.

C-22.4 Periodic Medical Examination

SR. NO.	ATTRIBUTE	AUDITEE INPUTES	AUDITEE REMARK	AUDITOR INPUTES	AUDITOR REMARK
a	Whether the periodical medical examination of employees, required under relevant statute is carried out?	YES	Form No. 32 For company employee and contractor worker maintained	YES	Verified.
b	Whether it is ensured that contractors employee are medically examined during pre-employment as well as during the course of employment?	YES	Form: 33 for pre-employment and medical checking are carried out.	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

c	During the periodical medical examination of the workers, are they examined as per the hazardous process in which they work? (First schedule of The Factories Act, 1948)	YES	Periodical medical examination as per statutory.	YES	Verified.
d	Are the records of all such examination maintained?	YES	Records are well maintained.	YES	Verified.

C-22.5 Personal Protective Equipment and Emergency Equipment

SR. NO.	ATTRIBUTE	AUDITEE INPUTES	AUDITEE REMARK	AUDITOR INPUTES	AUDITOR REMARK
a	Whether list of required PPE for each hazardous activity is available?	YES	List of required PPE for each hazardous activity is available and provided.	YES	Complied.
b	Whether feedback from workers obtained during selection of PPE?	YES		YES	Complied.
c	Have the workers been trained in proper use of PPE including BA sets?	YES	Training given and records available	YES	Complied.
d	What is the system of procurement, inspection, issue,	YES		YES	The system procedure/SOP of procurement, inspection, issue,

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

	maintenance and replacement of PPE?				maintenance and replacement of PPE prepared & implemented
e	Whether qualitative and quantitative fit-check for respirators is ensured prior to use?	YES		YES	Complied.
f	What are the arrangements for safe custody and storage of PPE?	YES	Locker provided, PPE's box provided at each plant area	YES	Complied.
g	Are the contractor's workers provided with the required PPE?	YES		YES	Complied.
h	Do the PPE conform to any standard?	YES	PPE conforms to IS standard	YES	Complied.
i	Are sufficient eye wash fountains and safety showers available?	YES	Sufficient eye wash fountains and safety showers are available. Total 58 numbers.	YES	Verified.
j	Whether appropriate respiratory protective devices are available in accordance to the hazard potential?	YES		YES	Complied.
k	Are the staff members trained in the right uses of respiratory protective devices?	YES		YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

C-22.6 Occupational Diseases

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Whether pre-employment medical checkup data available?	YES	Form:- 33 data are maintained.	YES	Verified.
b	During the medical checkup, is any person found having occupational diseases mentioned in 3rd schedule of The Factories Act, 1948?	NO	There is no having occupational diseases found mentioned in 3rd schedule of The Factories Act, 1948	NO	Complied.
c	Whether the medical practitioner informed the Chief Inspector of Factories about the occurrence of the occupational disease?	YES	No such diseases detect till date.	YES	Complied.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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C-23 ACCIDENT / INCIDENT REPORTING, INVESTIGATION AND ANALYSIS

C-23.1 Accident Reporting and Database Management

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	What is the procedure for accident / incident / dangerous occurrence reporting?	YES	Online “Suraksha Setu” portal has been used to reporting any kind of incident/accident, near miss, safety observation	YES	Verified.
b	Whether the accident data for the last five years for reportable and non-reportable accidents are available?	YES	Accident data available at Safety and HR Department.	YES	Verified.

C-23.2 Accident Investigation

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are all the accidents investigated?	YES	Available at Safety and HR Department.	YES	Verified.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

b	Whether accident investigation procedure is documented?	YES	Accident data available at Safety and HR Department.	YES	Verified.
c	Whether accident investigation reports are submitted to top management?	YES	Accident data available at Safety and HR Department.	YES	Verified.
d	How are the findings from accident investigation reports communicated to workers?	YES	Through mail & training and discussed in safety committee.	YES	Verified.

C-23.3 Analysis of Accidents

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Whether accident analysis is done as per IS 3786?	YES		YES	Accident analysis to be done as per IS 3786
b	Whether root causes of accidents are analyzed?	YES		YES	Procedure for accident / incident / dangerous occurrence reporting & investigation prepared & implemented.
c	Is the accident statistics effectively utilized? If yes, how?	YES	The data is appraised to avoid reoccurrence, for preventive action and to identified the training needs	YES	The accident statistics to be utilized effectively.

	THIRD PARTY SAFETY AUDIT – GFL, DAHEJ		
	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

- Note: IP of machine is captured by the browser of client machine.IP is depends upon the Internet Service Provider.

d	What nature of injuries occurred during the last five years?	YES	Soft tissue injuries, Sprain Injuries and Slip-Trip types of injuries.	YES	Complied.

C-23.4 Implementation of Recommendations

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	How does the management ensure implementation of the recommendations to avoid recurrence of accidents and incidents?	YES	By discussion, inspection, different types of safety reports, safety Audit and CAPA	YES	Complied.

C-23.5 Reporting and Investigation of Near-miss Incidents

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are all near-miss incidents reported and investigated?	YES	Data Maintained.	YES	Verified.

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	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

- Reply to Closure dated 03.01.2025 with annexures Uploaded in XGN on 13/01/2025 17:01:10 from IP No: 172.16.31.15.

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THIRD PARTY SAFETY AUDIT

b	Is there any system of classifying and analyzing the near-miss incidents?	YES		YES	Complied.

C-24.1 Site Specific Details

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Are the site area maps (including layout, access roads and assembly points) available in control room / emergency control center?	YES		YES	Complied.

C-24.2 Duties and Responsibilities of Key Personnel

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Is the hierarchy of emergency response personnel right from site emergency controller downward, and alternative officials identified?	YES	Organogram Available	YES	Complied.

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B	Are the duties and responsibilities assigned to the designated officials during emergency, both during and outside normal working hours clearly identified and understood by them?	YES	Covered in OSEP	YES	Verified.

C-24.3 Identification of Emergencies and Accident Scenario

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are the possible accident scenarios leading to emergency identified and known to the operating personnel?	YES	Covered in OSEP	YES	Verified.
b	Are approved emergency preparedness plans (on- site and off-site) in place?	YES	Covered in OSEP	YES	On-site plan is available.

C-24.4 Declaration and Termination of Emergency

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is the list of designated officials who are to be communicated about declaration and	YES	Covered in OSEP	YES	Verified.

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	termination of emergency available in the control room / emergency control center?				
b	Are the methods of communication (siren, public address system etc.) for declaration and termination of an emergency known to all the workers?	YES	Covered in OSEP	YES	Verified.

C-24.5 Resources-evacuation / Transport

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are the following resources (equipment, personnel and procedures) required to handle emergency available?	YES		YES	Complied.
1	Communications,	YES	PA system, telephone, Mobile	YES	Complied.
2	Public announcement systems	YES		YES	Complied.
3	Monitoring of hazardous releases into the environment,	YES	Portable multiple gas detector is available,	YES	Complied.
4	Emergency shelters at the facility,	YES		YES	Complied.

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5	Emergency exits with proper illumination, with uninterrupted power supply ,	YES	Emergency exits with proper illumination, with uninterrupted power supply is provided.	YES	Complied.
6	Direction for emergency exit / escape route marked in haulage / Alleyways,	YES	Evacuation plan is available and displayed.	YES	Complied.
7	Transport for evacuation of plant personnel,	YES		YES	Complied.
8	Medical care including administration of antidotes, and	YES	Antidotes details available at OHC.	YES	All antidotes are available.
9	Security / maintenance of law and order.	YES	Training given.	YES	Complied.

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C-24.6 Communication Facilities

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Does the emergency control center have direct communication links with the fire station and the plant control room?	YES		YES	Complied.
b	Are there adequate alarm points from which an emergency alarm can be raised?	YES		YES	Complied.
c	Is there infrastructure available for ensuring backup electric power supply for communication links where required	YES	UPS system available, DG set available	YES	Complied.

C-24.7 Medical Care

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is the procedure for emergency medical care available?	YES		YES	Complied.

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b	Whether the system has been tested at regular frequency through mock drill / exercises for its adequacy?	YES	Quarterly mock drill conducted. Record available	YES	Verified.
c	Does the system of periodic replacement of antidotes and medicines required in emergency exist?	YES	Replacement done as per expiry dates	YES	Complied.

C-24.8 Updation of Emergency Plan

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is the emergency plan updated based on the feedback from the periodic drills / exercises?	YES	On-site Emergency Action Plan is updated.	YES	Complied.
b	Are the contact details of all concerned officials kept updated in the emergency plan?	YES	On-site Emergency Action Plan is updated.	YES	Complied.



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DOCUMENT ID

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C-24.9 Periodic Drills / Exercises

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	CLIENT REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Are mock-exercises conducted at stipulated intervals?	YES	Quarterly on difference scenarios	YES	Complied.
b	Are the scenarios varied in the mock-exercises to ensure that all possible factors including meteorological conditions, affected plant personnel covered?	YES		YES	Complied.
c	Whether emergency preparedness Plans have been tested and reviewed at regular frequency through mock drill for its adequacy	YES		YES	Complied.

C-24.10 Training of Plant Personnel

SR. NO.	ATTRIBUTE	AUDITEE INPUTS (Y/N)	AUDITEE REMARK	AUDITOR INPUTS (Y/N)	AUDITOR REMARK
a	Are the plant personnel trained in handling emergency equipment?	YES	Training given on regular basis.	YES	Complied.

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	DOCUMENT ID	TPSA/GFL/2324/1003	
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C-24.11 Public Awareness Programmes

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	AUDITEE REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are public awareness programs conducted for the people around the site regarding the actions to be taken in case of off-site emergency?	YES		YES	Complied.

C-24.12 Mutual-aid Programme

SR. NO.	ATTRIBUTE	AUDITEE INPUTES	AUDITEE REMARK	AUDITOR INPUTES	AUDITOR REMARK
a	Are the types of accidents where external organizations would be involved in remedial actions identified? Are their responsibilities defined?	YES	Covered in OSEP	YES	Verified.
b	Is the plant responsible for rendering mutual aid assistance to any other external organizations? Does this assistance effect the plant's emergency preparedness?	YES	No it doesn't affect the plant's emergency preparedness	YES	Complied.

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	REVISION NO.	00	

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c	Whether the communication channels for mutual assistance identified and known with and between two organizations?	YES	Communication channels for mutual assistance identified and known with and between two organizations.	YES	Complied.

C-24.13 Emergency Control Centre

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is the emergency control center located beyond the effective distances of identified emergency scenarios?	YES	Emergency control center located beyond the effective distances of identified emergency scenarios. ECC located at Gate beyond the effective distances of any identified emergency scenarios.	YES	Complied.
b	Is the emergency control center located beyond the effective distances of identified emergency scenarios?	YES	ECC located at Gate beyond the effective distances of any identified emergency scenarios.	YES	Complied.



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THIRD PARTY SAFETY AUDIT

C-25 SAFETY INSPECTION

C-25.1 Inspection Programme

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are checklists available for inspections? For example availability of checklists like: a) Handling, Storage and Transportation of hazardous chemicals; b) Electrical hazards; c) Fire safety; d) Hand and portable power tools; e) Machine hazards; f) Lifting equipment; g) Ladders and scaffolding; h) Environmental Monitoring; j) Civil structure; k) Housekeeping; m) Emergency equipment; and n) Gas cylinder and other pressure vessels used / available in the organization	YES		YES	Complied.

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	DOCUMENT ID	TPSA/GFL/2324/1003	
	REVISION NO.	00	

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C-25.2 Safety Related Deficiency (SRD) Report

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are SRDs generated based on the area wise checklists?	YES	Process related and plant related deviation reported	YES	Complied.
b	What is the procedure for resolving the SRDs?	YES	Sheet maintained/ checklist available. (standard format is available)	YES	Verified.
c	Whether the procedure exists for notification and root cause analysis of non-conformities and action taken on them?	YES		YES	Complied.

C-25.3 Safety Inspection Records

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Are the safety inspection records maintained?	YES	Records available.	YES	Complied.

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C-25.4 Methodology and Inspection Team

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	Is there written procedure for safety inspection?	YES	Data available.	YES	Complied.
b	Whether safety inspection is carried out by a designated team?	YES	EHS department team done these jobs with help of concerned department HOD	YES	Complied.
c	What is the frequency of safety inspections?	YES	Every Month	YES	Complied.
d	Whether an inspection report is generated?	YES	Records available.	YES	Complied.

C-25.5 Compliance of Recommendations

SR. NO.	ATTRIBUTE	AUDITEE INPUTES (Y/N)	CLIENT REMARK	AUDITOR INPUTES (Y/N)	AUDITOR REMARK
a	To whom the recommendations are submitted	YES	To concern area In-charge	YES	Complied.
b	Are recommendations of safety inspections complied in time?	YES	Complied on time and Record available.	YES	Verified.

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c	Is compliance of recommendations sent to top management?	YES	Record available	YES	Verified.
d	Is compliance of recommendations reviewed by safety committee?	YES	Record available	YES	Verified.
e	Does top management follow-up the compliance?	YES	Record available	YES	Verified.



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END OF REPORT



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HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT



Gujarat Fluorochemicals Limited

Dahej, Gujarat



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	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Client: Gujarat Fluorochemicals Limited

Project: Hazard and Operability Study Review for CMS-1 Plant

Project No.: 24-728.01.620-gfl-dhj-hazop



09-01-2025	A	Draft Report	SS	SS	YSG	
Date	Rev	Remarks / Revision Summary	Prepared	Checked	Approved	Approved By
			HSE RMSPL			Client
REVISION RECORDS						

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

DISCLAIMER

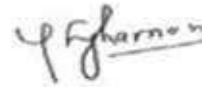
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ACKNOWLEDGEMENT

We express our sincere thanks to management & employees of “Gujarat Fluorochemicals Limited” for their co-operation and unstinted help without which the study & report on “**HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT**” could not have been possible. The courtesy extended to our team is highly appreciated.

For HSE RMSPL



AUTHORISED SIGNATORY

 GUJARAT FLUORO-CHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Strategies with One Solution	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Contents

DISCLAIMER.....	3
ACKNOWLEDGEMENT	4
LIST OF FIGURES.....	6
LIST OF TABLES	6
ABBREVIATIONS	7
EXECUTIVE SUMMARY	8
CONCLUSION	10
1. INTRODUCTION	11
1.1. COMPANY PROFILE.....	11
1.2. OBJECTIVE.....	11
1.3. SCOPE	11
1.4. PROCESS DESCRIPTION.....	12
2. HAZOP METHODOLOGY	14
2.1. HAZOP Concept	14
2.2. HAZOP Process	14
2.3. HAZOP Steps	14
2.4. Philosophy – Hazard v/s Operability Study	16
2.5. Definitions.....	17
3. Guidelines	19
3.1 Deviation.....	19
3.2 Software Used	19
3.3 Risk Matrix.....	20
3.4 Assumptions	23
3.5 Cautions.....	24
3.6 List of Participants	25
4. STUDY ELEMENT.....	26
4.1. NODE LIST	26
4.2. HAZOP Recording	29
5. RECOMMENDATIONS.....	29
6. REFERENCES	30

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

APPENDIX – A.....	31
HAZOP REVIEW WORKSHEET.....	31
(NUMBERS OF SHEETS-265).....	31
APPENDIX – B	32
P&IDS	32
(Number of P&ID-30)	32
APPENDIX – C	33
ATTENDANCE SHEET	33
(NUMBER OF SHEET - 1)	33

LIST OF FIGURES

Figure 2.3-1 HAZOP Methodology Flow sheet	16

LIST OF TABLES

Table 3-1 List of Assumptions.....	23
Table 4.1-1 List of Node	26
Table 5-1 List of HAZOP recommendations	29

 GFL GUJARAT FLUOROCHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Prepared with Care & Precision	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

ABBREVIATIONS

HAZOP Study	Hazard and Operability Study
MSDS	Material Safety Data Sheet
NA	Not Applicable
P & ID	Piping & Instrumentation Diagram
PPE	Personal Protective Equipment
PFD	Process Flow Diagram
SOP	Standard Operating Procedures
DCS	Distributed Control System
NRV	Non-Return Valve

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

EXECUTIVE SUMMARY

Upon request, a Hazard and Operability Study Review (HAZOP Study) was carried out for Gujarat Fluorochemicals Limited 'CMS-1 Plant'.

The objective of the study was to identify and evaluate potential hazards and operability problems and concerns and, where possible, develop recommendations for the mitigation or elimination of such identified issues or concerns. The purpose of a HAZOP is to identify hazards and operability related concerns (and not necessarily to solve them) and this was kept foremost in the minds of the members of the multidisciplinary team.

The detailed HAZOP worksheets are presented in Appendix-A. These provide a complete record of the deliberations.

The HAZOP study was based on typical project P&IDs (see Appendix-B) provided by Gujarat Fluorochemicals Limited.

This report consists of findings from HAZOP Study for the Project activity. This HAZOP Review session was conducted on 07/01/2025 on the MS Teams. The session was chaired by Mr. Yashpal Singh & Sarvesh Sharma and Scribed by Miss Shalini Singh in presence of multidisciplinary teams from Gujarat Fluorochemicals Limited. Brainstorming session was conducted with constructive participation and contribution by all team members.

There were **30 P&ID** that were undertaken for HAZOP Study, in which total **31 nodes** were decided, **567 deviations** were listed, **601 Causes** were identified with respect to which **437 Consequences** were analyzed and concluded with **110 numbers of recommendation**

The HAZOP study was conducted using **PHA Pro version 8 Software**.

HAZOP Study for 'CMS-1 Plant' is carried out.

Risk Ranking is evaluated in two Levels

- Risk Ranking Carried with Safeguard
- Risk Ranking Carried after Recommendation

Risk Class	With Safeguards	With Recommendations
1-3	7	11
4-9	306	62
10-12	9	0
16-25	5	0
No Hazardous Consequence	110	364
Total	15	15

Team discussed and agreed to perform the HAZOP study based on **31 nodes** for the project scope of work.

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Place(s) Used	Recommendations	Responsible Person / Dept	Priority	Status
Cat: 1.1.29.1.1.1	1. Perform regular sampling of Hot Oil for Methanol content to identify tube leakage	Process	R3	Closed
Cat: 1.2.22.1.1.1	2. Review the Chemical compatibility of Hot Oil at supply temperature with HCL	Process	R3	Closed
Cat: 1.6.21.1.1.1	3. Review closed sampling system from V-2105 bottom valve	Technical Cell	R3	Open
Cat: 1.9.17.1.1.1	4. Regular sampling (once on two weeks) of methanol to check for MDC content	Process	R3	Closed
Cat: 1.13.44.1.1.1	5. Regular inspection of all RDs	Engineering	R1	Closed
Cat: 1.15.47.1.1.1	6. Regular planned inspection of tubes.	Engineering	R3	Closed
Cat: 1.16.11.1.2.1, 1.16.11.2.2.1, 1.16.22.1.2.1, 1.16.35.1.2.1, 1.16.36.1.2.1	7. Ensure system is in place as part of Onsite Emergency Response plan to control & contain gaseous mixture at Incident location (like use of multiple fire water monitors and multiple Mayura curtains), thereby minimizing onsite and offsite environment impact to minimum level	Process / Safety	R4	Closed
Cat: 1.16.21.1.1.1	8. Provide PAH on steam line set at 9 kg/cm ²	Technical Services	R2	Open
Cat: 1.16.21.1.1.1, 1.16.37.1.1.1	9. Provide high Pressure alarm on PIC 2832, set point to be kept at level not exceeding normal operating pressure T- 2202 bottom	Inst	R2	Closed
Cat: 1.16.28.1.1.1	10. Recommended to close LV-2212 on LALL	Inst	R3	Closed
Cat: 1.16.36.1.1.1, 1.16.36.1.2.1	11. Identify PSM Critical equipment list and develop MI Program	Engineering	R3	Closed
Cat: 1.16.36.1.1.1, 1.16.36.1.2.1	12. Ensure Comprehensive MIQA plan	Engineering	R3	Closed

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Place(s) Used	Recommendations	Responsible Person / Dept	Priority	Status
Cat: 1.28.27.1.1.1	13. Prevent Exposure of T-2404 to direct sunlight.	Process	R3	Closed

Legend: Place(s) used for recommendations are given references for easy reference as mentioned below: E.g.: 1.1.2.3.4

1st digit indicates the Project; 2nd digit indicates the Node;

3rd digit indicates the Deviation; 4th digit indicates the Causes;

5th digit indicates the consequences

CONCLUSION

HAZOP Study were performed for the CMS-1 Plant at Gujarat Fluorochemicals Ltd., As per the IEC 61882:2001 "Hazard and operability studies (HAZOP studies) - Application guide. This study concluded with a total of 110 recommendations.

Close all the recommendations, i.e., the 110 recommendations outlined in Section 5, within the defined time period.

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

1. INTRODUCTION

1.1. COMPANY PROFILE

GFL is a leading producer of Fluoropolymers, Fluorospecialities, Refrigerants and Chemicals for applications in varied industries. GFL derives its strength from expertise in Fluorine Chemistry, vertical integration from natural minerals to Fluoropolymers and strong R&D, enabling it to provide one of the best quality products meeting all regulatory compliances, to our clientele globally.

The year 1989 marked commencement of Company's commercial operations with India's largest Refrigerant manufacturing unit at Ranjitnagar, Gujarat, India. The site was further expanded to produce Fluorospeciality products catering to the growing demands in global agriculture and pharmaceutical industry. Foraying into new avenues in 2007, with one of the world's most integrated facilities at Dahej, Gujarat, India, GFL now has a diverse portfolio of Fluoropolymers comprising PTFE, PFA, FEP, FKM, PVDF and Fluoropolymer Additives.

With three manufacturing facilities in India, a captive Fluorspar mine in Morocco, offices and warehouses in Europe and USA, and a marketing network spread across the world, GFL is one of the established players in Fluoropolymers and Fluorospecialities markets.

GFL Sustainability goals are interwoven with the way we do business all along our value chain. The company is signatory to the United Nations Global Compact (UNGC), and is a member of the Indian Chemical Council (ICC). GFL focus on Health, Safety and Environment is reflected in the wellbeing and safety of their people.

1.2. OBJECTIVE

To identify the hazards and Operability problems and to reduce the likelihood and/or Consequence of an incident that would have detrimental impact to the personnel, plant, environment.

1.3. SCOPE

Scope of the Study is limited to CMS-1 Plant located at Gujarat Fluorochemicals Limited, Dahej, Gujarat.

 HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT				
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

1.4. PROCESS DESCRIPTION

S.NO.	Node Description and Intent
1.	Methanol Feed preheating
2.	HCL Feed Preheating
3.	Hydrochlorination Reactor
4.	Hot oil circulation system
5.	Quenching and Dehydrating Section
6.	CH ₃ Cl compressor system
7.	CH ₃ Cl Condenser and transferring system
8.	21% HCL Tank System
9.	Methanol Storage
10.	Chlorine vapor from vaporizer to R-2201
11.	CH ₃ CL evaporator E-2201
12.	CH ₃ Cl feed preheater to Reactor R-2201
13.	-Thermal Reactor section -Emergency vessel -Quenching tower and heating system
14.	Condensation and recycle section
15.	Condensation and recycle section
16.	Recycle column system
17.	Distillation system
18.	CH ₂ Cl ₂ Azeotrope system
19.	CHCl ₃ distillation
20.	CHCl ₃ Azeotrope system
21.	CH ₂ Cl ₂ Check Tank

 GFL GUJARAT FLUORO-CHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Engaging with Our Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

S.NO.	Node Description and Intent
22.	CHCl ₃ Check Tank
23.	Residue system
24.	CCl ₄ Distillation system
25.	CCl ₄ Drying and Product checking system
26.	HCl Absorber System
27.	Organic Stripper System
28.	HCL Scrubber System
29.	31% HCl tank system
30.	Cold CH ₂ Cl ₂ system
31.	Sulfuric acid tanks system

 HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		
	HSE ref. no.	Doc. No.
	728.01.620	728.01.620-RP-HAZOP-CMS-1
	Rev.	Date
	A	09/01/2025

2. HAZOP METHODOLOGY

2.1. HAZOP Concept

The HAZOP process is based on the principle that a team approach to hazard analysis will identify more problems than when individuals working separately combine results. The HAZOP team is made up of individuals with varying backgrounds and expertise. The expertise is brought together during HAZOP sessions and through a collective brainstorming effort that stimulates creativity and new ideas, a thorough review of the process under consideration is made.

2.2. HAZOP Process

The HAZOP team focuses on specific portions of the process called "nodes". Generally, these are identified from the P&ID of the process before the study begins. A process parameter is identified, say flow, and an intention is created for the node under consideration. Then a series of guidewords is combined with the parameter "flow" to create deviations. For example, the guideword "no" is combined with the parameter flow to give the deviation "no flow". The team then focuses on listing all the credible causes of a "No flow" deviation beginning with the cause that can result in the worst possible consequence the team can think of at the time. Once the causes are recorded the team lists the consequences, safeguards and any recommendations deemed appropriate. The process is repeated for the next deviation and so on until completion of the node. The team moves on to the next node and repeats the process.

2.3. HAZOP Steps

The analysis develops through logical exercise by associating guide words and process/safety parameters in order to identify potentially hazardous situations in terms of causes, effects, and countermeasures.

A detailed list of the main steps of the analysis follows, together with a sample of guidewords and process/safety parameters to be used in developing the logical phase of the study. The list of deviations used in this HAZOP Study is listed in Section 2.1.

The following sequence of activities is implemented during the HAZOP Review study:

- Select a Node, which contains an elementary unit of the plant.
- Define the Node design intent and process conditions.
- Apply the first Parameter to the node such as Flow, Pressure, Temperature, Level, Composition, etc.
- Apply suitable Guide Word such as more, less, etc.
- Obtain a meaningful Deviation by combining Guideword and Parameter, e.g., more flow.

 GFL GUJARAT FLUORO-CHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Care	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

- f) Identify the potential and credible Causes associated with the Deviation by brainstorming.
- g) Assess the Consequences of each cause.
- h) Identify Safeguards included in the design to prevent and/or mitigate the hazard.
- i) Agree a Recommendation for action if the existing safeguards are found to be inadequate. If an immediate solution is available and acceptable to the team, the modification is recorded in the HAZOP worksheet and HAZOP master P&ID will be marked up accordingly. Where solutions are unlikely to be derived without a technical evaluation, the Chairman will refer the problem for separate assessment.
- j) Repeat the above procedures to the next guideword (move to step d) until these guidewords have been completed.
- k) Repeat the above procedures to the next parameter (move to step c) until these parameters have been completed.
- l) Move to the next node (go to step a) of the process system. All process systems will be examined this way by the team.

 GFL GUJARAT FLUORO-CHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Engaging with Our Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

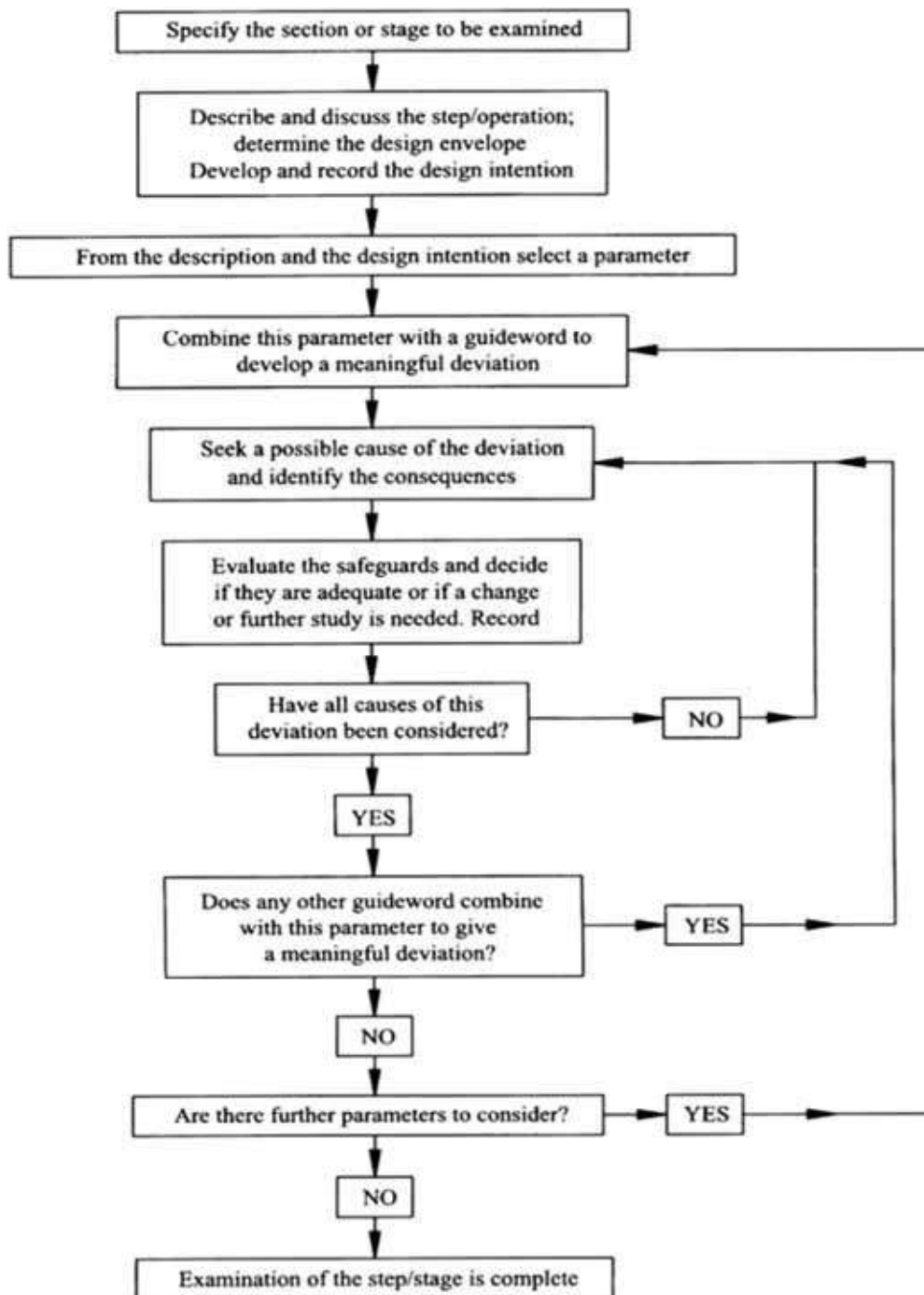


Figure 2.3-1 HAZOP Methodology Flow sheet

2.4. Philosophy – Hazard v/s Operability Study

 GUJARAT FLUOROCHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Care	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

HAZOPs concentrate on identifying both hazards as well as operability problems. While the HAZOP study is designed to identify hazards through a systematic approach, more than 80% of study recommendations are operability problems and are not, of themselves, hazards. Although hazard identification is the main focus, operability problems should be identified to the extent that they have the potential to lead to process hazards, result in an environmental violation or have a negative impact on profitability. A definition of hazard and operability is given below.

2.5. Definitions

Hazard - potential source of harm.

Operability-Any operation inside the design envelope that would cause a shutdown that could possibly lead to a violation of environmental, health or safety regulations or negatively impact profitability.

Study Nodes -The Node is the portion of the plant subject to the study, where single or limited process functions are assigned. The HAZOP Chairman identifies nodes for the comment of the HAZOP team. A reference number will identify the selected node. The team will identify the intention of the node and major process conditions will be recorded.

Even if the nodes will normally include one or more equipment and the connected lines, HAZOP analysis will be based on "line-oriented approach": deviations from normal process parameters will be identified on process lines; equipment issues will be then included as results of the analysis in the cause / consequence identification process.

Parameters -The usual parameters applied to all nodes are Pressure, Temperature and Composition. Additional parameters are Flow, Level, etc. These additional parameters may be required by the nature of each node.

Guidewords- word or phrase which expresses and defines a specific type of deviation from an element's design intent.

Deviations - departure from the design intent.

Specific deviations to be considered due to the peculiarity of a node will be agreed by the HAZOP team and used when required.

Causes- The HAZOP team finds most causes of a deviation using brainstorming. The cause/consequence identification process on a node will be as much "linear" as possible. If no possible causes are identified state "no causes identified" on the HAZOP worksheet and start a new deviation. The most probable causes will be identified and discussed. When not specifically needed, discussions longer than 10 minutes will be avoided. If the HAZOP team is not able to come

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

to an agreement about a cause or a consequence, a note will be taken on the HAZOP worksheet in order to plan further investigation by involved specialists.

Consequences -The potential consequences of each deviation are discussed and assessed within the limits of the information available and the expertise of the team.

The potential consequences threat must be assessed not considering operator or instruments intervention or any mitigation or safeguards. Consequences will be basically focused on possible major effects in terms of health and safety.

Safeguards -HAZOP team will investigate / identify effective safeguards to prevent or control the hazard. The team will discuss if there are adequate levels of protection for the identified hazard and record them on the worksheet.

Recommendations -The HAZOP team will provide recommendations if the existing protective measures are found to be inadequate, so that the situation is improved. If an immediate solution is available and acceptable to the team, the modification is recorded in the HAZOP worksheet and the HAZOP master P&ID will be marked up accordingly. Where solutions are unlikely to be derived without a technical evaluation, the Chairman will refer through a recommendation the problem for separate assessment. Resulting modifications (recommendations) will be evaluated during the HAZOP Follow-Up activities.

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

3. Guidelines

The HAZOP Study was carried as per IEC 61882:2001 "Hazard and operability studies (HAZOP studies) - Application guide".

3.1 Deviation

The applicable guidewords were finalized based on the system characteristics and HAZOP Leader's experience. List of deviations that have been used during this HAZOP Study workshop:

1. No/Less flow
2. More flow
3. Reverse flow
4. Misdirected Flow
5. As well as Flow
6. More Pressure
7. Less Pressure
8. High level
9. Low level
10. More Temperature
11. Less Temperature
12. More/ Less Viscosity/pH
13. Other Than Flow/ Contamination/ Composition/ Concentration
14. Less / No Agitation
15. Utility Failure
16. Power Failure
17. Mechanical Failure / Leakage
18. Startup/Shutdown Hazards
19. Incompatible fluid (Reactor vessel / jacket, seal, HE etc.)
20. Fire / Explosion Personal Protection Hazards
21. Personal Protection Hazards
22. Others

3.2 Software Used

The HAZOP Session was documented using Process Hazard Analysis Software (PHA Pro v8), which aligns with industry Standard. All recommendations were recorded in the worksheets. The

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

worksheets were projected onto a screen to allow the team to monitor progress and to facilitate agreement on the information recorded.

3.3 Risk Matrix

Evaluation and assessment of risk are carried out by taking both potential consequence of the hazard and the frequency of the hazard into considered. The frequency & consequence are qualitatively assessed using the risk matrix provided below:

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT				
				HSE ref. no.	Doc. No.
				728.01.620	728.01.620-RP-HAZOP-CMS-1
		Rev.	Date		
		A	09/01/2025		

Consequence				Risk Assessment Matrix (Risk Ranking = Consequence Rating x Probability Rating)				
Rating	People Injury	Asset Losses (INR)*	Environment Impact*	Reputation*	5	4	3	2
5	Multiple Fatality	Business interruption more than 1 months or Loss of > Rs.500 Lakh	Release causing impacts that justifies interrupting operations for an extended period of time or with potential human health or ecological impacts Significant agency action that limits operations	External reputation irreversibly damaged	10	15	20	25
4	Single Fatality or multiple Lost Work Day Case (LWC)	Business interruption less than 1 month or Loss of Rs.100-500 Lakh	Release causing measurable impact(s) on ecological receptors and/or the public Regulatory response including investigation	External reputation severely damaged, considerable efforts & expenses required to recover.	8	12	16	20
3	Lost Workday Case (LWC)	Business interruption less than one week or Loss of Rs.50-100 Lakh	Reportable release to the environment Regulatory response including orders, Violations, and/or fines	External reputation damaged, Some effort & expense required to recover	6	9	12	15
2	Medical treatment Case (MTC)	Business interruption less than one shift or Loss of Rs.10-50 Lakh	Non Reportable release to the environment Regulatory response excluding orders, Violations, and/or fines.	External reputation minimally affected, little effort or expense required to recover	4	6	8	10
1	Minor/ First aid injury	No Business interruption or Loss of < Rs.10 Lakh	Localized release contained within the building No regulatory exceedance	External reputation not affected, No effort or expense required to recover	2	3	4	5
Probability				1	2	3	4	5
				Highly unlikely Never Heard of in the Industry	Unlikely Heard in Industry 10 ⁻¹ -10 ⁻² /yr.	Possible Happened in the Org. 10 ⁻² -10 ⁻³ /yr.	Likely Happened at the Site >10 ⁻³ /yr.	Almost Certain Has happened at the site >1/yr.

 GUJARAT FLUOROCHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			 Prepared with Care & Precision	
	HSE ref. no.	Doc. No.		Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1		A	09/01/2025

1	Level 1	16 to 25	Intolerable	Develop recommendations to bring risk level immediately to level 3 or 4
2	Level 2	10 to 12	Undesirable (Needs Action)	Develop recommendations to bring risk level to 3 or 4
3	Level 3	4 to 9	Tolerable with controls	Team may suggest recommendations to bring risk level to 4
4	Level 4	1 to 3	Tolerable As is	Opportunity for improvement

SEVERITY CRITERIA				
Rating	People Injury	Asset Losses (INR)*	Environment Impact*	Reputation*
5	Multiple Fatality	Business interruption more than 1 months or Loss of > Rs.500 Lakh	Release causing impacts that justifies interrupting operations for an extended period of time or with potential human health or ecological impacts Significant agency action that limits operations	External reputation (Irreversibly) damaged
4	Single Fatality or multiple Lost Work Day Case (LWC)	Business interruption less than 1 month or Loss of Rs.100-500 Lakh	Release causing measurable impact(s) on ecological receptors and/or the public Regulatory response including investigation	External reputation severely damaged, considerable efforts & expenses required to recover.
3	Lost Workday Case (LWC)	Business interruption less than one week or Loss of Rs.50-100 Lakh	Reportable release to the environment Regulatory response including orders, Violations, and/or fines	External reputation damaged, Some effort & expense required to recover
2	Medical treatment Case (MTC)	Business interruption less than one shift or Loss of Rs.10-50 Lakh	Non-Reportable release to the environment Regulatory response excluding orders, Violations, and/or fines.	External reputation minimally affected, little effort or expense required to recover
1	Minor/ First aid injury	No Business interruption or Loss of < Rs.10 Lakh	Localized release contained within the building No regulatory exceedance	External reputation not affected, No effort or expense required to recover

 GUJARAT FLUORO-CHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

LIKELIHOOD CRITERIA		
	Score	Probability
Highly Unlikely	1	Never heard of in the industry
Unlikely	2	Heard in the industry 10^{-3} to 10^{-4} /yr
Possible	3	Happened in the organization 10^{-2} to 10^{-3} /yr
Likely	4	Happened at the site $>10^{-2}$ /yr
Almost Certain	5	Has happened at the site >1 /yr

3.4 Assumptions

Table 3-1 List of Assumptions

Sr. No.	Assumption	Place used
1.	Workers and operators are trained and experienced to operate the plant safely.	Entire report
2.	All the PIDs used in this HAZOP Study are latest and updated	Entire report

Category for Classifying Flammable Material:

Flammable Liquids vary in volatility and have a flash point below 93°C and a Vapor Pressure not exceeding 2.81 kg/cm^2 at 37.8°C . These are divided into three classes, as follows,

Class A: Flammable liquids having flash point below 23°C

Class B: Flammable liquids having flash point 23°C and above but below 65°C

Class C: Flammable liquids having flash point 65°C and above but below 93°C

Category for Classifying Toxic Material:

Chemicals having the following values of acute toxicity and which owing to their physical and chemical properties, are capable of producing major accident hazards:

 GUJARAT FLUOROCHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Sr. No	Degree of toxicity	(Medium lethal by the oral route toxicity) LD 50 (mg/kg body weight of test animals)	Medium lethal by the normal (dermal LD 50 body weight of test animals)	Medium lethal concentration by Inhalation route (Four hours) LC 50 (mg/1 Inhalation in test animals)
a)	Extremely toxic	1 – 50	1 – 200	0.1 - 0.5
b)	Highly toxic	51 – 200	201 – 2000	0.5 - 2.0

Category for Dust Explosion Test

No fire or explosion	St _{0H}
Dust fire or mild explosion	St _{1H}
Violent explosion	St _{2H}

Classification by Burning Test

No spreading of Fire	No ignition	1
	Brief ignition, rapid extinction	2
	Localized combustion or glowing without flame	3
Fire spreads	Glowing without sparks	4
	Slow quiet burning with flames	5
	Very rapid combustion	6

Specific Powder (Bulk) Resistivity:

Observation (Resistivity)	Inference
<10 ⁸ ohm.m	Conductive
10 ⁸ -10 ¹⁰ ohm.m	Moderately Conductive
>10 ¹⁰ ohm.m	Resistive

3.5 Cautions

Even the most rigorous HAZOP cannot be relied upon to foresee every hazard and some accidents may well occur in the future. When an incident occurs on a plant which has undergone a HAZOP study, several questions of particular significance should be asked:

- had the set of conditions (deviations) which led to the incident been considered by the HAZOP study team? If not, could the team reasonably have been expected to have done so? and

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

- if such deviations and their causes had been considered, had the team made a reasonable judgment of the likely frequency of the events and had concluded that they were unlikely to occur and thus posed 'acceptable risks'?

In such circumstances it is clearly important to document all the outcomes of study in order to answer these questions.

HAZOPs are an essential tool for hazard identification and have been used successfully to improve the safety and operability of both new and existing chemical plant. The technique is not confined to the chemical and pharmaceutical industries and has also been used successfully in several other industries, including the offshore oil and food industries.

3.6 List of Participants

The HAZOP Study members consisted of representative of Gujarat Fluorochemicals Limited. The HAZOP Study was chaired by independent chairman along with Scribe, engaged by HSE Risk Management Services Private Limited on 07/01/2025. Attendance Sheet is attached as Appendix-C for Reference.

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

4. STUDY ELEMENT

4.1. NODE LIST

The Node list for the HAZOP Study is shown in Table 4.1

Table 4.1-1 List of Node

Node	Node Description and Intent	List of P&IDs	Major Equipment
32.	Methanol Feed preheating	1308-7001-L102	E-2102 and E-2104
33.	HCL Feed Preheating	1308-7001-L102	E-2103
34.	Hydrochlorination Reactor	1308-7001-L103	R-2101
35.	Hot oil circulation system	1308-7001-L103	P-2102A/B/C, E-2107, R-2101 shell, S-2101, V-2102, Y-2101, V-2108
36.	Quenching and Dehydrating Section	1308-7001-L104	T-2101, S-2103, E-2108, S-2101, S-2102, D-2101, T-2104, D-2102, P-2106A/B, E-2113
37.	CH ₃ Cl compressor system	1308-7001-L106 Sht-1 of 2 and 1308-70	V-2105, C-2101A/B and V-2107
38.	CH ₃ Cl Condenser and transferring system	1308-7001-L107	E-2115, V-2106A/B, S-2104, E-2116-1, E-2116-3, P-2107A/B, E-2118
39.	21% HCL Tank System	1308-7001-L105 1308-7001-L406	E-2110A/B, V-2403A/B, P-2403A/B
40.	Methanol Storage	1308-7001-L101	V2101A/B, P-2101A/B, P-2109, E-2101
41.	Chlorine vapor from vaporizer to R-2201	1308-7001-L201	V-2206, M-2201

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Node	Node Description and Intent	List of P&IDs	Major Equipment
42.	CH ₃ CL evaporator E-2201	1308-7001-L201	E-2201,D-2201
43.	CH ₃ Cl feed preheater to Reactor R-2201	1308-7001-L201	E-2202A/B
44.	-Thermal Reactor section -Emergency vessel -Quenching tower and heating system	1308-7001-L202	-R-2201,Y-2201 -V-2201 -T-2201, E-2212A/B,V-2205A/B,
45.	Condensation and recycle section	1308-7001-L203	-E-2203, E-2204,D-2202, V-2202, P-2201A/B/C, P-2203A, S-2201, S-2202,E-2211
46.	Condensation and recycle section	1308-7001-L203 1308-7001-L204	E-2205,E-22022,E-2203 S-2203,V-2203,P2202A/B
47.	Recycle column system	1308-7001-L205 1308-7001-L203	T-2202,E-2206,E-2207,E-2208,E-2209,V-2204,P-2204B
48.	Distillation system	1308-7001-L203	S-2306, V-2301,P-2301A/B, T-2301-1, T-2301-2,P-2312A/B, E-2301,E-2302,E-2303,E-2304,E-2305,E-2306,S-2301
49.	CH ₂ Cl ₂ Azeotrope system	1308-7001-L303	E-2311,S-2302,E-2307,E-2312,P-2303A/B,P-2304A/B,E-2309,T-2302,E-2308
50.	CHCl ₃ distillation	1308-7001-L-304	S-2307,V-2304,E-2318,T-2303-1,T-2303-2P-2313A/B,E-2315A,E-2314A/BP

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Node	Node Description and Intent	List of P&IDs	Major Equipment
51.	CHCl ₃ Azeotrope system	1308-7001-L-306	E-2322,E-2319,S-2304,P-2308A/B,T-2304,E-2320,E-2321
52.	CH ₂ Cl ₂ Check Tank	1308-7001-L-307	V-2302A/B,P-2305A/B,Dryer,E-2310
53.	CHCl ₃ Check Tank	1308-7001-L-308	V-2305A/B,P-2310A/B,E-2323
54.	Residue system	1308-7001-L-310	V-2310A/B,P-2317A/B,V-2307,P-2311A/B
55.	CCl ₄ Distillation system	1308-7001-L311 2308-7001-L312	T-2305,V-2308A/B,E-2325,P-2316A/B, E-2326A/B/C, S-2305 ,E-2327, P- 2314A/B
56.	CCl ₄ Drying and Product checking system	1308-7001-L313 1308-7001-L314	E-2331, S-2308,P-2318A/B, P-2319A/B, S-2309A/B, V-2311A/B,P-2320A/B,E-2332
57.	HCl Absorber System	1308-7001-L401	E-2401,E-2402,V-2401,P-2401A/B
58.	Organic Stripper System	1308-7001-L402	T-2402,T-2403,E-2403,D-2401
59.	HCL Scrubber System	1308-7001-L403	T-2404, P-2405A/B/C, V-2405, E-2406
60.	31% HCl tank system	1308-7001-L405	V-2402A/B/C, N-V-2402D, P-2402A/B, V-2404, P-2404A/B, T-2401
61.	Cold CH ₂ Cl ₂ system	1308-7001-L822	E-2821-1,E-2821-3,P-2821A/B,V-2822
62.	Sulfuric acid tanks system	1308-7001-L407	V-2701,V-2702, P-2701, P-2702,P-2706

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
			Rev.	Date
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

4.2. HAZOP Recording

The discussion is recorded on various worksheets according to project sections studied. Information is recorded in columns on the worksheets as follows:

- Deviation;
- Causes;
- Consequences;
- Safeguards;
- Risk Ranking
- Recommendations
- Category

Once identified, it is necessary to analyze the hazard determining whether it poses significant risk and requires risk reduction/mitigation/management. The acceptability of the estimated risk must then be judged based on GFL Risk criteria, considering particular situation.

5. RECOMMENDATIONS

The HAZOP team made its recommendations based on the information available and provided to the team during the study, and on the knowledge and experience of the team members. However, all of the recommendations offered for consideration must be thoroughly reviewed from an engineering and operational viewpoint to ensure that the identified hazard is detected, prevented, or mitigated, and additional hazards are not created by implementing the recommendation.

For more details Refer Appendix A HAZOP Worksheet.

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

6. REFERENCES

- Project documents like P&IDs & SOP
- MSDS of Raw Materials & Product
- IEC 61882:2001 "Hazard and operability studies (HAZOP studies) - Application guide"

 GFL GUJARAT FLUOROCHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Safeguarding with Science	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

APPENDIX – A

HAZOP REVIEW WORKSHEET

(NUMBERS OF SHEETS-282)

 GFL GUJARAT FLUOROCHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Safeguarding with Science	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

APPENDIX – B

P&IDS

(Number of P&ID-30)

 GFL GUJARAT FLUOROCHEMICALS VALUE THROUGH BETTER CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Safety with Style	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

APPENDIX – C

ATTENDANCE SHEET

(NUMBER OF SHEET - 1)

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

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	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Worksheet

Project: 1. HAZOP Study for CMS-1 Plant

Node: 1.

P&IDs: 1308-7001-L102

Node Description and Intent: Methanol Feed preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
1N. 1.	Low/No Flow (E-2104 Tube side)	1. Faulty TT-2103 resulting in fail closure of hot oil return control valve TV-2103	1. No heating of methanol vapors causing low temperature of feed to reactor		2	3	6					
1N. 2.	Low /No flow of methanol to E-2102 shell side	1. Methanol supply pump trip OR Failure closure of LV-2102	1. Boil-up of shell side inventory. However, overpressure is not expected.	Low level alarm LT- 2102	2	3	6					
				Low flow alarm FT-2103								
1N. 3.	Low/No Steam flow to E-2102	1. Shell side PT-2102 faulty or steam header pressure low	1. loss of methanol vaporization and methanol level in E-2102 shell increases.	Level high alarm LT- 2102 resulting in closure of LV-2102	2	3	6					
				low temp alarm at superheater outlet TT- 2103								
				RV-2101								
			1. loss of methanol vaporization and	Level high alarm LT- 2102	2	3	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 1.

P&IDs: 1308-7001-L102

Node Description and Intent: Methanol Feed preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Blocked condensate flow	methanol level in E-2102 shell increases.	resulting in closure of LV-2102 low temp alarm at superheater outlet TT- 2103 RV-2101								
1N. 4.	Low/No feed flow to E-2104 tube side	1. Upstream control valve FV-2104 fails closed	1. Heating to residual methanol continues, no hazard is expected.									
1N. 5.	More flow of CH ₃ OH to E-2102 Shell side	1. LT-2102 on shell side is faulty resulting into failure opening of methanol control valve LV-2102	1. Shell side gets flooded and overpressure due to excess flow of methanol	RV-2101 set pressure is 7.2kg/cm ² High pressure alarm PT- 2102 High flow alarm FT- 2103	2	3	6					
1N. 6.	More flow of hot oil to E-2104 Shell side	1. Faulty TT-2103 on tube side resulting in full opening of hot oil return	1. Overheating of methanol vapors, tube side design temperature 300 °C is more than maximum hot oil									1. Addition al temperature indicator to be

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 1.

P&IDs: 1308-7001-L102

Node Description and Intent: Methanol Feed preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		control valve TV-2103	inlet temp. 250 °C. No hazard expected on E-2104 tube side.									installed on E-2104 possibly for mixed stream i.e. methanol and HCL to detect any abnormality in temperature.
1N. 7.	Reverse flow	1. No credible cause identified										
1N. 8.	Misdirected flow	1. Inadvertent opening of nitrogen valve E-2102 shell side outlet	1. Nitrogen pressure 6kg/cm2g is less than design pressure of E- 2104 tube side 8 kg/cm2g, however, it may overpressure reactor system	1. RD on reactor SS Wire Seal the gate valve on nitrogen line to E- 2102 located near to check	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 1.

P&IDs: 1308-7001-L102

Node Description and Intent: Methanol Feed preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			design at 5.2 kg/cm2g	valve is available								
1N. 9.	As well as Flow	1. No credible cause identified										
1N. 10.	High Temperature	1. No credible cause identified										
1N. 11.	Low Temperature	1. No credible cause identified										
1N. 12.	More Pressure	1. Steam control valve PV- 2102 fails open due to faulty PT- 2102 at E-2102 steam side	1. Excess heating of methanol resulting overpressure of E- 2102 shell side	RV-2101	2	3	6					
				Level low alarm LT- 2102								
				High flow of methanol vapor FT-2104								
1N. 13.	More Pressure	1. FV-2104 on methanol side fails closed	1. Excess vaporization of methanol due to continuation of steam Release of methanol to Atmosphere through RV-2101	RV-2101	3	2	6					
				High Pressure Interlock is provided to cut-off steam control valve								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 1.

P&IDs: 1308-7001-L102

Node Description and Intent: Methanol Feed preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
1N. 14.	Less Pressure	1. No credible cause identified										
1N. 15.	High level	1. No credible cause identified										
1N. 16.	Low level	1. No credible cause identified										
1N. 17.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
1N. 18.	More/ Less pH	1. Not Applicable										
1N. 19.	Agitator Failure	1. Not Applicable										
1N. 20.	Power failure	1. Power failure from grid	1. Plant shutdown	SD-10 interlock								
1N. 21.	Utility Failure-Instrument air	1. Instrument air failure	1. feed and heat input valves are FC	SD-11 instrument air interlock								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 1.

P&IDs: 1308-7001-L102

Node Description and Intent: Methanol Feed preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
1N. 22.	Mechanical Failure / Leakage	1. No credible cause identified										
1N. 23.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
1N. 24.	Startup Hazards	1. No credible cause identified	1.	SOP available for Startup								
1N. 25.	Shutdown Hazards	1. Methanol inlet LV-2102 and outlet valves FV-2104 of E-2102 shell side closed and steam continue	1. Boil-up of shell side inventory. Overpressure of E-2102 Shell side	RV-2101	3	2	6					
				High pressure alarm PT- 2102.								
				Steam cut-off interlock with SD-10 (ESD logic) is available								
1N. 26.	Sampling Hazards	1. No credible cause identified										
1N. 27.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 1.

P&IDs: 1308-7001-L102

Node Description and Intent: Methanol Feed preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
1N. 28.	Others- Tube Leak in E-2102	1. Wear and tear in long run	1. Methanol enters condensate side	Conductivity meter on condensate side	3	2	6					
1N. 29.	Others- Tube Leak in E-2104	1. Wear and tear in long run	1. Methanol enters Hot Oil side	Hot oil expansion tank RV-2103 located on S-2101. RV-2103 set pressure is 2.5kg/cm2	3	2	6	1. Perform regular sampling of Hot Oil for Methanol content to identify tube leakage				

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 2.

P&IDs: 1308-7001-L102

Node Description and Intent: HCL Feed Preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
2N. 1.	Low / No flow to E-2103 tube side	1. Inlet feed control valve FV-2105 fail close due to FT-2105 shows faulty reading	1. HCL overheating in E-2103 tube side	High pressure alarm PT- 2218A present on HCL feed line located in thermal section.	3	2	6					1. Consider P&T compensation for HCL flowmeter FT-2105
				High temp alarm TI- 2102 at E-2103 outlet								
				High pressure alarm PT- 2103 on HCL feed line								
2N. 2.	More Flow to E-2103 tube side	1. Inlet feed control valve FV-2105 fail opens due to FT-2105 shows faulty reading	1. High flow to reactor	Low pressure alarm PT- 2103 on HCL feed line	3	2	6					
				Low temp alarm TI- 2102 on HCL supply line								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 2.

P&IDs: 1308-7001-L102

Node Description and Intent: HCL Feed Preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
2N. 3.	Reverse flow	1. No credible cause identified										
2N. 4.	Misdirected Flow	1. No credible cause identified										
2N. 5.	As well as Flow	1. No credible cause identified										
2N. 6.	High Temperature	1. No credible cause identified										
2N. 7.	Low Temperature	1. No credible cause identified										
2N. 8.	More Pressure	1. No credible cause identified										
2N. 9.	Less Pressure	1. No credible cause identified										
2N. 10.	High level	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 2.

P&IDs: 1308-7001-L102

Node Description and Intent: HCL Feed Preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
2N. 11.	Low level	1. No credible cause identified										
2N. 12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
2N. 13.	More/ Less pH	1. Not Applicable										
2N. 14.	Agitator Failure	1. Not Applicable										
2N. 15.	Power failure	1. Power failure from grid	1. Plant shutdown									
2N. 16.	Utility Failure- Process Water/ Process Air	1. No credible cause identified										
2N. 17.	Mechanical Failure / Leakage	1. No credible cause identified										
2N. 18.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 2.

P&IDs: 1308-7001-L102

Node Description and Intent: HCL Feed Preheating

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
2N. 19.	Startup/Shutdown Hazards	1.	1.	SOP available for Startup/Shutdown								
2N. 20.	Sampling Hazards	1. Not Applicable										
2N. 21.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
2N. 22.	Others- Tube Leak in E-2103	1. Wear and tear in long run	1. HCL enters Hot Oil side	Hot oil expansion tank RV-2103 located on S-2101.	3	2	6	2. Review the Chemical compatibility of Hot Oil at supply temperature with HCL				
				RV-2103 set pressure is 2.5kg/cm2								
2N. 23.	Others- Materials of construct	1. High temperature difference between inlet and outlet side of E-2103 tube side (HCL)	1. Exchanger dome needs replacement every year									1. Review the design of an exchanger for temperature shock

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
3N. 1.	Low / No flow of HCL	1. Inlet feed control valve of E-2103 tube side FV-2105 fail closed due to FT-2105 shows faulty reading Or Inlet feed control valve of E-2103 tube side PV-2218A fail closed due to PT-2218A faulty	1. Reaction stops in reactor, excess methanol carry over to downstream absorber system. Possible condensation of methanol in downstream cooler E-2108. Absorption of methanol in 21% acid in S-2103.	low flow alarm FT-2105 on inlet of E-2103 HCL feed	3	2	6					
				Low temperature alarm TI-2113 and TI-2114 on reactor outlet								
				Acid sampling at S-2103 at regular shift								
				Low pressure alarm PT-2103 on HCL feed line (E-2103 Tube side)								
				High temp alarm TI-2102 on HCL supply line (E-2103 Tube side)								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
3N. 2.	Low flow of Methanol	1. LT-2102 on shell side of E-2102 is faulty resulting into fails close of methanol control valve LV- 2102	1. Reactor outlet temp. starts dropping. Also, Excess unreacted HCL goes to reactor downstream quenching system (T-2101) resulting in increasing concentration of HCL	High pressure alarm PT-2103 on HCL feed line (E-2103 Tube side)	3	2	6					
				Low temp alarm TI-2102 on HCL supply line (E-2103 Tube side)								
				Low temperature alarm TI-2113 and TI-2114 on reactor outlet								
				PS-2117 (Located at E-2103 tube side outlet) - High pressure interlock to cut-off HCL and methanol feed								
				PT-2107 (located on S-								

 GFL GUJARAT FLUOROCHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				2102) High pressure alarm. Regular sampling of S-2103 acid concentration								
3N. 3.	More flow of HCL	1. Inlet feed control valve of E- 2103 tube side FV-2105 fail opens due to FT-2105 shows faulty reading Or Inlet feed control valve of E- 2103 tube side PV-2218A fail opens due to PT-2218A faulty	1. Reactor outlet temp. starts dropping. Also, Excess unreacted HCL goes to reactor downstream quenching system (T-2101) resulting in increasing concentration of HCL	High pressure alarm PT-2103 on HCL feed line (E-2103 Tube side) Low temp alarm TI-2102 on HCL supply line (E-2103 Tube side) Low temperature alarm TI-2113 and TI-2114 on reactor outlet PS-2117 (Located at E-2103 tube side outlet) - High	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				pressure interlock to cut-off HCL and methanol feed								
				PT-2107 (located on S-2102) High pressure alarm.								
				Regular sampling of S-2103 acid concentration								
3N. 4.	More flow of Methanol	1. LT-2102 on shell side of E-2102 is faulty resulting into failure opening of methanol control valve LV-2102	1. Reaction stops in reactor, excess methanol carry over to downstream absorber system. Possible condensation of methanol in downstream cooler E-2108. Absorption of methanol in 21% acid in S-2103	low flow alarm FT-2105 on inlet of E-2103 HCL feed	3	2	6					
				Low temperature alarm TI-2113 and TI-2114 on reactor outlet								
				Acid sampling at S-2103 at regular shift								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				Low pressure alarm PT-2103 on HCL feed line (E-2103 Tube side)								
				High temp alarm TI-2102 on HCL supply line (E-2103 Tube side)								
3N. 5.	Reverse flow	1. Methanol supply pump trips resulting in higher opening of control valve LV-2102, which can lead to reverse flow of Reaction mass and HCl to Methanol storage	1. Possible pressurization of Methanol storage tank		3	3	9					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Fail opening of PV-2218 B due to faulty PT-2218B (located on S- 2203 overhead), which can create low pressure S- 2203, leading to reverse flow of Reaction mass and Methanol to HCl separator S-2203	1. Possible pressurization of HCl separator S-2203	Low pressure alarm of PT-2218A High temperature alarm for TT-2105	3	2	6					
3N. 6.	Misdirected flow	1. Steam valve to E-2107 inadvertently opens	1. Reduction in cooling of reactor, Possible Hot Spots in reactor	High temperature alarm TI-2110 on Hot Oil inlet SS Wire Seal steam valve is available	3	2	6					
		2. Cooling Water control valve	1. Reactor heat balance disturbs	Low temperature	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		TV- 2109 from E-2107 fail opens	and cooling to E- 2104 and E- 2103 will reduces	alarm TI-2114 and TI-2113 (Reactor outlet) Low temperature alarm TI-2109 and TI-2110 (Hot Oil)								
3N. 7.	As well as Flow	1. No credible cause identified										
3N. 8.	High Temperature - HCL	1. Faulty TT-2102 on tube side resulting in full opening of hot oil return control valve TV-2102	1. Overheating of HCL vapors, possible impact on reaction	High temperature alarm TI-2114	2	3	6					1. Addition al temperature indicator to be installed possibly for mixed stream i.e. methanol and HCL to detect

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				High temperature alarm TI-2113								any abnormality in temperature
3N. 9.	High Temperature - Methanol	1. Faulty TT-2103 on tube side resulting in full opening of hot oil return control valve TV-2103	1. Overheating of Methanol vapors, possible impact on reaction	High temperature alarm TI-2114	2	3	6					1. Additional temperature indicator to be installed possibly for mixed stream i.e. methanol and HCL to detect any abnormality in

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				High temperature alarm TI-2113								temperature
3N. 10.	High - Catalyst Temperature	1. Flow or Temperature disturbance in any of the feed streams - HCl or Methanol Or Hot oil temperature indicator TI-2109 faulty results in closure of cooling water return line control valve PV-2109	1. Possible uncontrolled reaction resulting in higher Catalyst Hot Spot temperatures, Runaway reaction is not expected.	High temperature alarm TI-2114 Reactor outlet High temperature alarm TI-2113 Reactor outlet High temperature alarm TI-2110 (Hot oil) Two TT provided in outlet line High temp interlock for TI-2113 and TI-2114 located at reactor outlet is	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				provided to trip reactor								
3N. 11.	Low / No Temperature - HCL	1. Loss of Hot oil to E-2103	1. Low temperature HCl feed to Reactor and possible impact on reaction	Low temperature alarm TI-2114	2	3	6					1. Addition al temperature indicator to be installed possibly for mixed stream i.e. methanol and HCL to detect any abnormality in temperature
				Low temperature alarm TI-2113								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
3N. 12.	Low Temperature - Methanol	1. Loss of Hot oil to E-2104	1. Low temperature Methanol feed to Reactor and possible impact on reaction	Low temperature alarm TI-2114	2	3	6					1. Addition al temperature indicator to be installed possibly for mixed stream i.e. methanol and HCL to detect any abnormality in temperature
				Low temperature alarm TI-2113								
3N. 13.	More Pressure	1. Flooding of downstream S-2103/T-2101	1. Overpressure of reactor	RV-2102 on reactor feed line	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		due to faulty LT- 2106 of S-2103		High pressure alarm PT-2117 High pressure alarm PT-2104 Differential pressure measurement from PT-2107								
3N. 14.	Less Pressure	1. No credible cause identified										
3N. 15.	High level	1. No credible cause identified										
3N. 16.	Low level	1. No credible cause identified										
3N. 17.	Other Than Flow/ Contamination/ Composition/ Concentration	1. Thermal section of HCL feed gets shutdown.	1. Different chemical may enter into reactor instead of or in addition to HCL, possible impact on reaction	High temperature alarm TI-2114 Reactor outlet High temperature	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				alarm TI-2113 Reactor outlet High temperature alarm TI-2110(Hot oil)								
3N. 18.	More/ Less pH	1. Not Applicable										
3N. 19.	Agitator Failure	1. Not Applicable										
3N. 20.	Power failure	1. Power failure from grid	1. Hydro section shutdown	Interlock (SD-10) initiated by Power Failure	3	2	6					
3N. 21.	Utility Failure-Instrument Air	1. Instrument Air supply interruption	1. Hydro section shutdown	Interlock (SD-10) initiated by Instrument Air Failure	3	2	6					
3N. 22.	Utility Failure-Steam	1. Steam supply interruption	1. Loss of methanol vaporization and methanol level in E-2102 shell increases.	Level high alarm LT-2102 resulting in closure of LV-2102	2	3	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				low temp alarm at superheater outlet TT-2103 RV-2101								
3N. 23.	Utility Failure-Cooling water	1. CW supply interruption	1. Possible uncontrolled reaction resulting in higher Catalyst Hot Spot temperatures, Runaway reaction is not expected.	High temperature alarm TI-2114 Reactor outlet High temperature alarm TI-2113 Reactor outlet High temperature alarm TI-2110 (Hot oil) Two TT provided in outlet line High temp interlock for TI-2113 and TI-2114 located at reactor outlet is	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				provided to trip reactor								
3N. 24.	Utility Failure-Refrigeration	1. Refrigeration Failure in Thermal Section	1. Different chemical may enter into reactor instead of or in addition to HCL, possible impact on reaction	High temperature alarm TI-2114 Reactor outlet	3	2	6					
				High temperature alarm TI-2113 Reactor outlet								
				High temperature alarm TI-2110 (Hot oil)								
3N. 25.	Mechanical Failure / Leakage	1. No credible cause identified										
3N. 26.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
3N. 27.	Startup Hazards	1. Hot oil pump trips	1. Possible overheating of Hot Oil due to Electrical Heating Y-2101	Electrical Heating Y-2101 trips if Hot Oil	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 3.

P&IDs: 1308-7001-L103

Node Description and Intent: Hydrochlorination Reactor

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				pump is not running								
3N. 28.	Shutdown Hazards	1.	1.	SOP available for Shutdown								
3N. 29.	Sampling Hazards	1. Not Applicable										
3N. 30.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
3N. 31.	Others	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 4.

P&IDs: 1308-7001-L103

Node Description and Intent: Hot oil circulation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
4N. 1.	Low / No flow	1. No credible cause identified										
4N. 2.	More flow	1. FV-2115 fail open due to faulty FT-2115	1. Reactor heat balance disturbs	Low Temperature alarm on HCL super heater is provided to take action by DCS Engineer	3	2	6					
4N. 3.	Reverse flow	1. No credible cause identified										
4N. 4.	Misdirected flow	1. Hot oil transfer to V-2102 valve inadvertently opens	1. Loss of cooling to reactor	SS Wire Seal hot oil transfer line valve is available	3	2	6					
4N. 5.	As well as Flow	1. No credible cause identified										
4N. 6.	High Temperature	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 4.

P&IDs: 1308-7001-L103

Node Description and Intent: Hot oil circulation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
4N. 7.	Low Temperature	1. No credible cause identified										
4N. 8.	More Pressure	1. PV-2106A fail open on Nitrogen blanketing line due to faulty PT- 2106	1. Overpressure of S- 2101 and V- 2102	Nitrogen pressure is less than design pressure of S- 2101 and V- 2102								
4N. 9.	Less Pressure	1. No credible cause identified										
4N. 10.	High level	1. No credible cause identified										
4N. 11.	Low level	1. No credible cause identified										
4N. 12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
4N. 13.	More/ Less pH	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 4.

P&IDs: 1308-7001-L103

Node Description and Intent: Hot oil circulation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
4N. 14.	Agitator Failure	1. Not Applicable										
4N. 15.	Power failure	1. No credible cause identified										
4N. 16.	Utility Failure	1. No credible cause identified										
4N. 17.	Mechanical Failure / Leakage	1. No credible cause identified										
4N. 18.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
4N. 19.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/Shutdo wn								
4N. 20.	Sampling Hazards	1. Not Applicable										
4N. 21.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 4.

P&IDs: 1308-7001-L103

Node Description and Intent: Hot oil circulation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
4N. 22.	Others- Tube Leak in E-2107	1. Cooling water enters hot oil system	1. possible contamination		3	2	6					
4N. 23.	Others- Tube leak- Reactor jacket leakage	1. Reaction mass enters hot oil system	1. possible contamination		3	2	6					

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
5N. 1.	Low / No from reactor to T-2101/S-2103	1. Isolation valve at the gas	1. Possible overpressure of T- 2101/S-2103	RV-2102 on reactor inlet line	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		outlet of S-2103 is closed		High pressure alarm PT- 2104 at methanol feed line to reactor								
		2. If methanol flow less or stops due to control valve stuck-up.	1. HCL concentration increases in downstream system resulting into overpressure.	Low flow alarm FT-2105 on HCL feed	3	2	6					
				Low flow alarm FT-2104 on Methanol feed								
5N. 2.	Low flow from S-2102 to S-2103	1. LV-2105 from S-2102 to S-2103 fails closed due to LT-2105 on S- 2102 shows faulty reading	1. Quenching of reaction gas in S-2103/T-2101 stops leading to exposure of S-2103/T-2101/E-2108 and downstream to high temperature. Note that S-2103 and E-2108 design temperature is below normal operating	High temperature alarm TT-2118 on S-2103	3	2	6					
				Emergency water supply through XV-2103 for quenching								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			temperature of reactor outlet gas.									
5N. 3.	Low Vent flow from S-2102	1. Due faulty PT-2107, PV-2107 fails closed resulting in no venting from S-2102	1. No normal flow, no hazard									
5N. 4.	Low - 98% fresh H2SO4 flow to T-2104	1. Loss of H2SO4 to T-2104	1. Reduction in moisture removal in T-2104	Regular sampling of bottom acid every 4 hours	3	2	6					
				Low flow alarm on FT- 2107								
5N. 5.	Low / - acid circulation to T-2104	1. Faulty FT-2106 results in closure of FV-2106	1. Moisture carry over to compressor	High level alarm LT- 2104	3	2	6					
			2. Level high in T-2104	T-2104 Top temperature high alarm TT-2120	3	2	6					
				Regular sampling of								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				bottom acid every 4 hours								
5N. 6.	More gas flow to T-2101/S-2103	1. Excess Feed HCL or methanol to upstream reactor	1. Possible overpressure of T- 2101/S-2103	RV-2102 on reactor inlet line	3	2	6					
				High pressure alarm PT- 2104 at methanol feed line to reactor								
				High flow alarm FT- 2105 on HCL feed								
				High flow alarm FT-2104 on Methanol feed								
5N. 7.	More flow of 21% HCL from S-2103 to V- 2403A/B	1. S-2103 LT-2106 malfunctions resulting in fail opens HCL transfer control valve LV-2107 leading into gas blow by to V- 2403A/B	1. Overpressure of V- 2403A/B due to gas blow-by Release of reaction gas to atmosphere		3	3	9					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
5N. 8.	More flow from S-2102 to S-2103	1. LV-2105 from S-2102 to S-2103 fails open due to LT-2105 on S-2102 shows faulty reading	1. S-2102 level depletes in S-2103. Reaction gas will partly bypass E-2108 and directly flows to T- 2104. However, some amount of water will enter in T-2104 but no hazard.	Regular sampling of T-2104 dilute H2SO4. High temperature alarm TT-2119 at T-2104 bottom								
5N. 9.	More -Nitrogen to S-2102	1. Nitrogen line valve or XV-2101 inadvertently opens due faulty PT-2107	1. Possible overpressure of S-2102	SS Wire Seal provided nitrogen line manual valve after XV-2101	3	2	6					1. Review requirement of XV on nitrogen line
5N. 10.	More Vent flow from S- 2102	1. Due faulty PT-2107, PV-2107 fails open resulting in venting of S-2102	1. No hazard									
5N. 11.	More H2SO4 flow to T- 2104	1. Manual valve inadvertently	1. High level in T-2104	High level alarm on T-2104	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		opens full on H2SO4 line to T- 2104		High flow alarm on FT-2107								
5N. 12.	Reverse flow	1. No credible cause identified										
5N. 13.	Misdirected flow	1. E-2113 process side bypass full opens	1. Temperature rise in T-2104	High temperature alarm TT-2113 on circulation line	3	2	6					
5N. 14.	As well as Flow	1. No credible cause identified										
5N. 15.	High Temperature	1. No credible cause identified										
5N. 16.	Low / No Temperature	1. No credible cause identified										
5N. 17.	More Pressure - Jacket of S-2103 and T-2101	1. Process operating when cooling	1. Jacket gets pressurized due to water vaporization		3	2	6					1. Equipment datasheet to be

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		water is isolated										updated for design pressure of jacket of S-2103 and T-2101
5N. 18.	More Pressure - D-2101	1. High level in T-2104 due to faulty LT leading to blocking of upstream D-2101	1. Pressurizing the D-2101	Operating pressure 3.5kg/cm2 and design pressure is 6kg/cm2	3	2	6					
5N. 19.	More Pressure -T-2104	1. Tripping of overhead compressor C-2101	1. Overpressure in T-2104	RV-2106 on T-2104 and Burst pressure 4.5 kg/cm2 (g) Relieving flow 4100 kg/hr At methanol feed rate of 57 TPD expected flowrate from	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				upstream of T-2104 is 4043 kg/hr.								
5N. 20.	More Pressure - E-2113 process side	1. Simultaneous closure of FV-2108 and LV-2104 due to instrument air failure	1. Overpressure of E-2113 process side due to shutoff pressure of P-2106A/B. Possible acid leakage from exchanger gaskets	Low flow alarm FT-2106	3	2	6					
5N. 21.	Less Pressure	1. Compressor C-2101 running and reactions stops	1. low pressure in upstream system	Antisurge provision PV-2111 at compressor suction along with low pressure alarm	3	2	6					
5N. 22.	High level	1. High level in T-2104 due to faulty LT-2104	1. Overfilling of T-2104 due to continued H2SO4 resulting in overpressure because ACID feed continues from P-2701A/B/C	RV-2106 on T-2104 and Burst pressure 4.5 kg/cm2 (g) Relieving flow 4100 kg/hr At methanol feed rate of 57	2	3	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				TPD expected flowrate from upstream of T-2104 is 4043 kg/hr.								
5N. 23.	Low level	1. Low level in T-2104 due to faulty LT-2104	1. Liquid inventory drained out resulting into pump (P-2106A/B) cavitation. Possible increase in temperature across column	FT-2108 low flow alarm on circulation T-2104 top temperature high alarm TT-2120	3	2	6					
5N. 24.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
5N. 25.	More/ Less pH	1. Not Applicable										
5N. 26.	Agitator Failure	1. Not Applicable										
5N. 27.	Power failure	1. Loss of power supply	1. T-2104 bottom circulation and overhead stops,	Interlock SD-11 to shutdown plant								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			feed to reactor stops, cooling water pump stops. No hazard	High temperature alarm TT-2118 on S-2103								
				Emergency water supply through XV-2103 for quenching								
5N. 28.	Utility Failure-Instrument Air	1. Loss of instrument air	1. C-2101 shutdown due to SD0- L emergency shutdown logic resulting into no flow in or out from the system. No hazard is expected.	Interlock SD-11 to shutdown plant	3	2	6					
				High temperature alarm TT-2118 on S-2103								
				Emergency water supply through XV-2103 for quenching								
				C-2101 shutdown due to SD0-L								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				emergency shutdown logic								
5N. 29.	Utility Failure- Cooling water	1. Loss of cooling water	1. Quenching of reaction gas in S-2103/T-2101 stops leading to exposure of S-2103/T-2101/E-2108 and downstream to high temperature. Note that S-2103 and E-2108 design temperature is below normal operating temperature of reactor outlet gas. Water will carry over to T-2104.	Interlock SD-11 to shutdown plant High temperature alarm TT-2118 on S-2103 Emergency water supply through XV-2103 for quenching	3	2	6					
5N. 30.	Mechanical Failure / Leakage - Tube leak	1. Jacket leak of S-2103 or T-2101	1. Water enters into Acid side	Regular sampling High level alarm LT-2106 of S-2101								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 5.

P&IDs: 1308-7001-L104

Node Description and Intent: Quenching and Dehydrating Section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
5N. 31.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
5N. 32.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
5N. 33.	Sampling Hazards	1. No credible cause identified	1.									
5N. 34.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
5N. 35.	Others-Materials of construct.	1. O-ring/graphite block of S-2103 fails	1. Corrosion of equipment	Measurement of pH Jacket MOC is Q235-A/ corrosion allowance 1 mm								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 6.

P&IDs: 1308-7001-L106 Sht-1 of 2 and 1308-70

Node Description and Intent: CH₃Cl compressor system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
6N. 1.	Low / No flow	1. Refer Node 3										
6N. 2.	More flow	1. Refer Node 3										
6N. 3.	Reverse flow	1. Compressor discharge check valve fails	1. Possible reverse flow to V-2105	RV-2108A C-2101A/B itself is a check valve as it is reciprocating type	3	2	6					
		2. Manual valve on V-2107 vent line inadvertently opens	1. Possible reverse flow to V- 2105 from V- 2107 vent valve	SS Wire seal is provided on V- 2107 Vent valve	3	2	6					
6N. 4.	Misdirected flow	1. Fail opening of PV-2111 due to faulty PT-2111 on V-2105	1. Temperature rise in T- 2104	RV-2108A	3	2	6					
				PT-2107 high pressure alarm								
				FT-2112 on V- 2107 low flow alarm								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 6.

P&IDs: 1308-7001-L106 Sht-1 of 2 and 1308-70

Node Description and Intent: CH₃Cl compressor system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
6N. 5.	As well as Flow	1. No credible cause identified										
6N. 6.	High Temperature	1. T-2104 circulation pump stops	1. T-2104 overhead temperature increase which will increase in compressor C-2101A/B suction and discharge temperature impacting V-2105 and V-2107	High temperature alarm TI-2120 at T-2104 top C-2101A/B trips on high discharge temperature and high discharge pressure	3	2	6					
6N. 7.	Low / No Temperature	1. No credible cause identified										
6N. 8.	More Pressure	1. C-2101A/B discharge system blockage	1. Overpressure of C-2101A/B	C-2101A/B trips on high discharge temperature and high discharge pressure	3	3	9					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 6.

P&IDs: 1308-7001-L106 Sht-1 of 2 and 1308-70

Node Description and Intent: CH₃Cl compressor system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				RV-101A/B/C								
		2. Gas outlet valve of V-2107 is closed	1. Overpressure of V-2107	High pressure alarm PT- 2112 RV-2108B	3	2	6					
6N. 9.	Less Pressure	1. No credible cause identified										
6N. 10.	High level	1. Liquid carryover from T-2104 to V-2105	1. Level high in V-2105		3	2	6					
6N. 11.	Low level	1. No credible cause identified										
6N. 12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
6N. 13.	More/ Less pH	1. Not Applicable										
6N. 14.	Agitator Failure	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 6.

P&IDs: 1308-7001-L106 Sht-1 of 2 and 1308-70

Node Description and Intent: CH₃Cl compressor system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
6N. 15.	Power failure	1. Refer Node 3										
6N. 16.	Utility Failure-Instrument Air	1. Loss of Instrument air	1. low pressure at compressor suction	SD0-L initiated by instrument air failure to trip compressor	3	2	6					
6N. 17.	Utility Failure-Cooling water	1. Loss of cooling water	1. Loss of cooling to compressor	Cooling water low pressure interlock to trip compressor	3	2	6					
6N. 18.	Mechanical Failure / Leakage	1. No credible cause identified										
6N. 19.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
6N. 20.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
6N. 21.	Sampling Hazards	1. V-2105 bottom valve inadvertently	1. CH ₃ Cl releases to atmosphere		3	3	9	3. Review closed sampling system from V-2105 bottom valve	3	2	6	

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 6.

P&IDs: 1308-7001-L106 Sht-1 of 2 and 1308-70

Node Description and Intent: CH₃Cl compressor system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		opens (Once per shift)										
6N. 22.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
6N. 23.	Others-Materials of construct.	1. Frequent failure was observed of RD/PSV located in compressor discharge PSV due to corrosion	1. Frequent maintenance resulting in compressor operation without PSV	Compressor trip on High discharge pressure	3	2	6					
6N. 24.	Others- Failure in lube oil system	1. Failure in lube oil system	1. Lube oil pressure low	Lube oil low pressure interlock to trip compressor	3	2	6					
6N. 25.	Other	1. XV-2102 on compressor discharge Depressuring line full opens	1. Downstream scrubber may impact due to sudden depressurization from compressor loop inventory		3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 6.

P&IDs: 1308-7001-L106 Sht-1 of 2 and 1308-70

Node Description and Intent: CH₃Cl compressor system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
6N. 26.	Other	1. Compressor jacket cooling water side fouling	1. low cooling water flow to jacket	Cooling water low pressure interlock is located at jacket cooling water outlet to trip C-2101	3	2	6					

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
7N. 1.	Low / No flow	1. Inadvertent closure of valve on tail line circulation of P-2107A/B/C	1. Pump damage		3	3	9					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
7N. 2.	More flow	1. No credible cause identified										
7N. 3.	Reverse flow	1. Nitrogen valve S-2104 inadvertently open	1. Process enters into nitrogen header in case NRV passes		3	2	6					
7N. 4.	Misdirected flow	1. Inadvertent opening of main circulation line of P-2107A/B/C	1. P-2107A/B trips on overload	Pump trip alarm on DCS								
				Low pressure alarm PT- 2205 on product transfer line								
				Low flow alarm FT-2205 on product transfer line								
7N. 5.	As well as Flow	1. No credible cause identified										
7N. 6.	High Temperature	1. E-2115 - Low cooling water supply	1. High outlet temperature of E-2115 and loss of	High temperature alarm TT-2128	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			condensation in E-2115 resulting in overpressure of S-2104	at E-2115 process outlet High pressure alarm PT- 2114 on S-2104 RV-2108B on V-2107 and RV2108B set pressure: 10.5 kg/cm ² (g); relieving capacity 3772 kg/hr								
7N. 7.	Low / No Temperature	1. No credible cause identified										
7N. 8.	More Pressure	1. E-2115 to V-2106 A/B liquid transfer line valve inadvertently closed	1. Flooding of E-2115 followed by overpressure of overpressure of V-2107, E-2115, S-2104	High pressure alarm PT- 2112 at V-2107 RV-2108B on V-2107, RV-2107 on S-2104	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			and E-2116-1 Tube side	High pressure alarm PT- 2114 on S-2104								
				RV-2107, RV-2109A/B and RV2107 set pressure: 4.5 kg/cm ² (g); relieving capacity 4100 kg/hr RV2109A/B set pressure:10.5 kg/cm ² (g); relieving capacity 11000 kg/hr								
		2. Faulty PT-2114 resulting into failure closure of PV-2114	1. Over pressurization of the system	High pressure alarm PT- 2112 on V-2107	3	2	6					
				High pressure alarm PT- 2116A/B on V-2106A/B								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				RV-2107, RV-2109A/B and RV2107 set pressure: 4.5 kg/cm ² (g); relieving capacity 4100 kg/hr RV2109A/B set pressure: 10.5 kg/cm ² (g); relieving capacity 11000 kg/hr								
		3. Inadvertent closure of vapor balance line valve on V- 2106A/B/C	1. Over pressurization of the system	High pressure alarm PT- 2112 on V-2107	3	2	6					
				High pressure alarm PT- 2116A/B on V- 2106A/B								
				RV-2107, RV-2109A/B and RV2107 set pressure: 4.5								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				kg/cm ² (g); relieving capacity 4100 kg/hr RV2109A/B set pressure:10.5 kg/cm ² (g); relieving capacity 11000 kg/hr								
				High pressure alarm PT- 2114								
7N. 9.	Less Pressure	1. Faulty PT-2114 resulting into failure opening of PV-2114	1. Product loss and loss of condensation in E- 2115 Increase in load of E-2116-1	High flow alarm FT- 2113 on S- 2104 vent line	3	2	6					1. Update P&ID to show TT- 2128
				High flow alarm FT- 2112 at compressor discharge								
				TT-2128 is provided with Low temperature								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				alarm at PV-2114 outlet								
7N. 10.	High level	1. No credible cause identified										
7N. 11.	Low level	1. No credible cause identified										
7N. 12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
7N. 13.	More/ Less pH	1. Not Applicable										
7N. 14.	Agitator Failure	1. Not Applicable										
7N. 15.	Power failure	1. No credible cause identified										
7N. 16.	Utility Failure-Refrigeration Failure	1. Loss of refrigeration to E-2116-1	1. Over pressurization of the system	High pressure alarm PT- 2112 on V-2107	3	2	6					
				High pressure alarm PT-								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				2116A/B on V-2106A/B								
				RV-2107, RV-2109A/B and RV2107 set pressure: 4.5 kg/cm ² (g); relieving capacity 4100 kg/hr RV2109A/B set pressure: 10.5 kg/cm ² (g); relieving capacity 11000 kg/hr								
				High pressure alarm PT- 2114								
7N. 17.	Mechanical Failure / Leakage - Tube leak	1. Tube Leak in E-2116-1	1. Process gas enters R-22 compressor side system - contamination in R22 side	Regular replacement (every 5 years) of tube bundles of E-2116-1 R22 sampling	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Tube Leak in E-2118	1. Process side (C1) enters into Cold MDC system and pressurization, No hazard on "CH ₃ Cl Condenser and transferring system" system									
		3. Tube Leak in E-2115	1. Process side enters cooling water side	pH meter with alarm on cooling water Continuous draining from pH meter for hydraulic expansion case	3	2	6					
7N. 18.	Fire / Explosion / Ignition Source	1. No credible cause identified										
7N. 19.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 7.

P&IDs: 1308-7001-L107

Node Description and Intent: CH₃Cl Condenser and transferring system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
7N. 20.	Sampling Hazards	1. No credible cause identified										
7N. 21.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
7N. 22.	Other	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 8.

P&IDs: 1308-7001-L105

1308-7001-L406

Node Description and Intent: 21% HCL Tank System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
8N. 1.	Low / No flow	1. No credible cause identified										
8N. 2.	More flow of 21% HCL from S-2103 to V- 2403A/B	1. S-2103 LT-2106 malfunctions resulting in fail opens HCL transfer control valve LV-2107 leading into gas blow by to V- 2403A/B	1. Overpressure of V- 2403A/B due to gas blow-by Release of reaction gas atmosphere	Acid vent system	3	3	9					
8N. 3.	Reverse flow	1. No credible cause identified										
8N. 4.	Misdirected flow	1. No credible cause identified										
8N. 5.	As well as Flow	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 8.

P&IDs: 1308-7001-L105

1308-7001-L406

Node Description and Intent: 21% HCL Tank System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
8N. 6.	High Temperature	1. No credible cause identified										
8N. 7.	Low / No Temperature	1. No credible cause identified										
8N. 8.	More Pressure	1. No credible cause identified										
8N. 9.	Less Pressure	1. Bottom pump P-2403 continuous pumping out	1. Low pressure in tank Tanks is not designed for full vacuum		3	2	6					
8N. 10.	High level	1. Faulty LT-2410A/B and mismatch in input and output of 21% acid	1. High level in tank leading to overpressure due to overfilling	Acid vent system	3	2	6					
8N. 11.	Low level	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 8.

P&IDs: 1308-7001-L105

1308-7001-L406

Node Description and Intent: 21% HCL Tank System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
8N. 12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
8N. 13.	More/ Less pH	1. Not Applicable										
8N. 14.	Agitator Failure	1. Not Applicable										
8N. 15.	Power failure	1. No credible cause identified										
8N. 16.	Utility Failure	1. No credible cause identified										
8N. 17.	Mechanical Failure / Leakage	1. No credible cause identified										
8N. 18.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
8N. 19.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 8.

P&IDs: 1308-7001-L105

1308-7001-L406

Node Description and Intent: 21% HCL Tank System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
8N. 20.	Sampling Hazards	1. No credible cause identified										
8N. 21.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
8N. 22.	Other	1. No credible cause identified										

Project: 1. HAZOP Study for CMS-1 Plant

Node: 9.

P&IDs: 1308-7001-L101

Node Description and Intent: Methanol Storage

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
9N. 1.	Low / No flow	1. No credible cause identified										
	More flow			PVRV-2101A/B	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 9.

P&IDs: 1308-7001-L101

Node Description and Intent: Methanol Storage

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
9N. 2.		1. Faulty PT-2101 resulting into fail opening of PV-2101A	1. Overpressure of E-2101, V-2101A/B due to access nitrogen flow	EV-2101A/B								
9N. 3.	Reverse flow	1. P-2101A/B trips and LV-2102 on E-2102 open full	1. Reverse flow from E-2102 to V-2101A/B and release of gases from V-2101A/B vent PV-2101B to atmosphere	PVRV-2101A/B EV-2101A/B	3	3	9					
		2. Unloading pump P-2109 discharge check valve fails and pump trips	1. Reverse flow from tank to tanker		3	2	6					
9N. 4.	Misdirected flow	1. No credible cause identified										
9N. 5.	As well as Flow	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 9.

P&IDs: 1308-7001-L101

Node Description and Intent: Methanol Storage

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
9N. 6.	High Temperature	1. Loss of cooling of MDC to E-2101	1. Venting of methanol via PV- 2101B and release to atmosphere		3	3	9					
9N. 7.	Low / No Temperature	1. No credible cause identified										
9N. 8.	More Pressure	1. No credible cause identified										
9N. 9.	Less Pressure	1. Faulty LT and P-2101A/B running	1. Low pressure in V-2101A/B	PVRV-2101A/B Dry run protection for P- 2101A/B	3	2	6					
9N. 10.	High level	1. Faulty LT-2101A/B	1. High level in V-2101A/B	PVRV-2101A/B Dry run protection for P- 2101A/B	3	2	6					
				EV-2101A/B Independent level alarm LSH-2101A/B								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 9.

P&IDs: 1308-7001-L101

Node Description and Intent: Methanol Storage

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Unloading to incorrect tank	1. Overfilling of tank due to incorrect interlock logic	PVRV-2101A/B Dry run protection for P- 2101A/B EV-2101A/B Independent level alarm LSH-2101A/B	3	3	9					
9N. 11.	Low level	1. No credible cause identified										
9N. 12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
9N. 13.	More/ Less pH	1. Not Applicable										
9N. 14.	Agitator Failure	1. Not Applicable										
9N. 15.	Power failure	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 9.

P&IDs: 1308-7001-L101

Node Description and Intent: Methanol Storage

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
9N. 16.	Utility Failure	1. No credible cause identified										
9N. 17.	Mechanical Failure / Leakage - Tube leak	1. Tube leak to E-2101	1. Cold MDC enters in methanol, Raw material contamination and possible carry over to hydro section reactor		3	3	9	4. Regular sampling (once on two weeks) of methanol to check for MDC content	3	2	6	
9N. 18.	Fire / Explosion / Ignition Source	1. No credible cause identified										
9N. 19.	Startup/Shutdown Hazards	1.	1.	SOP available for Startup/Shutdown								
9N. 20.	Sampling Hazards	1. No credible cause identified										
9N. 21.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 9.

P&IDs: 1308-7001-L101

Node Description and Intent: Methanol Storage

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
9N.22.	Other	1. No credible cause identified										

Project: 1. HAZOP Study for CMS-1 Plant

Node: 10.

P&IDs: 1308-7001-L201

Node Description and Intent: Chlorine Vapour from vaporizer to R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
10N.1.	Low / No flow	1. No flow from u/s Malfunctioning of PV-2201 is fully closed position.	1. Low pressure and temp in reactor (R-2201) leading to production upset. Over pressurization of the surge drum(V-	FALL -2203 alarm is given in DCS PSLL-2208 will activate the interlock SD-1 to Reactor trip.	2	3	6					

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 10.

P&IDs: 1308-7001-L201

Node Description and Intent: Chlorine Vapour from vaporizer to R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of FV-2201 is fully closed position Inadvertent closing of On/off valve XV-2201	2206) leading to release of Cl ₂ into the environment leading to formation of Cl ₂ cloud resulting to inhalation problem leading to injury to operating personnel.	TSLL-2211 will activate the interlock SD-1 to close FV-2203 (reactor trip) RV-2213 PSHH-2201 will activate the interlock SD-1 to close the PV-2204. PAHH-2201								
10N .2.	More flow	1. High pressure from B/L	1. Temp will increase the R-2201 leading to form more carbon in the reactor.	FAHH-2203 alarm is given in DCS	2	3	6					
		2. Malfunctioning of FV-2203 fully open position.	1. Over pressurization of reactor (R- 2201) leading to rupture of the reactor leading to release of HC into the environment, potential ignition	TSHH-2211 will activate the interlock SD-1 to close FV-2203 (reactor trip)	2	3	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 10.

P&IDs: 1308-7001-L201

Node Description and Intent: Chlorine Vapour from vaporizer to R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			resulting into injury to the operating personnel.									
		3. Malfunctioning of PV-2201 fully open position	1. Possible run-way reaction leading to rise in temp of reactor (R-2201) leading to carbon formation and choking into the reactor resulting to loss of containment.	PSHH-2208 will activate the interlock SD-1 to Reactor trip.	2	3	6					
10N .3.	Reverse flow	1. No credible cause identified	1.									1. Provision of NRV in CA plant is need to be checked
10N .4.	Misdirected flow	1. RV-2213 passes Drain valves to hypo plant are passing	1. Low pressure and temp in reactor R-2201 leading to production upset.	FALL -2203 alarm is given in DCS(Not shown in P&ID) TSLL-2211 will activate the interlock SD-1	1	3	3					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 10.

P&IDs: 1308-7001-L201

Node Description and Intent: Chlorine Vapour from vaporizer to R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				to close FV-2203 (reactor trip) PSLL-2208 will activate the interlock SD-1 to Reactor trip.								
10N .5.	As well as Flow	1. No credible cause identified										
10N .6.	High Temperature	1. Refer More flow										
10N .7.	Low / No Temperature	1. Low pressure in Cl ₂ vaporizer in CA plant	1. Cl ₂ get condensed at 39degC at 11 Kg/cm ² g	Electrical tracing is provided. line is insulated	1	1	1					
		No flow from u/s Malfunctioning of PV-2201 is fully closed position.	2. Low pressure and temp in reactor (R-2201) leading to production upset.	PAL-2202 is provided	1	1	1					
10N .8.	More Pressure	1. High pressure from B/L	1. Over pressurization of the surge drum(V-	RV-2213 is provided on	2	3	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 10.

P&IDs: 1308-7001-L201

Node Description and Intent: Chlorine Vapour from vaporizer to R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of FV-2203 to fully closed position Inadvertently closing of XCV-2201	2206) leading to release of Cl ₂ into the environment leading to formation of Cl ₂ cloud resulting to inhalation problem leading to injury to operating personnel.	the surge vessel .RV set pressure 18kg/cm ² g which is same as RV setting on vaporizer in CA plant. PSHH-2201 will activate the interlock to close the PV-2204. PAHH-2201								
10N .9.	Less Pressure	1. No Pressure from u/s Malfunctioning of PV-2201 is fully closed position.	1. Low pressure and temp in reactor (R-2201) leading to production upset.	PALL-2201 PSLL-2201 will activate the interlock SD-1 to close PV-2201	1	4	4					
10N .10.	High level	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 10.

P&IDs: 1308-7001-L201

Node Description and Intent: Chlorine Vapour from vaporizer to R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
10N .11.	Low level	1. No credible cause identified										
10N .12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
10N .13.	More/ Less pH	1. Not Applicable										
10N .14.	Agitator Failure	1. Not Applicable										
10N .15.	Power failure	1. Power failure from grid	1. Plant shutdown with no significant hazardous consequences									
10N .16.	Utility Failure	1. No credible cause identified										
10N .17.	Mechanical Failure / Leakage	1. No credible cause identified										
10N .18.	Fire / Explosion / Ignition Source	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 10.

P&IDs: 1308-7001-L201

Node Description and Intent: Chlorine Vapour from vaporizer to R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
10N.19.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
10N.20.	Sampling Hazards	1. No credible cause identified										
10N.21.	Personal Protection Hazards	1. No credible cause identified										
10N.22.	Other	1. No credible cause identified										

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				LAL-2201	2	4	8					

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN-CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
11N .1.	Low / No flow in feed line to Evaporator E-2201	1. Suction strainer choking of pump-2107 A/B Malfunctioning of FV- 2205 to fully closed position Malfunctioning of LV- 2201 to fully closed position.	1. Low level in the evaporator (E-2201) leading to rise in temp leading to deposition of carbon in evaporator, leading to mechanical damage of tubes resulting to asset loss. Over pressurization of line 50-AB2-MC-10711 leading to leakage from flanges/joints/gaskets resulting to potential ignition. Serious injury to the operator pump will go to the shutoff pressure. Low pressure and temp in reactor (R-	TAH/HH-2204 is provided on vaporizer(In DCS to be updated on P&ID)								
				PAH-2205								
				PAH-2204								
				PSHH-2203 will activate the interlock SD-3 to close PV-2204.								
				RV-2201 is provided on the Evaporator-E-2201								
				RD-2201 is provided on Evaporator-E-2201								
				SOP is in place to shut down								

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			2201) leading to production upset. Due to low pressure in vaporizer steam valve will open more.	the plant and start-up								
11N .2.	Low / No flow from D-2201 to E-2202A/B	1. Malfunctioning of FV- 2202 to fully closed position	1. Production upset.	FAL and FALL-2201	1	4	4					
			Pressure build-up in evaporator (E-2201) leading to rise in temp leading to deposition of carbon in evaporator,	PSHH-2203 will activate SD-2 to close PV-2204								
			leading to mechanical damage of tubes resulting to asset loss.	PAH-2204								
				RV-2201 is provided on the Evaporator-E-2201								
				RD-2201 is provided on Evaporator-E-2201								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
11N .3.	More flow in feed line to Evaporator	1. Malfunctioning of FV- 2205 to fully open position Malfunctioning of LV- 2201 B to fully open position	1. Rise in level in the Evaporator (E-2201) leading to lesser evaporation leading to process upset Uncontrolled rise in level can fill up the Feed preheaters E-2202A/B and enters into the reactor.	LV-2201 closes by interlock SD-2	1	4	4					
				LAH-2201 is provided								
				LAHH-2201 will activate the Interlock SD-2 and plant goes to shut down .								
				Steam valve PV-2204 will closed by interlock SD- 2								
11N .4.	More flow from D- 2201 to E-2202A/B	1. Malfunctioning of FV- 2202 to fully open position	1. Low pressure and temp in reactor R-2201 leading to production upset.	FAH-2201 is provided	1	5	5					
				Manual operation to be done to increase reactor temp.								
				SOP is in place.								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
11N .5.	Reverse flow from Crude product lines to D-2201	1. Low vaporizer pressure	1. Mixing of vapors in vaporizer. No serious consequence									1. NRV to be provided on 150-BB4-CT-20348-ET
11N .6.	Reverse flow	1. Tube failure	1. CH ₃ CL will enter into the steam line leading to fall of vaporizer pressure	CT-2834 Conductivity analyzer and PH analyzer - alarms provided on common header of condensate	1	4	4					
			2. Fluctuation in parameter	SOP to detect the source of failure	1	4	4					
			3. Increase the conductivity of steam condensate.		1	4	4					
			4. lowering of PH in condensate.		1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
11N .7.	Misdirected flow	1. No credible cause identified										
11N .8.	As well as Flow	1. No credible cause identified										
11N .9.	High Temperature	1. Malfunctioning of LV- 2201B is fully closed position.	1. Low level in the evaporator (E-2201) leading to rise in temp leading to deposition of carbon in evaporator, leading to mechanical damage of tubes resulting to asset loss.	TAH and TAHH- 2204 is provided on vaporizer	1	4	4					
		2. High steam flow due to malfunctioning of PV-2204 fully open position	1. Over pressurization of line 50-AB2-MC- 10711 leading to leakage from flanges/joints/gasket s resulting to potential ignition. injury to the operator	PAH-2204 is provided on vaporizer.	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			pump will go to the shutoff pressure.									
		3. Higher steam pressure	1. Low flow to reactor leading to production upset.	LAL-2201A/B PAH-2205 4.PAH-2204 PSHH-2203 will activate the interlock SD-3 to close PV-2204.	1	4	4					
			2. carbon formation in evaporator due to excessive heating leading to tube failure	RV-2201 is provided on the Evaporator-E-2201 RD-2201 is provided on Evaporator-E-2201	1	4	4					
11N .10.	Low / No Temperature	1. Low flow of steam due to malfunctioning of PV-2204 closed position	1. 1. Rise in level in the vaporizer leading to lessor evaporation.	1. TAL and TALL-2204 is provided	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			2. 2. Low flow to reactor leading to production loss.	2. LAH-2201 B is provided								
11N .11.	More Pressure in feed line to Evaporator	1. Malfunctioning of FV- 2204 is fully closed position.	1. Low level in the evaporator (E-2201) leading to rise in temp leading to deposition of carbon in evaporator, leading to mechanical damage of tubes resulting to asset loss.	PAH2205 is provided on CH ₃ CL feed line	2	4	8					
		2. Malfunctioning of LV- 2201B is fully closed position.	1. Over pressurization of line 50-AB2-MC-10711 leading to leakage from flanges/joints/gasket s resulting to potential ignition. injury to the operator pump will go to the shutoff pressure	PAHH-2203 is provided on vaporizer. PSHH-2203 will activate the interlock SD-2 to close the steam valve PV-2204 RV/RD-2201 is provided on vaporizer	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
11N .12.	More pressure in D- 2201 to E- 2202A/B	1. Malfunctioning of FV- 2202 is fully closed position.	1. Pressure build-up in evaporator (E-2201) leading to rise in temp leading to deposition of carbon in evaporator, leading to mechanical damage of tubes resulting to asset loss.	PSHH-2203 will activate SD-2 to close PV-2204	2	4	8					
				PAH-2204								
				RV-2201 is provided on the Evaporator-E-2201								
				RD-2201 is provided on Evaporator-E-2201								
		2. E-2202 tubes blocked due to carbon (Refer to Node No-12)										
11N .13.	Less pressure in feed line to Evaporator	1. Malfunctioning of FV- 2204 is Fully closed position.	1. No serious consequences	PAL-2205 is provided on the feed line	1	4	4					
				PAL-2204 is provided on the vaporizer.								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				SOP and inspection frequency is available								
11N .14.	Less pressure in D-2201 to E-2202A/B	1. No credible cause identified										
11N .15.	High level	1. Same as high flow scenario	1. Lower evaporation in vaporizer leading to lower production.	LAH-2201B is provided	1	4	4					
		2. Low steam flow due to malfunctioning of PV-2204	1. Overfilling of the vaporizer loop	LSHH-2202 will activate the interlock SD-2 will close the LV-2201 B ,PV-2204 and XV-2202	1	4	4					
11N .16.	High level in D-2201 to E-2202A/B	1. No credible cause identified										
11N .17.	Low-level in feed line to Evaporator	1. Same as high temp										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
11N .18.	Low level in D-2201 to E-2202A/B	1. No credible causes										
11N .19.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
11N .20.	More/ Less pH	1. Not Applicable										
11N .21.	Agitator Failure	1. Not Applicable										
11N .22.	Power failure	1. Power failure from grid	1. Plant shutdown with no significant hazardous consequences									
11N .23.	Utility Failure	1. No credible cause identified										
11N .24.	Steam high flow	1. Malfunctioning of PV- 2204	1. Higher vaporization leading to rise in pressure in the vaporizer.	PAHH-2204 will activate the interlock SD-2 to close the PV-2204	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		LP header pressure increase.		PSHH-2203 will activate the interlock SD-2 to close PV-2204 (Steam valve)								
11N .25.	Utility Failure- Steam Low/No flow	1. Malfunctioning of PV- 2204 fully closed position inadvertently closing of XCV-2202 Condensate line blocked due to malfunctioning of ball float trap	1. 1. Lower vaporization leading to lower pressure in the vaporizer resulting to increase in the level Reduce plant load. water hammering in the tubes leading to damage of the tubes/asset loss	1. FAL-2201 is provided 2. PAL-2203 on vaporizer is provided on the vaporizer.	1	5	5		1	5	5	
11N .26.	Mechanical Failure / Leakage- Tube leak	1. Low level in vaporizer	1. CH ₃ CL will enter into the steam line leading to fall of vaporizer pressure	CT-2834 Conductivity analyzer and PH analyzer -	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			2.Fluctuation in parameter	alarms provided on common header of condensate								
		2. Carbon deposited on tube	1. Increase the conductivity of steam condensate.		1	4	4					
		3. Overheating of tube	1. lowering of PH in condensate.	SOP to detect the source of failure	1	4	4					
11N .27.	Fire / Explosion / Ignition Source	1. No credible cause identified										
11N .28.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
11N .29.	Sampling Hazards	1. No credible cause identified										
11N .30.	Personal Protection Hazards	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 11.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃CL evaporator E-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
11N .31.	Other- Relief & blow down	1. High pressure in vaporizer	1. Pressure relief	RD-2201 and RV-2201 is provided. The set pressure is 11 Kg/cm ² g	1	4	4					
11N .32.	Other	1. Carbon formation in vaporizer tube	1. refer to tube leak	cleaning, plugging of tubes replacement of tube								

Project: 1. HAZOP Study for CMS-1 Plant

Node: 12.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃Cl feed preheater to Reactor R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
12N .1.	Low / No flow	1. Tubes getting blocked condition similar to NODE-11	1. same as node 11									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 12.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃Cl feed preheater to Reactor R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
12N .2.	More flow	1. High flow from u/s	1. same as node 11									
12N .3.	Reverse flow	1. No credible cause identified										
12N .4.	Misdirected flow	1. No credible cause identified										
12N .5.	As well as Flow	1. No credible cause identified										
12N .6.	High Temperature	1. Malfunctioning of TV- 2206 is fully open position	1. Process upset in Reactor	TAHH- 2206 is provided	1	4	4					
			2. Possibility of carbon formation on tube side	TAHH- 2206 is provided	1	4	4					
12N .7.	Low / No Temperature	1. Malfunctioning of TV- 2206 is fully closed position	1. Lower temp to reactor leading to process upset	TALL- 2206 is provided	1	4	4					
12N .8.	More Pressure	1. High pressure from u/s	1. Process upset.	PAH-2207	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 12.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃Cl feed preheater to Reactor R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. High back pressure from downstream	1. Process upset.	PAH-2207	1	4	4					
12N .9.	Less pressure	1. Low pressure from u/s	1. lower preheating leading to Process upset	PAL-2207	1	4	4					
		2. Partial leakage of preheater E-2202A/B	1. lower preheating leading to Process upset	PAL-2207	1	4	4					
12N .10.	High level	1. No credible cause identified										
12N .11.	Low-level	1. No credible cause identified										
12N .12.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
12N .13.	More/ Less pH	1. Not Applicable										
12N .14.	Agitator Failure	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 12.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃Cl feed preheater to Reactor R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
12N .15.	Power failure	1. Power failure from grid	1. Plant shutdown with no significant hazardous consequences									
12N .16.	Utility Failure	1. No credible cause identified										
12N .17.	Steam high flow	1. Malfunctioning of TV- 2206 is fully open position	1. Process upset in Reactor	TAHH- 2206 is provided	1	4	4					
			2. Possibility of carbon formation on tube side	TAHH- 2206 is provided	1	4	4					
12N .18.	Utility Failure- Steam Low/No flow	1. Malfunctioning of TV- 2206 is fully closed position	1. Lower temp to reactor leading to process upset	TALL- 2206 is provided	1	4	4					
12N .19.	Mechanical Failure / Leakage- Tube leak	1. Corrosion and Mechanical damage	1. Reverse flow from process to steam side leading to process upset.	CT-2834 Conductivity analyzer and PH analyzer - alarms provided on common	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 12.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃Cl feed preheater to Reactor R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				header of condensate SOP to detect the source of failure Exchanger Hydro jet / chemical Cleaning frequency annually								
12N.20.	Fire / Explosion / Ignition Source	1. No credible cause identified										
12N.21.	Startup/Shutdown Hazards	1.	1.	SOP available for Startup/Shutdown								
12N.22.	Sampling Hazards	1. No credible cause identified										
12N.23.	Personal Protection Hazards	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 12.

P&IDs: 1308-7001-L201

Node Description and Intent: CH₃Cl feed preheater to Reactor R-2201

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
12N .24.	Other-	1. No credible cause identified										

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
13N .1.	Low / No flow Thermal Reactor section	1. Low Cl ₂ flow from u/s	1. Low pressure and temp in reactor (R-2201) leading to Carbon formation will start below 380 degC resulting to production upset	TAL-2210 set at 360 degC	1	4	4					
				TAL-2211 set at 330 degC								
				TALL-2211 set at 320 degC								
			1. Low pressure and temp in reactor (R-	TAL-2210 set at 360 degC	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Low CH ₃ Cl flow from preheater	2201) leading to Carbon formation will start below 380 degC resulting to production upset	TAL-2211 set at 330 degC TALL-2211 set at 320 degC								
13N .2.	Low / No flow - Emergency vessel	1. Normally no flow										
13N .3.	Low / No flow to Quenching tower	1. Low flow from u/s Quench sparger choking Carbon deposition on trays Tripping of reactor	1. Loss of level in quenching tower T-2201 leading to inadequate quenching leading to process upset Higher reactor back pressure	SD-1 will activate on high reactor pressure. Annual inspection and cleaning of Sparger and trays during shutdown.	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
13N .4.	Low flow to V-2205A/B from Quenching tower	1. Drain valve at quench Tower opened manually for 1 to 2 min twice a shift.	1. No serious consequences									
13N .5.	More flow Thermal Reactor section	1. High Cl ₂ flow from u/s	1. Over pressurization of reactor (R- 2201) leading to rise in temp leading to rupture of the reactor leading to release of HC into the environment, potential ignition resulting into injury to the operating personnel.	TAH-2213 is provided, set at 440 degC	2	4	8					
				TAH-2211 set at 435 degC								
				TAHH-2211 and TTHH-2214 is provided (Both set at 455 degC) will activate the interlock SD-1 (Reactor) to plant shutdown.								
			2. Possible run-way reaction leading to	TAH-2214 set at 435 degC	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			rise in temp of reactor (R-2201) leading to carbon formation and choking into the reactor resulting to Less production of MDC and more of CFM , loss of containment.	TAHH-2211 and TTHH-2214 is provided (Both set at 455 degC) will activate the interlock SD-1 (Reactor) to plant shutdown.								
				PAH-2210 set at 7.2k g/cm2g								
				PAHH-2208 s								
				PSHH-2208 will activate interlock SD-1 to plant shutdown								
		2. High CH3Cl flow from preheater	1. Low pressure and temp in reactor (R-2201) leading to Carbon formation	TAL-2210 set at 360 degC	1	4	4					
				TAL-2211 set at 330 degC								

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE <i>Progress with Safe Solutions</i>	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			will start below 380 degC resulting to production upset.	TALL-2211 set at 320 degC								
13N .6.	More flow - Emergency vessel	1. Bursting of RD-2204	1. Over pressurization of emergency vessel (V-2201) leading to rupture of the vessel leading to release of HC into the environment, potential ignition resulting into injury to the operating personnel.	RD-2202	2	4	8					
				RD-2203								
				PAH-2209								
				SOP is in place								
13N .7.	More flow to Quenching tower	1. High flow from u/s High pressure in reactor.	1. Rise in level of the quenching tower leading to increasing the temp leading to flooding ,damage of the quench tower trays resulting to more carbon	TAH-2207	1	5	5					
				TAH-2208								
				TAHH-2209								
				TSHH-2208 will activate interlock SD-1 to shutdown reactor.								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			formation leading to process upset.									
13N .8.	More flow to V-2205A/B from Quenching tower	1. Inadvertent opening of drain valve due to operator error. Gas breakthrough to V- 2205 .	1. 1. Over pressurization of bottom accumulator-V-2205 leading to rupture of the bottom accumulator leading to release of crude product into the environment, potential ignition resulting to injury / fatality to the operating personnel. Loss of level in quenching tower T-2201 leading to inadequate quenching leading to process upset.	RV-2214A/B set at 10kg/cm2g 2RD-2214A/B set at 10kg/cm2g LAL-2203 Balancing line to V-2202 is always open	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
13N .9.	Reverse flow- Thermal Reactor section	1. RD-2204 breaks	1. No serious consequences.									
		2. Low flow of Cl ₂ and CH ₃ Cl	1. No serious consequences.									
13N .10.	Reverse flow in Quench	1. Bursting of RD-2204 on reactor	1. Rise in level of the quenching tower leading to increasing the temp leading to flooding ,damage of the quench tower trays resulting to more carbon formation leading to process upset.	Butterfly outlet valve needs to be closed manually	1	5	5					
				LAH-2203								
				TAH-2207								
				TSHH-2208 will activate interlock SD-1 to shutdown reactor.								
13N .11.	Reverse flow in V-2205A/B	1. Steam getting into process side due to tube leak.	1. Water entering into process side leading to serious corrosion	None	3	3	9					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
13N .12.	Misdirected flow	1. No credible cause identified										
13N .13.	As well as Flow	1. No credible cause identified										
13N .14.	Low / No Temperature - Thermal Reactor section	1. Low Cl ₂ flow from u/s High flow CH ₃ Cl from u/s	1. same as No/Less flow Cl ₂	TAL-2210 set at 360degC	1	5	5					
				TAL-2211 set at 330degC								
				TSL-2211 set at 320 degC will activate interlock SD-1 will trip reactor								
13N .15.	Low / No Temperature in Quench tower	1. Due to high quench liquid flow	1. No serious consequences	FAH-2207 on quench liquid line								
13N .16.	Low / No Temperature in V-2205A/B	1. Intermittent operation	1. No serious consequences									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
13N .17.	More Temperature - Thermal Reactor section	1. High Cl ₂ flow from u/s Less flow CH ₃ Cl from u/s	1. Same as high flow Cl ₂	TAH-2213 is provided, set at 440 degC	1	5	5					
				TAH-2211 set at 435 degC								
				TAH-2214 set at 435 degC								
				TAHH-2211 and TTHH-2214 is provided (Both set at 455 degC) will activate the interlock SD-1 (Reactor) to plant shutdown								
				PAH-2210 set at 7.2k g/cm ² g								
				PAHH-2208								
				PSHH-2208 will activate interlock SD-1								

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN-CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				to plant shutdown								
13N .18.	Electric Heater:- for start-up Electrical cable touching reactor shell Thermal Reactor section	1. No Credible causes due to robust construction of heater.										
13N .19.	More Temperature in Quench tower	1. Malfunctioning of LT/LV- 2203 fully closed	1. Condenser E-2203 will get overloaded resulting in less condensation and higher back pressure.	TSHH-2208 will activate SD-1 will trip reactor.	1	5	5					
		2. High flow from u/s	1. Rise in level of the quenching tower leading to increasing the temp leading to flooding ,damage of the quench tower trays resulting to more carbon	PAH-2211 FAL-2207 on quench liquid line	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			formation leading to process upset.									
13N .20.	More Temperature in V-2205A/B	1. High steam flow High stem temp from B/L	1. Over pressurization of bottom accumulator-V-2205 leading to Rise in templating to rupture of the bottom accumulator leading to release of crude product into the environment, potential ignition resulting to injury to the operating personnel.	RV-2214A/B set at 10kg/cm2g RD-2214A/B set at 10kg/cm2g Intermittent operation	1	4	4					
13N .21.	More pressure Thermal Reactor section	1. High Cl ₂ and CH ₃ Cl flow from u/s High Reaction Temp	1. Same as high flow Cl ₂	PSHH-2208 will activate the interlock SD-1 will trip rector PAH-2210 is provided	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Blockage in Quench Tower T-2201 inlet sparger		PAHH-2210 will activate interlock SD-1 to trip the reactor.								
		Flooding in Quench tower-T-2201 due to malfunctioning of LV-2203		RD-2204								
		Bottom pump P-2403 continuous pumping out										
		Increase in back-pressure in downstream equipment's										
13N.22.		1. Bursting of RD-2204	1. Over pressurization of emergency vessel	RD-2202	2	4	8					
				RD-2203								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	More Pressure - Emergency vessel		(V-2201) leading to rupture of the reactor leading to release of HC into the environment, potential ignition resulting into injury to the operating personnel.	PAH-2209 SOP is in place								
13N.23.	More Pressure in Quench tower	1. Higher back pressure from d/s(Malfunctioning of PV- 2218 A)	1. Over pressurization of reactor (R- 2201) leading to rise in temp leading to rupture of the reactor leading to release of HC into the environment, potential ignition resulting to injury to the operating personnel.	PAH-2211 PAH-2210 set at 7.2k g/cm2g PAHH-2208 PSHH-2208 will activate interlock SD-1 to plant shutdown	2	4	8					
13N.24.	More Pressure in V-2205A/B	1. More steam flow	1. No serious consequences									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		high level										
13N .25.	Less pressure in Thermal Reactor section	1. Low Cl ₂ and CH ₃ Cl flow from u/s Low pressure in d/s leakage in RD-2204	1. same as No/Less flow Cl ₂	PAL-2210 PALL-2210 will activate interlock SD-1 to trip the reactor	1	5	5					
13N .26.	Less Pressure - Emergency vessel	1. No credible cause identified										
13N .27.	Less Pressure in Quench tower	1. Sparger blocked	1. Loss of level in quenching tower T-2201 leading to inadequate quenching leading to process upset	PAH-2211 PAH-2210 set at 7.2k g/cm ² g	2	4	8					
				PAHH-2208 set	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			2. Over pressurization of reactor (R- 2201) leading to rise in temp leading to rupture of the reactor leading to release of HC into the environment, potential ignition resulting to injury to the operating personnel.	PSHH-2208 will activate interlock SD-1 to plant shutdown								
13N.28.	Less Pressure in V-2205A/B	1. Operation intermittent	1. No serious consequences									
13N.29.	High level in quench tower	1. Malfunctioning of LV-2203 on quenching line is fully open position	1. Rise in level of the quenching tower leading to increasing the temp leading to flooding ,damage of the quench tower trays resulting to more carbon	TAH-2207	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			formation leading to process upset.									
		2. Malfunctioning of LT-2203 on quenching line is fully open position	1. Increase in reactor back pressure leading to process upset.	TAH-2208 TAHH-2209 TSHH-2208 will activate interlock SD-1 to shutdown reactor. LAH-2203	1	5	5					
13N .30.	High level in v-2205A/B	1. Uncontrolled draining from quench tower	1. No serious consequences (Intermittent operation)	1. SOP is in place								
13N .31.	Low-level in Quench tower	1. Inadvertent opening of drain valve due to operator error.	1. Over pressurization of bottom accumulator-V-2205 leading to Rise in templating to rupture of the bottom accumulator leading to release of	LAL-2203 RV-2214A/B is provided on V-2205 A/B RD-2214 A/B is provided on V-2205A/B	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			crude product into the environment, potential ignition resulting to injury to the operating personnel.									
			2. Loss of level in quenching tower T-2201 leading to inadequate quenching leading to process upset	LALL-2203	1	5	5					
13N.32.	Low-level in V-2205A/B	1. Intermittent operation	1. No serious consequences									
13N.33.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
13N.34.	More/ Less pH	1. Not Applicable										
13N.35.	Agitator Failure	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
13N.36.	Power failure	1. Power failure from grid	1. Plant shutdown with no significant hazardous consequences									
13N.37.	Utility Failure-N2 (Emergency vessel)	1. Nitrogen Failure from upstream	1. Used only during shutdown for sweeping of process gases.	1. No serious consequences								
13N.38.	Mechanical Failure / Leakage-Tube leak E-2212A/B	1. Corrosion and Mechanical damage	1. Steam will enter into process side and getting to downstream equipment's	1. None	3	3	9					
13N.39.	Fire / Explosion / Ignition Source	1. No credible cause identified										
13N.40.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
13N.41.	Sampling Hazards	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
13N.42.	Personal Protection Hazards	1. No credible cause identified										
13N.43.	Other- Relief & blow down RD-2204 Normal Operation	1. Sudden surge in pressure	1. Reactor low pressure Reactor trip through SD-1	RD-2204 set at 10kg/cm ² g .The surge in pressure is so quick it cannot be seen on trend graph.	1	4	4					
13N.44.	Other- Relief & blow down (Emergency vessel)	1. RD-2203,2202 and RV-2202	1. It is observed that all the three safety devices open, when RD- 2204 on reactor opens.	None	3	5	15	5. Regular inspection of all RDs	2	4	8	
13N.45.	Other- RD-2204 Start-up Operation	1. Bursting during start-up	1. Delay in start-up by 24hr mini Replacement of RD		1	4	4					
13N.46.	Other- Shutdown Evacuation of V-2201	1.	1.									1. This Evacuati on line 50-AB2-CP-20205

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 13.

P&IDs: 1308-7001-L202

Node Description and Intent: -Thermal Reactor section

-Emergency vessel

-Quenching tower and heating system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
												should be used for normal evacuation.

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
14N .1.	Low / No flow to E-2203 and E-2204 tube side	1. Low flow from u/s	1. More condensation in E- 2203..No serious consequences									
14N .2.	Low flow E-2204 Shell side	1. Low flow from u/s	1. Loss in level in E-2204 shell side leading to less evaporation in	LAL-2204	1	5	5					

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of TV-2220 to fully closed position	shell tube side leading to process upset.									
		Suction strainer choking of pump P-2202A/B	2. Over pressurization in line 80- BB3-CP-20419-C leading to leakage of CCP from the flanges/joints/gasket s leading to fire hazard. Pump P-2202A/B will go to its shutoff pressure.	Stand by pump is available FAL-2209	1	5	5					
14N .3.	Low / No flow in V-2202	1. Less condensation in E- 2203,2204 and E-2211	1. Drop in level of feed tank V-2202 leading to dry running of pump P- 2201A/B leading to leakage of HC potential ignition fire hazard, injury to the operating personnel	LAL-2208 PAL-2213 Stand by pump is available.	1	4	4					
14N .4.	Low/No flow in P-2201A/B	1. Malfunctioning of control	1. No flow from P-2201 can result in runaway	LAH-2208 V-2202	3	2	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		valve LV-2203,FV-2217 on discharge	temp in the reactor. This is happened on earlier occasions.									
		Cavitation due to low NPSH availability	Damage to pump seal leak									
			2. Refer the high flow/Level condition in vessel V-2202									
14N .5.	Low flow in P-2203A	1. Malfunctioning /wrong operation of FV-2218	1. High level in E-2204 Resulting in flooding on shell side	LSHH-2205 will activate the interlock SD-4 to close inlet valve TV-2220	1	4	4					
		Suction strainer choking		FAL-2218 is in place								
14N .6.	Low/No flow in E-2211	1. No vaporization in V-2212	1. No condensation	None, intermittent operation	1	5	5					
14N .7.		1. High flow from u/s	1. Less condensation in E-2203 leading to	Higher condensate	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	More flow to E-2203 and E-2204 tube side		condensing load shifting to E-2204 leading to process upset.	temp will open TV-2220. TAH-2220								
14N .8.	More flow E-2204 Shell side	1. TV-2220 malfunctioning	1. Increase in level shell side leading to more evaporation in tube side. Mechanical damage of the tube leading to asset loss.	LAH-2204 LSHH-2205 will activate SD-4 which will close inlet valve TV-2220 RV-2207	1	4	4					
14N .9.	More flow in V-2202	1. More condensation from E- 2203 ,E-2204 and E-2211 Plant upset	1. Rise in level of feed tank V-2202 leading to over pressurization of feed tank (V-2202) leading to rupture of the vessel leading to release of HC into the environment, potential ignition resulting into injury to the operating personnel.	LAH-2208 PAH-2213 RD-2208 RV-2206	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
14N.10.	More flow in P-2201A/B	1. Malfunctioning of control valves LV-2203 ,FV-2217 on discharge	1. Low level in V-2202 resulting in dry running of pump P-2202 leading to pump damage	LAL-2208 in V-2202 FAH-207 is provided on Quenching tower.	3	4	12					
14N.11.	More flow in P-2203A	1. Malfunctioning /wrong operation of FV-2218	1. Low level in E-2204 resulting of dry running of P-2203A resulting in pump damage.	LAL- 2204 in E-2204 FAH-2218	3	4	12					
14N.12.	More flow in E-2211	1. More flow from V-2205	1. Lower condensation and rise in pressure	Balancing line is provided to main process stream. pressure cannot increase. Intermittent operation	1	5	5					
14N.13.	Reverse flow in E-2203	1. Tube leak	1. Hydrocarbon will get into cooling water	PHI-2201 with low alarm	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			(CW) circuit.pH will drop steeply									
14N.14.	Reverse flow in E-2204	1. Tube leak	1. Crude products will enter into process side leading to process upset.	Annual inspection of tube bundle.	1	4	4					
14N.15.	Reverse flow line number A. 80-BB4-CP-20319 B.80-BB4-CP-20321	1. Pump 2201 trip Low discharge pressure of pump	1. Reversal of gas from Quench tower T-2201 into V-2202 Reverse gas flow from recycle tower T-2202(OP about 9kg/cm2g) , over pressurization of V-2202 leading to possible damage of V-2202	None to prevent reverse gas flow PAHH-2213 on V-2202	1	5	5					
14N.16.	Misdirected flow	1. No credible cause identified										
14N.17.	As well as Flow	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
14N.18.	Low Temperature in E-2203 Tube side (Process side)	1. Inlet temp low	1. More condensation . No serious consequences									
14N.19.	Low Temperature in E-2204 tube side	1. low pressure in shell side	1. More condensation in tube side leading to lowering temp in tube side. No serious consequences.	TAL-2220 TALL-2220								
14N.20.	Low Temperature in E-2204 Shell side	1. Low shell side pressure.	1. More condensation in tube side. No serious consequences	TAL-2219								
14N.21.	Low Temperature in V-2202	1. Low condensation temp	1. No serious consequences	TAL-2221								
14N.22.	More Temperature in E-2203 tube side	1. High temp from u/s cooling water failure	1. Load will shift to E-2204 and E- 2205 leading to production upset leading to production loss, change in product	TAH-2217	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		High temp of cooling water scaling in shell side Process side tube choking	composition leading to process upset									
14N.23.	More Temperature in E-2204 tube side	1. High temp from u/s High temp in shell side Tube side choking Suction strainer choking of pump P-2202A/B Malfunctioning of TV-2220	1. Load will shift to E-2205 leading to production upset leading to production loss, Change in product composition leading to process upset.	TAH-2220	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
14N.24.	More Temperature in E-2204 Shell side	1. High inlet temp on tube side High pressure on shell side	1. Low condensation on tube side leading to load getting shifted to E-2205 leading to change in product composition leading to process upset.	TAH-2219	1	5	5					
14N.25.	More Temperature in V-2202	1. High condensation temp	1. No serious consequences	TAH-2221								
14N.26.	More pressure in E-2203 and E-2204 tube side	1. High pressure from u/s	1. Condensation will increase	PAH-2213 is provided	1	4	4					
		Inadvertent closing of XV-2205. Tube blockage in E-2203 and 2204 Tube leak in E-2204	2. Increase in pressure of V-2202	PAH-2213 is provided	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
14N .27.	More pressure in E-2204 Shell side	1. Malfunctioning of PV-2214 High level in shell side.	1. Low evaporation and condensation on shell side leading to process upset.	RD-2207	1	4	4					
				RV-2207								
14N .28.	More pressure in V-2202	1. High system pressure Inadvertent closing of XV-2204.	1. Rise in level of feed tank V-2202 leading to over pressurization of feed tank (V-2202) leading to rupture of the vessel leading to release of HC into the environment, potential ignition resulting into injury to the operating personnel.	PAH,HH-2213	1	4	4					
				RD,RV-2206								
14N .29.	Less Pressure in E-2203 and E-2204 tube side	1. Low pressure from u/s Malfunctioning of PV-2218 A	1. Low evaporation and condensation on tube side leading to process upset.	PAL-2213	1	4	4					
14N .30.	Less Pressure in E-2204 Shell side	1. Malfunctioning of PV-2214	1. No serious consequences									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Low inlet flow	1. No serious consequences									
		3. Low condensation in tube side	1. No serious consequences									
		4. Low evaporation on shell side	1. No serious consequences									
14N.31.	Low pressure in V-2202	1. Low system pressure	1. Drop in level of feed tank V-2202 leading to dry running of pump P- 2201A/B leading to leakage of HC potential ignition fire hazard, injury to the operating personnel	SD-1 will activate at low pressure LAL-2208	1	4	4					
14N.32.	High level in E-2204 shell	1. Malfunctioning of TV-2220 Malfunctioning of LT/LV- 2204	1. Liquid carryover to Vapour side. Leading to rise in level leading to reduction in plant	LAH-2204 LSHH-2205 will activate interlock SD-4 will close TV-2220	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Pump P-2203A tripping	load leading to process upset.									
14N.33.	High level in V-2202	1. Tripping of pump P-2201A/B More liquid in flow	1. same as high flow	LAH-2208	1	4	4					
14N.34.	High level	1. More condensation from E- 2203 and 2204	1. Increase in level in V-2202 leading to possible increase a pressure leading process upset.	LAH-2206 LAH-2207	1	5	5					
		2. XCV -2205 malfunctioning to closed position	1. Flooding of S-2201 and S-2202 entering the liquid into Vapour space resulting to lower condensation in E- 2204 and E- 2205. leading to process upset.	Alarm for XV-2205 is provided with valve close induction (XZAL-2205)	1	5	5					
14N.35.	Low level in E-2204 shell	1. 1. Low flow from u/s	1. Low condensation on tube side leading	LAL-2204	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of TV-2220 Malfunctioning of LT/LV- 2204 High process side inlet temp	to reduction in plant load. Leading to process upset.									
14N .36.	Low level in V-2202	1. Low condensation on the process side Malfunctioning of XCV- 2204	1. Cavitation of pump- P-2201A/B/C and possible damage to pumps Process upset	LAL-2208 .	5	4	20					
14N .37.	Low level	1. Loop bypass Valve passing/ wrong opening	1. Low gas break through into V-2202 with ultimate equalization of pressure	Dip leg provided on the liquid drain line from S- 2201 and S-2202 which is adequate to prevent gas	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				break through into V-2202								
14N.38.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
14N.39.	More/ Less pH	1. Not Applicable										
14N.40.	Agitator Failure	1. Not Applicable										
14N.41.	Power failure											
14N.42.	Utility Failure- Cooling Water	1. Tripping of cooling tower pumps.	1. Low condensation in process side leading to rise in pressure resulting to plant shut down.	SD-1 will shut down the plant Cooling Tower pumps stop alarms are provided.	1	4	4					
14N.43.	Mechanical Failure / Leakage-Tube leak	1. Tube leak	1. Crude products will enter into process side .	Annual inspection of tube bundle.	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
14N.44.	Mechanical Failure / Leakage-Tube leak	1. Corrosion and Mechanical damage	1. Process gases will enter into cooling water side will increase acidity of cooling water.	low pH-2901 alarm is provided at 6.5, located at cooling tower far away	1	4	4					1. It is suggested to manually check the pH of cooling water outlet of E-2211 once a day.
14N.45.	Fire / Explosion / Ignition Source	1. No credible cause identified										
14N.46.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
14N.47.	Sampling Hazards	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 14.

P&IDs: 1308-7001-L203

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
14N.48.	Personal Protection Hazards	1. No credible cause identified										
14N.49.	Other- Loss of containment	1. Mechanical seal failure of Pump -P-2201A/B/C(Single mechanical seal)	1. Possibility of fire Leakage into atmosphere leading to environment degradation.	P-2201A/B/C (Single mechanical seal of better quality) is provided	2	4	8					
		2. Mechanical seal failure of Pump -P-2203A (Single mechanical seal)	1. Leakage into atmosphere leading to environment degradation and health hazards Possibility of fire Cloud of anhydrous HCl resulting to possible severe injury	P-2201A/B/C (Single mechanical seal of better quality) is provided	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N .1.	Low/No flow E-2205-1 tube side	1. Malfunctioning of PV-2218A to fully closed position	1. E-2205-1 outlet temp will decrease lowering the vaporization in shell side. No serious consequences	TAL-2222	1	4	4					
15N .2.	Low/No flow E-2205-1 Shell side	1. Refrigeration compressor trip	1. Reduction plant load and possible plant shutdown	1. LAL-2209 is provided	1	4	4					
			2. Low level in E-2205 -1									
15N .3.	Low/No flow E-2205-2 Shell side	1. Low flow from u/s	1. Low condensation E-2205-3	Compressor can be brought back within 24hr								
15N .4.	Low/No flow E-2205-3 Shell side	1. Malfunctioning of LV- 2209A/B to fully closed position	1. Low condensation of E-2203-1 more pressure on the tube side, leading to process upset.	SOP is in place.								
			2. Refer to high pressure on tube side E- 2205-1									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N .5.	Low flow in pump-P- 2202A/B	1. Malfunctioning of TV-2220 (inlet to E-2204)	1. lower vaporization in E-2204 resulting in process upset.	LAH -2211 on V-2203	1	4	4					
			2. Increase in Level in V-2203	LAH -2211 on V-2203	1	4	4					
15N .6.	More flow E-2205-1 tube side	1. Malfunctioning of PV-2218A High flow from u/s	1. E-2205-1 outlet temp will increase leading to more vaporization in E-2205-1 resulting to higher pressure on shell side	PAH-2215 is provided	1	4	4					
				RV-2823 is provided set pressure 16.5kg/cm2g design pressure 20kg/cm2g								
				TAH-2222 is provided								
15N .7.	More flow E-2205-1 Shell side	1. high flow from u/s (compressor receiver)	1. High level in E-2205-1	1. LAH-2209	1	4	4					
			2. More oil will carryover		1	4	4					
			3. More condensation in 2205-3 .		1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			4. No serious consequences									
15N .8.	More flow E-2205-2 Shell side	1. high flow from u/s (compressor receiver)	1. High level in E-2205-1	1. LAH-2209	1	4	4					
			2. More oil will carryover		1	4	4					
			3. More condensation in 2205-3 .		1	4	4					
			4. No serious consequences									
15N .9.	More flow E-2205-3 tube side	1. high flow from u/s (compressor receiver)	1. High level in E-2205-1	1. LAH-2209	1	4	4					
			2. More oil will carryover		1	4	4					
			3. More condensation in 2205-3 .		1	4	4					
			4. No serious consequences									
15N .10.	More flow to V-2203	1. conditions are similar to E-	1. Increase in level in V-2203 may resulting to overfilling leading to	LAH -2211	1	5	5					
				RV-2209 set at 10kg/cm2g								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2205- 1 tube side	rise in pressure leading to leakage resulting release of HC into the environment, possible fire hazard	RD-2209 set at 10kg/cm2g								
15N .11.	More flow in pump-P- 2202A/B	1. Malfunctioning of TV-2220 (inlet to E-2204)	1. 1. Drop in level of V-2203 leading to dry running of the pump leading to leakage from pump resulting to damage to pumps/loss of containment High level in E-2204 leading likely over pressurization of E-2204.	LAL-2211 on V-2203 Dry running protection for pump P-2202A/B (Low amp) FAH,FAHH-2212 PAH,PAHH-2217 High level in E-2204 shell side LSHH-2205 will activate the interlock SD-4 closing TV-2220	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N .12.	Reverse flow	1. Lower pressure after PV-2218 A due to malfunctioning of PV- 2219A and PV-2219B	1. Process gas containing CH ₃ Cl and H ₂ O can reverse into HCl gas line causing extensive corrosion.	None	2	4	8					
15N .13.	Reverse flow from E- 2204 shell side to V- 2203	1. P-2202 A/B trips	1. Increase in level in V- 2203 Emptying of E-2204 shell side due high elevation No cooling in E-2204 High inlet temp in E- 2205-1 Process upset	LAH- 2211 on V- 2203 PAH,PAHH-2216 on V-2203	1	5	5					
15N .14.	Misdirected flow	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N .15.	As well as Flow	1. No credible cause identified										
15N .16.	Low Temperature E-2205-1 tube side	1. Low inlet temp Higher cooling from shell side Lower shell side pressure	1. Load on E-2103 will increase (Hydro section)	TAL-LL -2222 is provided. Temp control TC-2102 provided on E-2103 (Hydro section)	1	4	4					
15N .17.	Low Temp E-2205-1 Shell side	1. Low pressure on shell side of E-2205-1	1. conditions are similar to E-2205-1 on shell side	Same as low pressure in E-2205-1	1	4	4					
15N .18.	Low Temp E-2205-2 Shell side	1. Low pressure on shell side of E-2205-1	1. conditions are similar to E-2205-1 on shell side	Same as low pressure in E-2205-1	1	4	4					
15N .19.	Low Temp E-2205-3 tube side	1. Low pressure on shell side of E-2205-1	1. conditions are similar to E-2205-1 on shell side	Same as low pressure in E-2205-1	1	4	4					
15N .20.	Low temp in V-2203	1. conditions are similar to E-										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2205- 1 tube side										
15N .21.	More Temperature E-2205-1 process inlet tube side	1. Less heat recovery in E-2203 and 2204	1. High outlet temp leading to upset in downstream process. No serious consequences	TAH-2222	1	4	4					
15N .22.	More Temperature E-2205-1 process outlet tube side	1. Due to high pressure on shell side resulting in higher temp in shell side and lower cooling Lower level in shell side Fouling of tubes	1. Higher temp of gas going to Hydro section. Process upset in hydro reactor Possible side reaction	TAH-2222 TIC -2102 provided on E-2103, to control excess inlet temp.	1	4	4					
15N .23.		1. High inlet temp on tube side.	1. Suction pressure and consequently the	RV-2823 is provided on E-	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	More High Temp E-2205-1 Shell side	High pressure in Shell side	discharge pressure of R22 compressor will increase.	2205-1 set at 16.5kg/cm2g PAH-2215								
			More vaporization in shell side of E- 2205-1 leading to high pressure.	Compressor trip on the high pressure								
15N .24.	More High Temp E-2205-2 Shell side	1. High inlet temp on tube side. High pressure in Shell side	1. Suction pressure and consequently the discharge pressure of R22 compressor will increase.	RV-2823 is provided on E-2205-1 set at 16.5kg/cm2g PAH-2215	1	4	4					
			More vaporization in shell side of E- 2205-1 leading to high pressure.	Compressor trip on the high pressure								
15N .25.	More Temp E-2205-3 tube side	1. High inlet temp on tube side. High pressure in Shell side	1. Suction pressure and consequently the discharge pressure of R22 compressor will increase.	RV-2823 is provided on E-2205-1 set at 16.5kg/cm2g PAH-2215	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			More vaporization in shell side of E- 2205-1 leading to high pressure.	Compressor trip on the high pressure								
15N .26.	More temp in - 2203	1. conditions are similar to E- 2205- 1 tube side										
15N .27.	More pressure in E-2205-1 tube side	1. Malfunctioning of PV-2218A to fully closed position High pressure from u/s	1. High back pressure unto reactor	PAH-2218 B PV-2218 B is provided to relieve excess pressure PSHH-2208 on reactor will activate SD-1 to trip reactor, if pressure continuous to rise	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				PV-2218 B get a signal from another PT (separate PT is available)								
15N .28.	More pressure in E-2205-1 shell side	1. High Pressure E-2205-1 due to high tube side inlet temp	1. Suction pressure and consequently the discharge pressure of R22 compressor will increase.	RV-2823 is provided on E-2205-1 set at 16.5kg/cm2g PAH-2215 Compressor trip on the high pressure	1	4	4					
15N .29.	More pressure in E-2205-2 shell side	1. High Pressure E-2205-1 due to high tube side inlet temp	1. Suction pressure and consequently the discharge pressure of R22 compressor will increase.	RV-2823 is provided on E-2205-1 set at 16.5kg/cm2g PAH-2215 Compressor trip on the high pressure	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N .30.	More pressure in E-2205-3 shell side	1. High Pressure E-2205-1 due to high tube side inlet temp	1. Suction pressure and consequently the discharge pressure of R22 compressor will increase.	RV-2823 is provided on E-2205-1 set at 16.5kg/cm2g	1	4	4					
				PAH-2215								
				Compressor trip on the high pressure								
15N .31.	More pressure In V-2203	1. conditions are similar to E-2205- 1 tube side	1.	RD-2209	1	5	5					
				RV-2209								
				PAH-2218A/B								
15N .32.	Low Pressure E-2205-1 tube side	1. Malfunctioning of PV-2218 A Malfunctioning /inadvertent opening of PV-2218B	1. Process upset in reactor system	PAL-2218A	1	4	4					
				PAL-2218B								
15N .33.	Low Pressure E-2205-1 Shell side	1. Less vaporization on shell side	1. Low suction pressure in R-22 compressor resulting in low	Compressor trips on low suction pressure	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		(less condensation on tube side) Low level in shell side	discharge pressure leading to process upset	PAL-2215								
15N.34.	Low pressure in V-2203	1. conditions are similar to E-2205- 1 tube side										
15N.35.	High Level E-2205-1 Shell side	1. Malfunctioning of LV- 2209A/B to fully open Low vaporization due to low process inlet temp.	1. 1. Increase in E-2205-1 shell side pressure leading to increase suction pressure of R22 compressor. Process upset. Overfilling of E-2205-1 shell side leading to liquid carryover to compressor suction	Compressor trips on high suction pressure Compressor trips in high level in compressor suction KOD LAH-2209	1	4	4					
				LAH-2210	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N .36.	High level in S-2203	1. high condensation on process side from E-2205-1 Malfunctioning of XCV-2207	1. Overfilling of liquid into vapor line to Hydro section, resulting in hammering and damage to pipeline and equipment's Increase in system pressure leading to process upset Likely plant shut down	PAH-2218A								
				PAH-2218B								
				XCV-2207 close alarm .								
15N .37.	High level in V-2203	1. High condensation on process side	1. High level in V--2203 leading to overfilling of the vapor line resulting in hammering and damage to piping and equipment's	LAH-2211	2	4	8					
				RV-2209								
				RV-2209	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Pump P-2202A/B tripping	1. High level in V--2203 leading to overfilling of the vapor line resulting in hammering and damage to piping and equipment's	Pump P-2202A/B trip alarm								
		3. Malfunctioning of TV-2220 (inlet to E-2204)	1. High level in V--2203 leading to overfilling of the vapor line resulting in hammering and damage to piping and equipment's	RD-2209 V-2203 volume is large and sufficient time is available for to take proper	2	4	8					
15N .38.	Low Level E-2205-1 Shell side	1. Malfunctioning of LV- 2209A/B to fully closed High vaporization due to high process inlet temp.	1. Low condensation on tube side Increase in system pressure Process upset	LAL-2209 Compressor trips on low suction pressure	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			Low pressure on shell side E-2205-1									
15N.39.	Low level in S-2203	1. Low condensation E-2205-1	1. No serious consequences									1. Recommended to provide LAL alarm on LT-2210
15N.40.	Low level in V-2203	1. Malfunctioning of TV-2220 (inlet to E-2204) Malfunctioning of XCV-2207 Low condensation in E-2205-1 process side	1. Pump cavitation P-2202A/B resulting in lower evaporation in shell side E-2204. Process upset. Dry running of the pump P-2202A/B leading to leakage from pump resulting to damage to pumps /loss of containment	LAL-2211 on V-2203 PAL-2217 on pump discharge FAL-2212 on pump discharge	1	4	4		1	4	4	

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N.41.	Other Than Flow/ Contamination/ Composition/ Concentration- Different chemical	1. Change in product ratio in V- 2203	1. Possible cavitation in pump P-2202A/B , even at normal level	Recycle line from P-2202 to V-2203 is always open.	1	5	5					
			2. No other serious consequences									
15N.42.	More/ Less pH	1. Not Applicable										
15N.43.	Agitator Failure	1. Not Applicable										
15N.44.	Power failure	1. Power failure from grid	1. Plant shutdown									
15N.45.	Utility Failure- Cooling Water											
15N.46.	Mechanical Failure / Leakage-											
15N.47.	Mechanical Failure / Leakage-Tube leak In E-2205-1	1. Corrosion and Mechanical damage	1. Process gas enters R-22 system leading to severe corrosion	PAH-2215	1	5	5	6. Regular planned inspection of tubes.	1	4	4	
				RV-2823								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			Increase in temp and pressure in shell side. Mixing of liquid on shell side affecting evaporation and vaporization. Plant shut down									
15N.48.	Mechanical Failure / Leakage-Tube leak In E-2205- 2 and E-2205-3	1. Corrosion and Mechanical damage	1. Mild temp variation on R22 inlet to E-2205-1									
			2. No serious consequences									
15N.49.	Fire / Explosion / Ignition Source	1. No credible cause identified										
15N.50.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 15.

P&IDs: 1308-7001-L203

1308-7001-L204

Node Description and Intent: Condensation and recycle section

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
15N.51.	Sampling Hazards	1. No credible cause identified										
15N.52.	Personal Protection Hazards	1. No credible cause identified										
15N.53.	Other- Relief & blow down	1. High pressure in V-2203	1. No serious consequences as blowdown is taken to caustic scrubber									

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				FAL-2217	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
16N .1.	Low/No flow Main feed from P-2201A/B to T-2202	1. Malfunctioning of FV-2217	1. Fall in level in T-2202 leading to rise in top temp of the column leading to increase in bottom temp resulting to process upset. Higher Quench Tower T-2201 top temp resulting in reactor trip (SD-1)	TAH-2227								
				TAHH-2227								
				TAH-2224								
				LAL-2212								
				This situation can be tolerated up to 15 min by this type spare pump P-2201 must be started								
16N .2.	Low/No flow from P-2203 to T-2202	1. Malfunctioning of FV-2218	1. Increase in top temp leading to more MDC on top ,no serious consequences	FALL-2218	1	5	5					
				TAH-2227								
				TAHH-2227								
16N .3.	Low/No flow from P- 2204 (Reflux) to T- 2202	1. Malfunctioning of FV-2219 Tripping of pump P-2204B	1. Top temp of T-2202 will increase resulting to Increase in column pressure. Resulting to Column pressure profile will	TAH2227	1	5	5					
				TAHH-2227								
				PAH-2221								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			upset leading to process upset.									
16N .4.	Low/No flow of steam to T- 2202	1. Malfunctioning of TV-2224	1. Low temp in reboiler leading to lower temp in column leading to low pressure in the column resulting upset in distillation in the column-T-2202	TAL-2224	1	5	5					
				TALL-2224								
				PAL-2220								
				PALL-2220								
16N .5.	Low/No flow to Reflux Tank V2204 through Condenser E2207	1. HIC-2202 malfunction and stuck close	1. No process upset									
		2. XCV-2209 malfunction and stuck close	1. No process upset									
16N .6.	Low flow in P-2204B	1. pump tripping and cavitation	1. High top temp of column T-2202 Upset in distillation	FAL-2219	1	4	4					
				FALL-2219								
				Intermittent operation								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
16N .7.	More flow in T-2202. Main feed from P-2201A/B	1. FV-2217 malfunctioning	1. Increase in level T-2202 leading to upset in distillation leading to column flooding and product recovery will change resulting to process upset.	LAH-2212	1	5	5					
				FAH-2221 on crude product line (bottom product)								
				PAH-2221								
				PSHH-2220 will activate the interlock SD-5 to close TV-2224 on steam line								
				FAH-2217 on main feed line								
			2. High pressure drop in column possible increase in pressure leading to process upset.		1	5	5					
16N .8.	More flow from P-2203 to T-2202	1. Malfunctioning of FV-2218	1. Decrease in top temp of T-2202	FAH-2218	1	5	5					
				TAL-2227								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			leading to affecting distillation leading to process upset.	TALL-2227								
16N .9.	More flow from P-2204 (Reflux) to T-2202	1. Malfunctioning of FV-2219	1. Decrease in top temp of T-2202 leading to affecting distillation resulting to low MDC content on top resulting to process upset.	TAL-2227	1	5	5					
				TALL-2227								
				FAH-2219								
16N .10.	More flow of steam to T-2202	1. Malfunctioning of TV-2224	1. Increase in temp in the column leading to rise in column pressure will disturb the pressure profile of the column leading to process upset	TAH-2224	1	5	5					
				TAHH-2224								
				PAH-2220								
				PAHH-2220								
				PSHH-2220 will activate interlock SD-5 to close TV-2224 on steam line								
				RD-2210								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				RV-2210								
16N .11.	More flow to Reflux Tank V2204 through Condenser E2207	1. HIC-2203 malfunction and stuck close	1. High level in V-2204 may lead to pressurization of V-2204 and minor leakages from any of the flanges joints of pipelines and connecting lines leading to area operator exposure	LT-2213 with High Level Alarm LAHH2213	4	1	4					
				PT-2222 with High Pressure Alarm PI-222								
				RD-2212 and PSV RV-2212 is provided on the V-2204								
				Onsite Emergency Response plan available								
				Gas Detectors are available to alert people								
			2. High level in V-2204 may lead to pressurization of V-2204 and minor	LT-2213 with High Level Alarm LAHH2213	3	1	3	7. Ensure system is in place as part of Onsite Emergency Response plan to	3	1	3	

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			leakages from any of the flanges joints of pipelines and connecting lines leading to environment impact (reportable release to the environment)	PT-2222 with High Pressure Alarm PI-222 RD-2212 and PSV RV-2212 is provided on the V-2204 Onsite Emergency Response plan available Gas Detectors are available to alert people				control & contain gaseous mixture at Incident location (like use of multiple fire water monitors and multiple Mayura curtains), thereby minimizing onsite and offsite environment impact to minimum level				
			3. Flooding of T-2202 may lead to process upset with no major PEAR (Person, Environment, Asset, Reputation) impact									
		2. More steam to Reboiler E-2206 of T-2202 due	1. Possible pressurization of T-2202 may lead to	PT-2221 with High Pressure Alarm PI-2221	4	1	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		to loop malfunction of TCV-2224	minor leakages from any of the flanges joints of pipelines and connecting lines leading to area operator exposure	RD-2212 and PSV RV-2212 is provided on the V-2204 Onsite Emergency Response plan available Gas Detectors are available to alert people								
			2. Possible pressurization of T-2202 may lead to minor leakages from any of the flanges joints of pipelines and connecting lines leading to environment impact (reportable release to the environment)	PT-2221 with High Pressure Alarm PI-2221 RD-2212 and PSV RV-2212 is provided on the V-2204 Onsite Emergency Response plan available	3	1	3	7. Ensure system is in place as part of Onsite Emergency Response plan to control & contain gaseous mixture at Incident location (like use of multiple fire water monitors and multiple Mayura curtains), thereby	3	1	3	

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				Gas Detectors are available to alert people				minimizing onsite and offsite environment impact to minimum level				
16N.12.	More flow in P-2204B	1. Malfunctioning of FV-2219	1. Low top temp of column T-2202 Upset in distillation	FAH-2219 FAHH-2219 Intermittent operation	1	4	4					
16N.13.	Reverse flow from V-2202 to V-2301	1. Isolation valve on line 50- BB4-20508 is kept open inadvertently	1. Reverse flow from V-2202 (OP.pressure 6.5kg/cm2 into V-2301 operating at 1Kg/cm2) C1 and HCl will get mixed with crude CMS in V-2301 resulting to upset the product quality of MDC .	No safeguards available	1	5	5					
16N.14.	Misdirected flow	1. No credible cause identified										

 GFL GUJARAT FLUORO-CHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

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					S	L	RR		S	L	RR	
16N .15.	As well as Flow	1. No credible cause identified										
16N .16.	High Temperature in T-2202	1. Malfunctioning of TV-2224	1. High pressure in column T-2202 Leading to high top temp of the tower T-2202 resulting to upset in distillation	PAH-2221	1	5	5					
				RD-2210								
				RV-2210								
				TAH-2227								
16N .17.	High temp E-2206 steam side	1. High temp from B/L (Improper pressure control and less desuperheating)	1. More boiling leading to high temp column bottom resulting to high column pressure resulting to disturb the column pressure profile resulting to process upset.	TAH-2224	1	5	5					
				TAHH-2224								
				PAH-2220								
				PAHH-2220								
				PSHH-2220 will activate interlock SD-5 to close TV-2224 on steam line								
				RD-2210								
				RV-2210								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

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					S	L	RR		S	L	RR	
16N .18.	Low Temperature in T-2202	1. Low temp in reboiler High flow from P-2203	1. Distillation will be upset leading to more of C1 and HCl in the bottom product leading Increase in column level leading Increasing bottom product flow resulting to process upset.	LAH-2212	1	5	5					
				FAH-2221								
				TAL-2224								
16N .19.	Low Temp E-2206 in steam side	1. Low temp from B/L	1. Low boiling in reboiler leading to low pressure in column T-2202, .No serious consequences	TAL-2224	1	5	5					
				TALL-2224								
				PAL-2220								
				PALL-2220								
16N .20.	More Pressure in T-2202	1. Malfunctioning of PV-2221 Closure of HIC-2203	1. Rise in pressure in tower T-2202 leading to upset the column pressure profile leading to process upset.	PAH-2221	1	5	5					
				PSHH-2220 will activate the interlock SD-5 to close TV-2224 on steam line								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

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					S	L	RR		S	L	RR	
		More reboiling in E-2206		SOP is in place								
				RD-2210								
		CW failure in E-2207		RV-2210								
		Inadvertent closing of HV-2203										
16N.21.	More Pressure in E-2206 steam side	1. Header pressure goes high	1. High temp of steam and high process temp leading to possibility of steam entering on process side when the tube leaks resulting extensive corrosion	TAH-2224	2	5	10	8. Provide PAH on steam line set at 9 kg/cm2	1	5	5	
				TAHH-2224				9. Provide high Pressure alarm on PIC 2832, set point to be kept at level not exceeding normal operating pressure T-2202 bottom				
				PAH-2220								
				PAHH-2220								
				PSHH-2220 will activate								

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				interlock to close TV-2224 on steam line								
16N .22.	More Pressure in V-2204	1. HIC-2203 malfunction and stuck close	1. High level in V-2204 may lead to pressurization of V-2204 and minor leakages from any of the flanges joints of pipelines and connecting lines leading to area operator exposure	LT-2213 with High Level Alarm LAHH2213	4	1	4					
				PT-2222 with High Pressure Alarm PI-222								
				RD-2212 and PSV RV-2212 is provided on the V-2204								
				Onsite Emergency Response plan available								
				Gas Detectors are available to alert people								
			2. High level in V-2204 may lead to	LT-2213 with High Level	3	1	3	7. Ensure system is in place as part of	3	1	3	

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

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					S	L	RR		S	L	RR	
			pressurization of V-2204 and minor leakages from any of the flanges joints of pipelines and connecting lines leading to environment impact (reportable release to the environment)	Alarm LAHH2213 PT-2222 with High Pressure Alarm PI-222 RD-2212 and PSV RV-2212 is provided on the V-2204 Onsite Emergency Response plan available Gas Detectors are available to alert people				Onsite Emergency Response plan to control & contain gaseous mixture at Incident location (like use of multiple fire water monitors and multiple Mayura curtains), thereby minimizing onsite and offsite environment impact to minimum level				
16N.23.	Less pressure in T-2202	1. Low steam to reboiler Malfunctioning of PV-2221 Inadvertent opening of XV-	1. Low pressure in column leading to upset the temp profile of the column resulting to upset in distillation leading to plant shut down	PALL-2221	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

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					S	L	RR		S	L	RR	
		2210 on emergency relief line										
16N .24.	Less pressure in E-2206 shell side	1. Less reboiling	1. Upset in distillation column T-2202									
			2. No serious consequences									
16N .25.	Less pressure in V-2204	1. No credible cause identified										
16N .26.	High level in T-2202	1. High flow from u/s Low reboiling Malfunctioning of LV-2212	1. Overfilling of the column leading to Increase in pressure leading to possible damage to column trays resulting to hammering in column.	LAH-2212	2	4	8		1	5	5	
				PAH-2221								
				PAH-2220								
				PAHH-2220								
				RV-2210								
				RD-2210								
16N .27.	High level in V-2204	1. Refer Deviation "More flow to Reflux Tank V2204 through										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Condenser E2207 " and Cause "HIC-2203 malfunction and stuck close"										
16N.28.	Low Level in T-2202	1. Malfunctioning FV-2217 Malfunctioning LV-2212	1. Insufficient circulation in reboiler leading to overheating of reboiler tube resulting to possible failure of tubes in reboiler Possible emptying of T-2202 into V-2301	LAL-2212 TAH-2224	2	4	8	10. Recommended to close LV-2212 on LALL	1	5	5	
16N.29.	Low level in V-2204	1. No credible cause identified										
16N.30.	Other Than Flow/ Contamination/	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	Composition/ Concentration											
16N .31.	More/ Less pH	1. Not Applicable										
16N .32.	Agitator Failure	1. Not Applicable										
16N .33.	Power Failure	1. Power failure from grid	1.	System will go in Safe Shutdown mode in case of power failure								
16N .34.	Utility Failure-Cooling Water	1.	1.	System will go in Safe Shutdown mode in case of Cooling water failure								
16N .35.	Steam high flow	1. More steam to Reboiler E-2206 of T-2202 due to loop malfunction of TCV-2224	1. Possible pressurization of T-2202 may lead to minor leakages from any of the flanges joints of pipelines and connecting lines	PT-2221 with High Pressure Alarm PI-2221 RD-2210 and PSV RV-2210 is provided on the T-2202	4	1	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			leading to area operator exposure	Onsite Emergency Response plan available								
				Gas Detectors are available to alert people								
			2. Possible pressurization of T-2202 may lead to minor leakages from any of the flanges joints of pipelines and connecting lines leading to environment impact (reportable release to the environment)	PT-2221 with High Pressure Alarm PI-2221	3	1	3	7. Ensure system is in place as part of Onsite Emergency Response plan to control & contain gaseous mixture at Incident location (like use of multiple fire water monitors and multiple Mayura curtains), thereby minimizing onsite and offsite environment impact to minimum level	3	1	3	
				RD-2210 and PSV RV-2210 is provided on the T-2202								
				Onsite Emergency Response plan available								
				Gas Detectors are available to alert people								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
16N .36.	Mechanical Failure / Leakage	1. Mechanical Failure Due to any reason	1. Possible leakages of MDC, Methyl Chloride leading to exposure of persons in the plant to toxic chemical which may lead to Multiple fatality	PM Schedule is available	5	1	5	11. Identify PSM Critical equipment list and develop MI Program	5	1	5	
				Inspection and testing plan of the vessels as per GFR				12. Ensure Comprehensive MIQA plan				
				NDT for critical process pipelines								
				Isolation Valve replacement as per observations and inspection check from the Plant								
				Gas Detectors are available to alert people								
				Onsite Emergency								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				Response plan available								
			2. Possible leakages of MDC, Methyl Chloride leading to measurable impact on the environment	PM Schedule is available	4	1	4	11. Identify PSM Critical equipment list and develop MI Program	4	1	4	
				Inspection and testing plan of the vessels as per GFR								
				NDT for critical process pipelines				12. Ensure Comprehensive MIQA plan				
				Isolation Valve replacement as per observations and inspection check from the Plant				7. Ensure system is in place as part of Onsite Emergency Response plan to control & contain gaseous mixture at Incident location (like use of multiple fire water monitors and multiple Mayura curtains), thereby minimizing onsite and offsite				

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

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					S	L	RR		S	L	RR	
								environment impact to minimum level				
16N.37.	Mechanical Failure / Leakage- Tube leak in E-2206	1. Corrosion and Mechanical damage	1. When steam pressure is lower than process side pressure a. Process gases containing HCl will enter steam side causing high acidity on condensate loop b. High corrosion on steam and condensate section	PHAL-2834 on condensate header CTAH-2834 on condensate header (Conductivity)	2	3	6					
			2. When steam pressure is higher than the process side pressure a. Steam enters process side causing excessive corrosion. b. Damage to equipment's	PAH-2220 PAHH-2220 PSHH-2220 will activate the interlock SD-5 to close TV-2224	2	3	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
16N .38.	Mechanical Failure / Leakage-Tube leak in E-2207	1. Corrosion and Mechanical damage	1. Process gas containing HCl enters CW side causing severe corrosion on CW circuit.	PHAL-2202 provided on CW outlet of E-2207	1	4	4					
				PHAL-2901 on CW common header								
16N .39.	Mechanical Failure / Leakage- Tube leak in E-2208 and E-2209	1. Corrosion Mechanical damage Choking of tubes due to carbon	1. Process gas containing HCl enters CW side causing severe corrosion on CW circuit.	PHAL-2203 provided on CW outlet E-2208 and E-2209	1	4	4					
				PHAL-2901 on CW common header								
				Complete exchangers being replaced once in 5 to 6 years.								
				SOP is in place to clean tube side regularly								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 16.

P&IDs: 1308-7001-L205

1308-7001-L203

Node Description and Intent: Recycle column system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
16N.40.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
16N.41.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
16N.42.	Sampling Hazards	1. No credible cause identified										
16N.43.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
16N.44.	Other	1. No credible cause identified										

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N .1.	Low/No flow in V-2301	1. Less flow from T-2202 2. Malfunctioning/Closure of LV-2212	1. Drop in level in V-2301 leading to dry running of the pump P-2301A/B/C resulting to pump damage. Refer to consequences under low level in V-2301	LAL-2303	1	5	5					
				LALL-2303								
				FAL-2221								
				FALL-2221								
				Vessel volume large								
17N .2.	Low/No flow in S-2306	1. FO-2302 provided to establish flow	1. No serious consequences									
17N .3.	Low/No flow in T-2301-1 and T-2301-2	1. Suction strainer choking in pump P-2301 Tripping of P-2301 3. Malfunctioning of FV-2301	1. fall in level in T-2301-1 and T-2301-2, leading to increase in bottom temp T-2301-1 leading to fall in pressure resulting to disturbance in distillation	FAL-2301	1	5	5					
				2. FALL-2301								
				LAL,LL-2301								
				LAL,LL-2302								
				TAH,HH-2303								
				PAL,LL-2301								
				PAL,LL-2302								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Low reflux from pump P- 2302										
17N .4.	More flow in V-2301	1. High flow from T-2202 Back flow from V-2202	1. Increase in level-2301 leading to increase in pressure of the vessel leading to leakage in vessel resulting to loss of containment	LAH-2303 LAHH-2303 Vessel volume very large to accommodate to increase in flow NRV recommended to install on line 50-BB4- 20508 FAH-2221 FAHH-2221	1	5	5					
17N .5.	More flow in S-2306	1. High flow from P-2301A/B	1. Possible effect on moisture removal in S- 2306	1. Flow orifice FO -2302 is provided at outlet	1	4	4					
17N .6.		1. Increase flow from P-2301	1. Level increase in T-2301 leading to	FAH-2301 FAHH-2301	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	More flow in T-2301-1 and T-2301 -2	2.Malfunctioning of FV-2301	lowering of column bottom temp and low reboiling leading to Increase in column pressure resulting to disturbance in distillation	LAH-2301 LAHH-2301 TAL-2303 TALL-2303 PAH-2301 PSHH-2301 will activate interlock SD-6 to close								
17N .7.	Reverse flow into all intermittent lines connected to V-2301 except 40-AB3-MCI-30211	1. No credible causes.	1.	Intermittent operation Proper SOP is available	1	5	5					
17N .8.	Reverse flow in 40- AB3-MCI-30211	1. Isolation valve on this line is passing	1. Overhead quality of top product MDC affected.		1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Liquid from V-2301 to P- 2303 A/B suction										
17N .9.	Misdirected flow from V-2202 to V-2301	1. Isolation valve on line 50- BB4-20508 is kept open inadvertently	1. Reverse flow from V-2202 (OP.pressure 6.5kg/cm2 into V-2301 operating at 1Kg/cm2 C1 and HCl will get mixed with crude CMS in V-2301 resulting to upset the product quality of MDC .		1	5	5					
17N \ .10. \	As well as Flow	1. No credible cause identified										
17N .11.	High temperature in V-2301	1. Fouling in E-2208 and E-2209	1. High temp in V-2301 Increase in pressure in V-2301	TAH-2301 TAHH-2301 RV-2301 RD-2301	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		High bottom temp of recycle column		TAH-2231 outlet of E- 2209								
17N .12.	High temperature in S-2306	1. No credible cause identified										
17N .13.	High temperature In T-2301-1 and T-2301-2	1. High Steam flow in reboiler E-2302 Low/No reflux to T-2301-1 Low/No reflux to T-2301-2	1. Disturbance in distillation and product mix leading fall in level T-2301-1 resulting to process upset.	FAH,HH-2302 FAL,LL-2303 P-2302 tripping alarm High temp Alarms on trays	1	4	4					
17N .14.	Low temperature in V-2301	1. Low temp from recycle	1. No serious consequences									
17N .15.	Low temperature in S-2306	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N .16.	Low temperature In T-2301-1 and T-2301-2	1. Low temp in reboiler	1. Disturbance in distillation and product mix leading rise in level T-2301-1 resulting to process upset.	FAL,LL-2302 on steam line to reboiler	1	4	4					
		High flow reflux		TAL,LL-2303								
		Fouling of reboiler tubes		TAL,LL-2308								
				Low temp alarm on trays								
17N .17.	More pressure In V-2301	1. N2 valve PV-2303A is passing and PV-2303B closed	1. Pressurization of V-2301 Possible full opening of LV-2212 on recycle tower bottom	Vessel pressure open to atm	1	5	5					
				PAH-2303								
				V-2301 design pressure 13 kg/cm2, much higher than N2 pressure of 6 kg/cm2								
				V-2301 volume large 5.RD-2301								
				RV-2301								
				RD-2311	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N .18.	More pressure in S-2306	1. Inadvertent closing of outlet valve	1. Pressure increasing to P-2301 maximum discharge pressure.	RV-2311 set at 12.5 kg/cm2								
17N .19.	More pressure In T-2301- 1 and T-2301-2	1. Malfunctioning of PV- 2304B CW failure in E-2301 Low flow of MDC in E-2206 Malfunctioning of PV- 2304A	1. Rise in pressure of the column leading to disturbance in distillation resulting to product mix/ process upset.	PAH,HH-2321	1	4	4					
				PAH,HH-2323								
				PAH-2301								
				PSHH-2301 will activate SD-6 to close steam valve to reboiler TV-2303								
				RV-2302								
				RD-2302								
17N .20.	Less pressure In V-2301	1. Malfunctioning of PV- 2303B Malfunctioning of PV- 2303A	1. Possible air entry into V-2301	PAL-2303	1	5	5					
17N .21.	Less pressure In S-2306	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N.22.	Low pressure In T-2301- 1 and T-2301-2	1. Malfunctioning of PV- 2304B	1. Drop in pressure of the column leading to disturbance in distillation resulting to product mix/ process upset.	PAL,LL-2321	1	4	4					
		Closure of steam to reboiler TV-2303		PAL,LL-2323								
				PAL-2301								
17N.23.	High level In V-2301	1. High flow from T-2202	1. Increase in level-V-2301 leading to increase in pressure of the vessel leading to leakage in vessel resulting to loss of containment	LAH-2303	1	5	5					
		Pump P-2301A/B is tripping/Suction strainer choking		LAHH-2303								
				Vessel volume large to take care of increase in level SOP is in place to increase downstream plant load								
17N.24.	High level in S-2306	1. No credible cause identified										
17N.25.	High level in T-2301-1	1. High inlet flow	1. Level may go beyond vapor inlet	LAH,HH-2301	1	5	5					
				FAH,HH-2301								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Low reboiling Malfunctioning of LV-2302 Malfunctioning of LV-2301 at column bottom Possible increase in pressure	nozzle causing hammering leading to damage to equipment's	TAL,LL-2303 PAH,HH-2301 5PSHH-2301 will activate SD-6 to close steam valve TV-2303								
17N .26.	High level in T-2301-2	1. high flow from T-2301-1 High reflux due to malfunctioning of FV-2303	1. Level may go beyond vapor inlet nozzle causing hammering leading to damage to equipment's	FAH,HH-2303 LAH,HH-2302 PAH,HH--2322 PAH-2302 PAH,HH-2323	1	5	5					
17N .27.	High level in S-2301	1. High flow from u/s	1. Liquid overflowing the vapor line leading hammering	LAH-2304 FAL/LL-2303	3	3	9					

 GUJARAT FLUOROchemicals SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		High condensation E-2301 and E-2206 Pump P-2302A/B trip Malfunctioning of LT-2304 Malfunctioning of FV-2303	.possible damage to equipment's.									
17N.28.	Low Level in V-2301	1. Low flow from recycle column T-2202 Malfunctioning of FV-2301	1. Drop in level in V-2301 leading to dry running of the pumpP-2301A/B/C resulting to pump damage.	LAL-2303 LALL-2303 FAH-2301 Vessel volume is large	1	4	4					
17N.29.	Low Level in S-2306	1. No credible cause identified										
		1. Low inlet flow		LAL,LL-2301	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N.30.	Low level in T-2301-1	Low reflux 3.malfunctioning of LV-2301	1. Disturbance in distillation Carbon deposited on tubes	LSLL-2301 will activate the interlock SD-6 and close steam inlet to reboiler. FAL,LL-2301								
17N.31.	Low level in T-2301-2	1. Low vapor flow from T- 2301-1 Low reflux Malfunctioning of LV-2302	1. Disturbance in distillation 2.Possibility of pump cavitation P- 2312A/B leading dry running of pump resulting to pump damage.	LAL,LL-2302 FAL,LL-2303	1	4	4					
17N.32.	Low level in S-2301	1. Low condensation in E- 2201 and E-2206 Malfunctioning of LT-2303 and FV-2303	1. Dry running of pump P-2302 leading to cavitation resulting in pump damage	LAL-2304	2	5	10					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N.33.	Other Than Flow/ Contamination/ Composition/ Concentration- Different chemical Carbon carryover from reactor section	1. Carbon formation in thermal Reactor	1. Choking and fouling of exchangers	Manual cleaning of exchangers being done regularly.	1	5	5					
17N.34.	More/ Less pH	1. Not Applicable										
17N.35.	Agitator Failure	1. Not Applicable										
17N.36.	Power Failure	1. Not Applicable										
17N.37.	Utility Failure	1. Not Applicable										
17N.38.	Mechanical Failure / Leakage- Loss of containment P-2301A/B	1. Mechanical seal failure	1. Health hazard	Pump Mechanical seal is of better quality	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N.39.	Mechanical Failure / Leakage--Loss of containment P-2312A/B	1. Mechanical seal failure	1. Health hazards									
17N.40.	Mechanical Failure / Leakage--Loss of containment P-2302	1. Mechanical seal failure	1. Fire hazards									
17N.41.	Mechanical Failure / Leakage-Tube leak in E-2301,E-2303 and E-2304	1. Corrosion Mechanical damage	1. Process fluid enters cooling water system increasing its acidity Corrosion in CW system	PHAL-2901 provided on Cooling tower.								
17N.42.	Mechanical Failure / Leakage-Tube leak in E-2306	1. Corrosion Mechanical damage	1. Process fluid enters into cold MDC system Pressurization cold MDC loop	PAH,PAHH provided on cold MDC loop Shell side and tube side liquids and compatible								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N.43.	Mechanical Failure / Leakage-Tube leak in E-2302	1. Corrosion Mechanical damage	1. Steam enters process side causing extensive corrosion Increase in pressure on process side Increase in temp on process side	PAH-2301 PSHH-2301 will activate interlock SD-6 to close the steam to reboiler								
17N.44.	Mechanical Failure / Leakage-Tube leak in E-2305	1. Corrosion Mechanical damage	1. Cold MDC can enter V-2301 affecting its composition Load on T-2301-1 and 2 will increase 3.V-2301 level will increase Possible drop in temp V-2301	LAH,HH-2303 TAL,LL-2301								
17N.45.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
17N.46.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
17N.47.	Sampling	1.	1. Due to open sampling operators are getting exposed to hazardous chemicals such as CFM and CCl4		3	3	9					
17N.48.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
17N.49.	Other-Draining from V-2301, P-2301	1.	1.	Closed drain system provided. But presently is being collected in small carboys / Half cut drums								
17N.50.	Others-Relief & blow down for S-2306	1.	1.									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 17.

P&IDs: 1308-7001-L203

Node Description and Intent: Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	Downstream of RV- 2311 a line has been taken to emergency VG- 4 header, While outlet is vented to atm											
17N .51.	Others- Venting from column overhead after E-2306	1. Continuous	1. Possible discharge of CH ₃ Cl and CH ₂ Cl ₂ into atm due disturbance upstream.		2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 18.

P&IDs: 1308-7001-L303

Node Description and Intent: CH₂Cl₂ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
18N .1.	Low / No flow from E-2304	1. Low flow from u/s 2. Malfunctioning of valve FV-2304	1. Cavitation in pump P-2303 resulting to damage to seal and pump.	FAL/LL-2304 Recirculation line from pump discharge is provided	2	4	8					
18N .2.	Low flow to T-2302	1. Malfunctioning of valve FV-2306 Tripping of Pump P-2304	1. Low level in column High bottom temp 3. Disturbance in distillation	LAL/LL-2306 FAL/LL-2306 TAH-2318	1	5	5					
18N .3.	More flow from E-2304	1. Malfunctioning of valve FV-2304 High flow from u/s	1. No serious consequences	FAH/HH-2304 FAL/LL-2304	1	5	5					
18N .4.	More flow to T-2302	1. Malfunctioning of FV-2306	1. Increase in column level Fall in bottom temp in column	LAH/HH-2306 TAL/LL-2318 TIC-2318 will close	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 18.

P&IDs: 1308-7001-L303

Node Description and Intent: CH₂Cl₂ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			2.Disturbance in distillation	condensate feed to E-2308								
18N .5.	Reverse flow	1. No credible cause identified										
18N .6.	Misdirected flow	1. Loss of caustic flow into S-2302	1. impact on neutralization of feed to T-2302 CH ₂ Cl ₂ product quality affected	Test for acidity in CH ₂ Cl ₂ product carried out 2 times a shift	1	5	5					
18N .7.	As well as Flow	1. No credible cause identified										
18N .8.	High temperature in T-2302	1. Malfunctioning of TV- 2318	1. increase in condenser load E-2307 ,E-2312	TAH/HH-2318 at the bottom TAH/HH-2319 on top	1	5	5					
18N .9.	Low temperature in T-2302	1. Malfunctioning of TV- 2318	1. Disturbance in distillation	TAL/LL-2318 at the bottom TAL/LL-2319 on top	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 18.

P&IDs: 1308-7001-L303

Node Description and Intent: CH₂Cl₂ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
18N.10.	More Pressure in T- 2302	1. high bottom temp	1. Increase in boiling point of CH ₂ Cl ₂	RV-2303	1	5	5					
				RD-2303								
		Cooling water failure in condenser E-2307	Disturbance in distillation	PAH/HH-2305								
18N.11.	Low Pressure in T- 2302	Failure of Cold CH ₂ Cl ₂										
		Malfunctioning of PV- 2305										
18N.12.	High Level in S- 2302	1. Malfunctioning of PV- 2305	1. Disturbance in distillation	PAL/LL-2305	1	5	5					
				TAL/LL-2318								
		Low column bottom temp	Process upset									
		1. Suction strainer choking of pump P- 2304A/B	1. CH ₂ Cl ₂ will overflow into waste water regeneration/drying system	LAH-2305A/B	1	5	5					
				SOP is in place to tackle the situation								
				LAH/HH-2306	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 18.

P&IDs: 1308-7001-L303

Node Description and Intent: CH₂Cl₂ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
18N .13.	High Level in T-2302	1. Malfunctioning of LV- 2306	1. Overfilling of the column	PAH/HH-2305								
				RV-2303								
		Malfunctioning of LT- 2306	Disturbing the packing	RD-2303								
		Malfunctioning of FV- 2306	liquid entry into vapor line	PAH-2319 is not shown in P&ID								
			Process upset									
			Increase in pressure									
			Hammering									
18N .14.	Low Level in S-2302	1. Tripping of pump P-2302	1. Cavitation of pump P- 2304A/B. possible seal leak resulting to damage to pump	LALL-2305A/B	2	4	8					
		Malfunctioning of valve FV- 2306		Two LT are provided on S-2302								
18N .15.	Low Level in T-2302	1. Malfunctioning of LV- 2306 and LT-2306	1. Gas breakthrough into V- 2302A/B	LAL/LL-2306	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 18.

P&IDs: 1308-7001-L303

Node Description and Intent: CH₂Cl₂ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			Possible contamination of CH ₂ Cl ₂ product									
18N.16.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
18N.17.	More/ Less pH	1. Not Applicable										
18N.18.	Agitator Failure	1. Not Applicable										
18N.19.	Power Failure	1. Not Applicable										
18N.20.	Utility Failure	1. Not Applicable										
18N.21.	Mechanical Failure / Leakage- Tube leak in E-2308	1. Corrosion Mechanical damage	1. Condensate will enter into process side causing extensive Corrosion. Condensate pressure is higher than column pressure T 2302		2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 18.

P&IDs: 1308-7001-L303

Node Description and Intent: CH₂Cl₂ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
18N.22.	Mechanical Failure / Leakage- Tube leak in E-2307 E-2309	1. Corrosion Mechanical damage	1. cooling water will enter process side causing extensive Corrosion		2	4	8					
18N.23.	Mechanical Failure / Leakage- Tube leak in E-2311 and E-2312	1. Corrosion Mechanical damage	1. Cold CH ₂ Cl ₂ will enter into process side Load on T-2302 will increase Production interruption		1	5	5					
18N.24.	Mechanical Failure / Leakage- Loss of containment P-2303A/B and 2304A/B	1. Pump-P-2303A/B seal failure	1. Health hazards- CH ₂ Cl ₂ is carcinogenic Fire hazards	Pump-P-2303A/B mechanical seal of better quality	3	4	12					
18N.25.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 18.

P&IDs: 1308-7001-L303

Node Description and Intent: CH₂Cl₂ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
18N.26.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
18N.27.	Sampling	1. No credible cause identified										
18N.28.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
18N.29.	Others- Venting	1. Venting from E-2311 through PIC-2305	1. Continuous venting of Vapors containing small quantity of CH ₂ Cl ₂ which is carcinogenic		3	4	12					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
19N .1.	Low / No flow in V- 2304	1. Low flow from T-2301	1. Fall in level in V-2304 2.cavitation and dry running of P-2306A/B	LAL/LL-2307 vessel volume large (70m3) to take care of flow variation	1	5	5					
19N .2.	Low/No flow in S-2307	1. No credible cause identified										
19N .3.	Low/No flow in T-2303-1 and T2303-2	1. Malfunctioning of FV/FT-23082. Malfunctioning of LV-23093. Malfunctioning of FV-2309	1. Low level in columns Pump cavitation P-2313 A/B	FALL-2308 LAL-2308 PAL/LL-2306 PAL/LL-2329 LAL/LL-2309 FAL-2309 TAL/LL-2332 TAL/LL-2327	1	5	5					
19N .4.	Low / No in S-2303	1. Less condensation in E- 2313 and E-2317	1. Fall in level of S-2303	Refer to level								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
19N .5.	More flow in V-2304	1. High flow from T-2301	1. Increase in level Increase in pressure	LAH/HH-2307 pressure equalization line is provided RV-2304 RD-2304 vessel volume large (70m ³) to take care of flow variation	1	5	5					
19N .6.	More flow in S-2307	1. No credible cause identified										
19N .7.	More flow in T-2303-1 and T2303-2	1. Malfunctioning of FV/FT-23082. Malfunctioning of LV-23093. Malfunctioning of FV-2309	1. Increase in level in T-2303-1 and 2 Fall in bottom temp in T-2303-1 and 2 Increase in pressure	FAHH-2308 LAH-2308 PAH/HH-2306 PAH/HH-2329 LAH/HH-2309 FAH-2309 TAL/LL-2332	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				TAL/LL-2327								
19N .8.	More flow in S-2303	1. More condensation in E-2313 and E-2317	1. Rise in level of S-2303	Refer to level								
19N .9.	Reverse flow	1. No credible cause identified										
19N .10.	Misdirected flow	1. No credible cause identified										
19N .11.	As well as Flow	1. No credible cause identified										
19N .12.	High temperature in V-2304	1. High temp from E-2303 due to failure of CW	1. increase in pressure in V-2304	PAH/HH-2308A/B	1	5	5					
				RV-2304A								
				RD-2304A								
				Vessel volume is large to take care of temp variation								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				TAHH-2313								
19N .13.	High Temp in T-2303-1 and T2303-2	1. Malfunctioning of TV-2323	1. High pressure in both columns Process upset	TAH/HH-2323	1	5	5					
				FAH/HH-2314								
				PSHH-2306 will activate interlock SD-7 to close TV-2323								
19N .14.	Low temperature in V-2304	1. No credible causes										
19N .15.	Low Temp in T-2303-1 and T2303-2	1. Malfunctioning of TV-2323	1. Process upset	FALL-2314	1	5	5					
				TAL/LL-2323								
19N .16.	More pressure in V-2304	1. Equalization valve inadvertently closed Malfunctioning of PV- 2308A/B	1. Increase in pressure	PAH/HH-2308A/B	1	5	5					
				RV-2304A								
19N .17.	More pressure in S-2307	1. Inadvertent closure of outlet valve	1. Pressure will reach RV/RD - 2312 set pressure (8 Kg/cm ² ,	Intermittent operation. RV/RD-2312	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			which is same as normal discharge pressure of P-2206A/B) Opening of RV/RD-2312 Flow of crude CMS into VG-4 system									
19N .18.	More pressure in T-2303-1 and T2303-2	1. Failure of CW of E-2313 Malfunctioning of TV-2323 Malfunctioning PV-2309A/B	1. Disturbance in distillation Production upset High temp in column	PAH/HH-2326 PAH/HH-2329 PAH/HH-2306 RV-2314 RV-2305 RD-2305 TAH/HH-2332 PSHH-2306 will activate interlock SD-7 to close TV-2323	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
19N.19.	Low pressure in V-2304	1. No credible causes										
19N.20.	Low pressure in T-2303-1 and T2303-2	1. Malfunctioning of PV-2309A/B Malfunctioning of TV-2323	1. Process upset									
19N.21.	High Level in V-2304	1. Same as high flow in V- 2304 Suction strainer choking of Pump P-2306A/B Tripping of P-2306A/B	1. Increase in level Increase in pressure	LAH/HH-2307	1	5	5					
				Pressure equalization line is provided								
				RV-2304								
				RD-2304								
				vessel volume large (70m ³) to take care of								
19N.22.	High Level in T-2303-1 and T2303-2	1. Same as high flow in T- 2303-1 and T2303-2										
19N.23.	High Level in S-2303	1. Malfunctioning of FV- 2309	1. Overfilling of S-2303 and vapor lines causing hammering, possible damage to	LAH/HH-2310	2	5	10					
				PAH/HH-2309								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Tripping of the pump P-2307A/B More condensation in E- 2313 and E-2317	equipment's and pipe Pressure fluctuation									
19N .24.	Low Level in V-2304	1. Same as low flow in V-2304	1. fall in level in V-2304 2.cavitation and dry running of P-2306A/B	LAL/LL-2307 vessel volume large (70m3) to take care of flow variation	1	5	5					
19N .25.	Low Level in T-2303-1 and T2303-2	1. Same as Low flow in T- 2303-1 and T2303-2										
19N .26.	Low in S-2303	1. Malfunctioning of FV- 2309 Less condensation in E- 2313 and E-2317	1. Cavitation and dry running of the pump P-2307A/B 2.Fluctuation in reflux flow	LAL/LL-2310 FAH/HH-2309 FAL/LL-2309	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
19N.27.	Other Than Flow/ Contamination/ Composition/ Concentration-	1. No credible cause identified										
19N.28.	More/ Less pH	1. Not Applicable										
19N.29.	Agitator Failure	1. Not Applicable										
19N.30.	Power Failure	1. Not Applicable										
19N.31.	Utility Failure	1. Not Applicable										
19N.32.	Mechanical Failure / Leakage-Loss of containment-Pump P-2306A/B	1. Seal failure	1. Liquid containing CHCl ₃ will leak out causing unconsciousness	Pump P-2306A/B (Mechanical seal of better quality) is provided	3	4	12					
19N.33.	Mechanical Failure / Leakage-Loss of containment-	1. 1.Mechanical reasons	1. Liquid containing 95% CHCl ₃ & 5% CCl ₄	Common dyke provided for volume of 150m ³ (dyke	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	Bottom flange leak in V-2304			size LxBxH 30x10x0.5m)								
19N .34.	Mechanical Failure / Leakage-Tube leak in E-2314A/B	1. Corrosion Mechanical damage	1. Steam entering column T- 2303-1 and 2 process system resulting in high pressure, Corrosion in the system.	PAH/HH-2326 and 2329 PSHH-2306 will activate interlock SD-7 to close TV-2323 No protection for Corrosion Analysis of moisture in T-2301 top (P-2307 discharge) product.	2	4	8					
19N .35.	Mechanical Failure / Leakage-Tube leak in E-2315A	1. Corrosion Mechanical damage	1. Cooling water will enter into process(Crude CCl ₄) causing , extensive Corrosion.	Moisture analysis done every shift in the top and bottom product at different locations.	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				Hydraulic test carried out for all exchangers annual turnaround								
19N.36.	Mechanical Failure / Leakage-Tube leak in E-2318A	1. Corrosion Mechanical damage	1. Cold CH ₂ Cl ₂ will enter V-2304 Composition of V-2304 will change Process upset. fall in temp in V-2304	TAL/LL-2321 Analysis of CH ₂ Cl ₂ in V-2304 carried out every shift.	2	4	8					
19N.37.	Mechanical Failure / Leakage-Loss of containment I.P-2313A/B	1. Seal Failure	1. Liquid containing CHCl ₃ will leak out which is the health hazard.	P-2313A/B (Mechanical seal of better quality) is provided	3	4	12					
19N.38.	Mechanical Failure / Leakage-Tube	1. Corrosion Mechanical damage	1. Cooling water will enter into process side causing expensive Corrosion	Analysis for moisture in top product carried out every shift.	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	leak in E-2313 and E-2316			Annual inspection and hydro test								
19N.39.	Mechanical Failure / Leakage-Tube leak in E-2317	1. Corrosion Mechanical damage	1. Cold CH ₂ Cl ₂ will enter S-2303 Change in composition of reflux fall in temp in S-2303 Process upset.	Analysis of CH ₂ Cl ₂ (Full GC) in Reflux carried out 2 times a shift.	2	4	8					
19N.40.	Mechanical Failure / Leakage-Loss of containment Pump P-2307A/B	1. 1. Seal failure	1. Leakage of CHCl ₃ causing unconsciousness	P-2307A/B (Mechanical seal of better quality) is provided	3	4	12					
19N.41.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
19N.42.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 19.

P&IDs: 1308-7001-L-304

Node Description and Intent: CHCl₃ distillation

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
19N .43.	Sampling	1. No credible cause identified	1.	Systems are established for external fire								
19N .44.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
19N .45.	Others- Venting from E- 2317	1. Valve PV- 2309B opening intermittently to maintain column pressure	1. Possible release of Hydrocarbon intermittently causing health Hazard		2	4	8					

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
20N .1.	Low / No in T- 2304	1. Malfunctioning of FV- 2312	1. Fall in level in T-2304	LAL/LL-2312	1	5	5					
				TAH/HH-2337								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Tripping of the pump P-2309A/B	Higher bottom temp Increase in column pressure Disturbance in distillation Process upset	RV-2306 RD-2306								
20N .2.	More flow in T-2304	1. Malfunctioning of FV- 2312	1. High level in T-2304 Fall in bottom temp Disturbance in distillation. Fall in pressure	LAH/HH-2312 PAL/LL-2310	1	5	5					
20N .3.	Reverse flow	1. No credible cause identified										
20N .4.	Misdirected flow	1. Loss of caustic flow into S-2304	1. impact on neutralization of feed to T-2304	Test for acidity in CHCl ₃ product carried out 2 times a shift	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			CHCl ₃ product quality affected									
20N .5.	As well as Flow	1. No credible cause identified										
20N .6.	High temperature In T-2304	1. Malfunctioning of TV- 2337	1. high pressure in the column	RV-2306	1	5	5					
				RD-2306								
			More boiling at the bottom	TAH/HH-2337								
				TAH/HH-2338								
				PAH/HH-2310								
20N .7.	Low temperature in T2304	1. Malfunctioning of TV- 2337	1. Low pressure in the column	PAL/LL-2310	1	5	5					
				TAL/LL-2337								
			Drop the temp of the column	TAL/LL-2338								
20N .8.	More pressure In T-2304	1. CW failure in E-2319 Failure cold CH ₂ Cl ₂ in E-2322	1. Disturbance in distillation	PAH/HH-2310	1	5	5					
				RV_2306								
			Release of process gas into the atm	RD-2306								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of TV- 2337										
20N .9.	Low pressure in T2304	1. Malfunctioning of TV- 2337	1. Disturbance in distillation Production upset	PAL/LL-2310	1	5	5					
20N .10.	High Level in T- 2304	1. Malfunctioning of LV- 2312 Malfunctioning of FV- 2312	1. Overfilling of the column into vapor space possible breakage of ceramic packing Possible hammering Disturbance in distillation	LAH/HH-2312 PAH/HH-2310 TAL/LL-2337 SOP is in place to bring the level to normalcy	2	4	8					
20N .11.	High Level in S- 2304	1. Tripping of the pump P- 2309A/B More condensation	1. Overfilling the vapor line causing hammering , damage to pipeline and equipment's	LAH/HH-2311A LAH/HH-2311B Overflow line is provided to regeneration/drying system	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		in E- 2322 and E-2319										
20N .12.	Low Level in T2304	1. Malfunctioning of LV- 2312 Malfunctioning of FV- 2312 tripping of pump P-- 2309A/B	1. Production upset High bottom temp High pressure in column change in composition V-2305 A/B	TAH/HH-2337 PAH/HH-2310	1	5	5					
20N .13.	Low Level in S- 2304	1. Tripping of pump P- 2308A/B Malfunctioning of FV- 2312	1. Cavitation and dry running of the pump P-2309A/B 2. Production upset.	LAL/LL-2311A LAL/LL-2311B	1	5	5					
20N .14.	Other Than Flow/ Contamination/ Composition/ Concentration-	1. No credible cause identified										
20N .15.	More/ Less pH	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
20N.16.	Agitator Failure	1. Not Applicable										
20N.17.	Power Failure	1. Not Applicable										
20N.18.	Utility Failure	1. Not Applicable										
20N.19.	Mechanical Failure / Leakage- Tube leak in E-2320	1. Corrosion Mechanical damage	1. Condensate will enter into process side causing extensive Corrosion. Condensate pressure is higher than column pressure T 2304	Moisture analysis in bottom product carried out 2 times a shift	2	4	8					
				Annual inspection and hydro test carried out								
20N.20.	Mechanical Failure / Leakage- Tube leak in E-2319 E-2321	1. Corrosion Mechanical damage	1. cooling water will enter process side causing extensive Corrosion	Moisture analysis in bottom product carried out 2 times a shift	2	4	8					
				Annual inspection and								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				hydro test carried out								
20N .21.	Mechanical Failure / Leakage- Tube leak in E-2322	1. Corrosion Mechanical damage	1. Cold CH ₂ Cl ₂ will enter into process side Load on T-2304 will increase 3.Production interruption	Contamination of CHCl ₃ in S-2304 analyzed 2 times a shift	1	5	5					
20N .22.	Mechanical Failure / Leakage- Loss of containment Pump-2308A/B	1. Seal failure	1. Escape of CHCl ₃ in atm causing health hazard	P-2308A/B (mechanical seal of better quality) is provided	3	4	12					
20N .23.	Mechanical Failure / Leakage- Loss of containment Pump-2309A/B	1. Seal failure	1. Escape of CHCl ₃ in atm causing health hazard	P-2309A/B (mechanical seal of better quality) is provided	3	4	12					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 20.

P&IDs: 1308-7001-L-306

Node Description and Intent: CHCl₃ Azeotrope system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
20N .24.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
20N .25.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
20N .26.	Sampling	1. No credible cause identified										
20N .27.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
20N .28.	Others-	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 21.

P&IDs: 1308-7001-L-307

Node Description and Intent: CH₂Cl₂ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
21N .1.	Low / No in V-2302 A/B	1. Low flow from E-2309	1. Low level in V-2302A/B	LAL/LL-2313 A/B Vessel volume is large (49m ³)	1	5	5					
21N .2.	More flow in V-2302A/B	1. High flow from E-2309	1. High level in V-2302 High pressure in V-2302	LAH/HH-2313A/B RV-2307A2/B2 PAH/HH-2311	1	5	5					
21N .3.	Reverse flow	1. No credible cause identified										
21N .4.	Misdirected flow	1. No credible cause identified										
21N .5.	As well as Flow	1. No credible cause identified										
21N .6.	High Temperature in V-2302 A/B	1. High temp from u/s (E-2309)	1. Increase in pressure More evaporation of CH ₂ Cl ₂ Loss of product	PAH/HH-2311	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 21.

P&IDs: 1308-7001-L-307

Node Description and Intent: CH₂Cl₂ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
21N .7.	Low Temperature in V-2302 A/B	1. No credible causes										
21N .8.	More pressure in V- 2302A/B	1. Malfunctioning of PV- 2311A/B Failure of Cold CH ₂ Cl ₂ in E- 2310	1. pressure increase to design pressure (3Kg/cm ²)	RV-2307A2/B2 PAH/HH-2311 One vessel is online while other is under discharge	1	5	5					
21N .9.	Low pressure in V- 2302A/B	1. Malfunctioning of PV- 2311A/B	1. No serious consequences	PALL-2311								
21N .10.	High Level in V- 2302 A/B	1. High flow from u/s Malfunctioning of LT- 2313A/B	1. Overfilling of vessel into vapor space and getting discharge at the vent . Fire Hazard Health Hazard.(Carcinogenic)	LAH/HH-2313A/B Back-up level gauges LG-2313A1/A2/B1/B2 Intermittent operation Vessel volume large SOP is in place to compare	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 21.

P&IDs: 1308-7001-L-307

Node Description and Intent: CH₂Cl₂ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				with daily production								
21N .11.	Low Level in V-2302 A/B	1. Low flow from u/s Malfunctioning of LT- 2313A/B High discharge from P-2305A/B	1. Cavitation and dry running of pump P-2305A/B	LALL-2313A will activate interlock I-30701 to trip the pump P--2305A/B	1	5	5					
21N .12.	Other Than Flow/ Contamination/ Composition/ Concentration-	1. No credible cause identified										
21N .13.	More/ Less pH	1. Not Applicable										
21N .14.	Agitator Failure	1. Not Applicable										
21N .15.	Power Failure	1. Not Applicable										
21N .16.	Utility Failure	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 21.

P&IDs: 1308-7001-L-307

Node Description and Intent: CH₂Cl₂ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
21N .17.	Mechanical Failure / Leakage- Tube leak in E-2310	1. Corrosion Mechanical damage	1. Cold CH ₂ Cl ₂ will enter V- 2302A/B No serious consequences, since the system handles CH ₂ Cl ₂	Annual inspection and Hydro test done depletion of cold CH ₂ Cl ₂ from the closed circuit loop being monitored (Cold CH ₂ Cl ₂ tank- V-2822)	1	4	4					
21N .18.	Mechanical Failure / Leakage- Loss of containment P- 2305A/B	1. Seal failure	1. Discharge of CH ₂ Cl ₂ in atm	P-2305A/B (mechanical seal of better quality) is provided	3	4	12					
21N .19.	Mechanical Failure / Leakage- Loss of containment- Failure of bottom flange of V- 2302A/B	1. Mechanical failure	1. 1.Discharge of CH ₂ Cl ₂ in atm Fire Hazard	Dyke wall is provided to contain entire volume of V- 2302A/B leakage from one vessel	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 21.

P&IDs: 1308-7001-L-307

Node Description and Intent: CH₂Cl₂ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
21N .20.	Mechanical Failure / Leakage- Loss of containment- Breakage of Stabilizer liquid bottle	1. Bottle made of glass and handled manually	1. As per MSDS 1.Highly inflammable 2.Highly toxic Can decompose in presence of light and heat	PPE used while handling	3	5	15					
21N .21.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
21N .22.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
21N .23.	Sampling	1. No credible cause identified										
21N .24.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
21N .25.	Others- Drier containing CaCl ₂ -High pressure	1. Vessel reaching shutoff pressure of	1. Design pressure not available to be checked	Vessel has not been used for long time.	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 21.

P&IDs: 1308-7001-L-307

Node Description and Intent: CH₂Cl₂ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		pump P-2305A/B	Vessel may rupture if the design pressure is less than P- 23005A/B shut off pressure.									

Project: 1. HAZOP Study for CMS-1 Plant

Node: 22.

P&IDs: 1308-7001-L-308

Node Description and Intent: CHCl₃ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
22N .1.	Low / No in V-2305 A/B	1. Low flow from E-2321	1. Low level in V-2305A/B	LAL/LL-2314 A/B	1	5	5					
				Vessel volume is large (49m ³)								
22N .2.	More flow in V-2305A/B	1. High flow from E-2321	1. High level in V-2305	LAH/HH-2314A/B	1	5	5					
			High pressure in V-2305	PVRV-2301A/B								
				PAH/HH-2312								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 22.

P&IDs: 1308-7001-L-308

Node Description and Intent: CHCl₃ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
22N .3.	Reverse flow	1. No credible cause identified										
22N .4.	Misdirected flow	1. No credible cause identified										
22N .5.	As well as Flow	1. No credible cause identified										
22N .6.	High Temperature in V-2305 A/B	1. High temp from u/s (E-2321)	1. Increase in pressure More evaporation of CH ₂ Cl ₂ Loss of product	PAH/HH-2312	1	5	5					
22N .7.	Low Temperature in V-2305 A/B	1. No credible causes										
22N .8.	More pressure in V- 2305A/B	1. Malfunctioning of PV- 2312A/B Failure of Cold CH ₂ Cl ₂ in E-2323	1. pressure increase to design pressure (0.02Kg/cm ²) Collapse of tank V-2305 and release of	PVRV-2301A/B	1	5	5					
				PAH/HH-2312								
				One tank is online while other is under discharge								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 22.

P&IDs: 1308-7001-L-308

Node Description and Intent: CHCl₃ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of PVRV-2301A/B	contents to environment.									
22N .9.	Low pressure in V- 2305A/B	1. Malfunctioning of PV- 2312A/B Malfunctioning of PVRV-2301A/B High evacuation rate from tank V-2305	1. Imploding of the tank V- 2305A/B release of contents to environment.	PALL-2312 PVRV-2301A/B	1	4	4					
22N .10.	High Level in V- 2305 A/B	1. High flow from u/s Malfunctioning of LT- 2314A/B	1. Overfilling of tank into vapor space and getting discharge at the vent . possible collapse of tank	LAH/HH-2314A/B Back-up level gauges LG-2314A1/A2/B1/B2 Intermittent operation Vessel volume large	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 22.

P&IDs: 1308-7001-L-308

Node Description and Intent: CHCl₃ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			Health Hazard.(Carcinogenic)									
22N .11.	Low Level in V-2305 A/B	1. Low flow from u/s Malfunctioning of LT- 2314A/B High discharge from P-2310A/B	1. Cavitation and dry running of pump P-2310 A/B	LALL-2314A will activate interlock I-30801 to trip the pump P--2310A/B	1	5	5					
22N .12.	Other Than Flow/ Contamination/ Composition/ Concentration-	1. No credible cause identified										
22N .13.	More/ Less pH	1. Not Applicable										
22N .14.	Agitator Failure	1. Not Applicable										
22N .15.	Power Failure	1. Not Applicable										
22N .16.	Utility Failure	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 22.

P&IDs: 1308-7001-L-308

Node Description and Intent: CHCl₃ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
22N .17.	Mechanical Failure / Leakage- Tube leak in E-2323	1. Corrosion Mechanical damage	1. Cold CH ₂ Cl ₂ will enter V- 2305A/B Product contamination	Analysis of product is done once per shift to check its quality and contamination.	1	4	4					
				Annual inspection and Hydro test done								
				depletion of cold CH ₂ Cl ₂ from the closed circuit loop being monitored (Cold CH ₂ Cl ₂ tank-V-2822)								
22N .18.	Mechanical Failure / Leakage- Loss of containment P-2310A/B	1. Seal failure	1. Discharge of CH ₂ Cl ₃ in atm	P-2310A/B (mechanical seal of better quality) is provided	3	4	12					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 22.

P&IDs: 1308-7001-L-308

Node Description and Intent: CHCl₃ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
22N.19.	Mechanical Failure / Leakage- Loss of containment- Failure of bottom flange of V-2305A/B	1. Mechanical failure	1. Discharge of CH ₂ Cl ₃ in atm Fire Hazard	Dyke wall is provided to contain entire volume of V-2305A/B leakage from one vessel	2	4	8					
22N.20.	Mechanical Failure / Leakage- Loss of containment- Breakage of Stabilizer liquid bottle	1. Bottle made of glass and handled manually	1. As per MSDS 1.Highly inflammable 2.Highly toxic Can decompose in presence of light and heat	PPE used while handling	3	5	15					
22N.21.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
22N.22.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
22N.23.	Sampling	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 22.

P&IDs: 1308-7001-L-308

Node Description and Intent: CHCl₃ Check Tank

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
22N .24.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
22N .25.	Others-	1. No credible cause identified	1.	PPEs Systems are established								

Project: 1. HAZOP Study for CMS-1 Plant

Node: 23.

P&IDs: 1308-7001-L-310

Node Description and Intent: Residue system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
23N .1.	Low / No flow in V- 2307	1. pump -2317 tripping	1. Low level in V-2307 2.Cavitation and dry running of pump P-2311A/B	LAL-2316	1	5	5					
		Suction strainer choking		Back-up level gauges LG-2316A/B								
				Tank residence time approx. 100 hrs								

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 23.

P&IDs: 1308-7001-L-310

Node Description and Intent: Residue system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
23N .2.	Low / No flow in V- 2310A/B	1. Low flow from BCM column Choking of BCM bottom cooler with carbon	1. Fall in level in 2310A/B	LAL-2315A/B	1	5	5					
23N .3.	More flow in V- 2307	1. High flow from P- 2317A/B Malfunctioning of LT- 2316	1. Rise in level of V-2307 with possibility of overflow CCl4 will flow into atm	LAH-2316 Backup level gauges LG-2316A/B As per present operating procedure level in V-2307 is being maintained is about 25% only Tank residence time approx. 100 hrs	2	4	8					
23N .4.	More flow in V- 2310A/B	1. High flow from the BCM	1. Increase in level in V- 2310A/B	LAH/HH-2315A/B	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 23.

P&IDs: 1308-7001-L-310

Node Description and Intent: Residue system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		column bottom	Possibility of CCl ₄ coming out of the vent Environment Hazard	Vessel has got residence time of approx. 8 hrs Intermittent operation production figure being checked								
23N .5.	Reverse flow	1. CHCl ₃ from V-2304 can reverse into P-2317A/B discharge and then V-2307A/B	1. Contamination of P-2307 with CHCl ₃		1	5	5					
23N .6.	Misdirected flow	1. No credible cause identified										
23N .7.	As well as Flow	1. No credible cause identified										
23N .8.	High temperature in V-2310A/B	1. Failure of CW in E-2334	1. Temp can reach 115 degC which the bottom temp of									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 23.

P&IDs: 1308-7001-L-310

Node Description and Intent: Residue system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Insufficient cooling in E-2334										
23N .9.	High temperature in V-2307	1. No credible cause identified										
23N .10.	Low temperature in V-2307	1. No credible cause identified										
23N .11.	More pressure	1. No credible cause identified										
23N .12.	Low pressure	1. No credible cause identified										
23N .13.	High Level in V-2307	1. High flow from P- 2317A/B Malfunctioning of LT-2316	1. Same as high flow in V-2307	Same as high flow in V-2307	2	4	8					
23N .14.	High Level in V-2310A/B	1. High flow from BCM column	1. Increase in level	LAH-/HH-2315A/B	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 23.

P&IDs: 1308-7001-L-310

Node Description and Intent: Residue system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Malfunctioning of LT- 2315 A/B	possibility of overflow from vent Health Hazard	Vessel residence time 8 hrs Common dyke wall is provided								
23N .15.	Low in V-2307	1. Pump tripping P-2317 Malfunctioning of LT- 2316 High evacuation rate by P- 2311A/B	1. same as low flow in V-2307	same as low flow in V-2307	1	4	4					
23N .16.	Low in V-2310A/B	1. Low flow from BCM column	1. Fall in level in 2310A/B Cavitation of pump P-2317A/B	Intermittent operation LAL-2315A/B	1	5	5					
23N .17.	Other Than Flow/ Contamination/ Composition/ Concentration-	1. Carbon entering the system from Thermal section	1. Choking of heat exchangers ,pump suction strainer		1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 23.

P&IDs: 1308-7001-L-310

Node Description and Intent: Residue system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	Different chemical											
23N.18.	More/ Less pH	1. Not Applicable										
23N.19.	Agitator Failure	1. Not Applicable										
23N.20.	Power Failure	1. Not Applicable										
23N.21.	Utility Failure	1. Not Applicable										
23N.22.	Mechanical Failure / Leakage- Loss of containment P-2311A/B	1. Seal failure	1. Discharge of CCl ₄ into atm High toxicity of liquid	P-2311A/B (mechanical seal of better quality) is provided	3	4	12					
23N.23.	Mechanical Failure / Leakage- Loss of containment- Bottom flange leak	1. Mechanical damage	1. CCl ₄ getting released into atm	common dyke wall provided to contain full contents of tank. (Check total dyke size and volume)	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 23.

P&IDs: 1308-7001-L-310

Node Description and Intent: Residue system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
23N .24.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
23N .25.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
23N .26.	Sampling	1. No credible cause identified										
23N .27.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
23N .28.	Others- Venting from V- 2307,V- 2310A/B	1. Tank open to atm. vent condenser provided earlier has been deleted.	1. continuous release of traces of CCl4 into atm Health Hazard on long time exposure.		1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
24N .1.	Low / No in T-2305	1. Tripping of P-2311A/B, suction strainer choking Malfunctioning of FV/FT- 2320 Malfunctioning of FT/FV- 2321	1. Low level in column high bottom temp increase in pressure Disturbance in distillation	LAL-2317	1	4	4					
				TAH/HH-2340								
				TAH/HH-2351								
				TAH/HH-2341								
				PAH-2317								
				PAH-2315								
24N .2.	Low flow in V-2308A/B	1. Low flow from P-2316A/B	1. No serious consequences									
24N .3.	Low / No flow in S-2305	1. low condensation from E-2326A/B/C and E-2327 High discharge flow from P-2314A/B	1. Loss in level in S-2305 Cavitation and dry running of pump P-2314A/B	LAL/LL-2319	1	5	5					
				FAH/HH-2321								
24N .4.	More flow in T-2305	1. More flow from P- 2311A/B	1. Increase in level in column	LAH-2317	1	4	4					
				TAL-2340								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of FV/FT- 2320 Malfunctioning of FT/FV- 2321	fall in bottom temp Disturbance in distillation	Non critical operation								
24N .5.	More flow in V- 2308A/B	1. High flow from P-2316	1. Liquid overfilling vessel into the atm Environmental hazard	None Intermittent operation Vessel volume larger than column bottom hold- up volume	2	5	10					
24N .6.	More flow in S- 2305	1. 1.More condensation from E- 2326A/B/C and E-2327	1. Rise in level in S-2305 Possible overfilling of S-2305 (Refer the high level in S-230)	LAH/HH-2319	1	5	5					
24N .7.	Reverse flow	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
24N .8.	Misdirected flow	1. CW from jacket can enter in vessel in case of leakage in the jacket	1. Increase the level in vessel No serious consequences	Intermittent operation								
24N .9.	As well as Flow	1. No credible cause identified										
24N .10.	High Temperature in T-2305	1. Malfunctioning of TV- 2340	1. Low level in column High pressure Disturbance in distillation	TAH/HH-2340	1	5	5					
				TAH/HH-2341								
				PAH/HH-2317								
				TAH/HH-2351								
				PAH/HH-2315								
24N .11.	High Temperature in V-2308 A/B	1. No credible cause identified										
24N .12.	High Temperature in S-2305	1. Failure of CW in E-2326A/B/C Failure of Cold CH ₂ Cl ₂ E-2327	1. Increase in system pressure	Refer high pressure in T-2305								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
24N .13.	Low Temperature in T-2305	1. Malfunctioning of TV-2340/steam failure Tripping of pump P-2316	1. Disturbance in distillation Low column pressure	TAL/LL-2340 TAL/LL-2341 TAL/LL-2351 PAL/LL-2317 PAL/LL-2315	1	4	4					
24N .14.	Low Temperature in V-2308 A/B	1. No credible cause identified										
24N .15.	Low Temperature in S-2305	1. No credible causes										
24N .16.	More pressure in T-2305	1. Failure of CW into E- 2326 A/B/C Malfunctioning of TV- 2340 Malfunctioning of PV- 2317A/B Low flow of reflux	1. CCl ₄ gas will escape into atm disturbance in distillation production upset	PAH/HH-2317 PAH-2315 RV-2310 RD-2310 FAI-2321	1	4	4					

 GFL GUJARAT FLUOROCHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		failure of cold CH ₂ Cl ₂ in E-2327										
24N .17.	More pressure in V-2308A/B	1. No credible cause identified	1.	vessel open to atm								
24N .18.	Low pressure in T-2305	1. Malfunctioning of PV- 2317A/B Malfunctioning of TV- 2340 Tripping of pump P- 2316A/B	1. Disturbance in distillation	PAL/LL-2315 PAL/LL-2317	1	4	4					
24N .19.	Low pressure in V-2308 A/B	1. No credible cause identified	1.	vessel open to atm								
24N .20.	High level in T-2305	1. High feed flow 2.malfunctioning of LT- 2317	1. Liquid overfilling the column and vapor line hammering	LAH/HH-2317 TAL/LL-2340	2	3	6					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			possible damage to trays and packing Possible discharge of liquid into atm to the vent Low bottom temp									
24N.21.	High level in V-2308A/B	1. High flow from P-2316	1. Refer to high flow in V-2308A/B	Refer to high flow in V-2308A/B								
24N.22.	High level in S-2305	1. More condensation from E-2326A/B/C and E-2327 Low reflux flow from Pump - 2314A/B Tripping of reflux pump P-	1. High level leading to overfilling the vapor space Hammering Liquid coming out of the vent.	LAH/HH-2319	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl4 Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
24N .23.	Low level in T-2305	1. Low feed flow more discharge to V- 2308A/B	1. cavitation of pump P-2316A/B High bottom temp 3.Disturbance in distillation	LAL-2317 P-2316 trip alarm	1	5	5					
24N .24.	Low level in V-2308A/B	1. No credible cause identified	1.	vessel is emptied out regularly								
24N .25.	Low level in S-2305	1. low condensation from E-2326A/B/C and E-2327	1. Loss in level in S-2305 2.Cavitation and dry running of pump P-2314A/B Disturbance in column T-2305 distillation	LAL/LL-2319	1	5	5					
24N .26.	Other Than Flow/ Contamination/ Composition/ Concentration-	1. No credible cause identified										
24N .27.	More/ Less pH	1. Not Applicable										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
24N .28.	Agitator Failure	1. Not Applicable										
24N .29.	Power Failure	1. Not Applicable										
24N .30.	Utility Failure	1. Not Applicable										
24N .31.	Mechanical Failure / Leakage- Tube leak In E-2325	1. Corrosion Mechanical damage	1. Steam enters process side causing extensive Corrosion		2	4	8					
24N .32.	Mechanical Failure / Leakage- Loss of containment P-2316	1. Seal failure	1. Discharge of CCl ₄ and heavies into atm	P-2316 (mechanical seal of better quality) is provided	3	4	12					
24N .33.	Mechanical Failure / Leakage- Loss of containment- P-2314A/B	1. Seal failure	1. Discharge of CCl ₄ and heavies into atm	P-2314A/B (mechanical seal of better quality) is provided	3	4	12					
24N .34.	Mechanical Failure /	1. Tube leak		PAH/HH-2317	1	5	5					
				TAH/HH-2341								

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	Leakage- Tube leak in E-2326A/B/C		1. Cooling water enter into process side causing Corrosion Change in reflux composition Disturbance in distillation	Testing for moisture in reflux in every shift								
24N.35.	Mechanical Failure / Leakage- Tube leak in E-2327	1. Mechanical Damage	1. Cold CH ₂ Cl ₂ will enter into reflux drum S-2305 Disturbance in column distillation Fall in level of cold CH ₂ Cl ₂ tank V-2821	Full GC analysis of reflux being done 2 times in shift	1	5	5					
24N.36.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
24N.37.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 24.

P&IDs: 1308-7001-L311

2308-7001-L312

Node Description and Intent: CCl₄ Distillation system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
24N.38.	Sampling	1. No credible cause identified										
24N.39.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
24N.40.	Others-	1. No credible cause identified										

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
25N.1.	Low / No flow in S-2308		1. Low level in S-2308	LAL-2320A	1	5	5					
				LAL-2320B								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		1. Low condensation in E- 2331 P-2314A/B tripping P-2318A/B tripping	Cavitation of pump P-2319A/B	U loop seal provided at s-2308 bottom outlet								
25N .2.	Low / No flow in S- 2309A/B	1. Malfunctioning of LV- 2320A Tripping of pump P- 2319A/B	1. No serious consequences									
25N .3.	Low / No flow in V-2311 A/B	1. Low flow from S-2309	1. Low level in V- 2311A/B Cavitation of pump P- 2320A/B	LAL/LL-2322 A/B Back-up level gauge LG- 2321A1/A2 LSLL-2322A/B will activate interlock I-31401	1	5	5					

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				to trip pump P-2320A/B								
25N .4.	More flow in S-2308	1. More condensation in E- 2331	1. High level in S-2308	LAH-2320A	1	5	5					
				LAH-2320B								
				Overflow line is provided (to waste water system)								
25N .5.	More flow in S-2309A/B	1. Malfunctioning of LV- 2320A High level in S-2308	1. No serious consequences									
25N .6.	More flow in V-2311A/B	1. High flow from S-2309	1. High level in V-2311A/B High pressure in V-2311A/B	LAH/HH-2322A/B	1	5	5					
				PVRV-2303A/B								
				PAH/HH-2319								
				Back-up level gauge LG-2321A1/A2								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				Tank Volume large enough 15.9 m3								
25N .7.	Reverse	1. Possible syphoning of S-2309A/B during shut down	1. Liquid from S-2309 will be drawn into V-2311 with possible creation of very low pressure to vacuum.	syphon-breaking hole provided at inlet dip pipe in V-2311 A/B	1	5	5					
25N .8.	Misdirected flow	1. Loss of caustic injection to P 2318A/B	1. poor neutralization in S-2308	caustic pump P-2705C trip alarm testing of acidity in the product from S-2308 every shift	1	5	5					
25N .9.	As well as Flow	1. No credible cause identified										
25N .10.	High Temperature in S-2308	1. No credible cause identified										

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN-CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
25N .11.	High Temperature in S-2309A/B	1. No credible cause identified										
25N .12.	High Temperature in V-2311 A/B	1. No credible cause identified										
25N .13.	Low Temperature in S-2308	1. No credible cause identified										
25N .14.	Low Temperature in S-2309A/B	1. No credible cause identified										
25N .15.	Low Temperature in V-2311 A/B	1. No credible cause identified										
25N .16.	More pressure in S-2308	1. Malfunctioning of PV- 2318	1. Increase in pressure up to design pressure	PAH/HH-2318	1	5	5					
				CCl ₄ has very low vapor pressure								
25N .17.	More pressure in S-2309A/B	1. Inadvertent closing of	1. Increase in vessel pressure up to design pressure.	RV,RD-2309A/B set at 6Kg/cm ² (Design	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		valves at inlet of V-2311	Production upset	pressure 7 kg/cm ²)								
		Choking of calcium chloride bed		RV, RD safe discharge to V-2501.								
25N.18.	More pressure in V- 2311A/B	1. Malfunctioning of PV- 2319A/B	1. Pressure increase to design pressure	PVRV-2303A/B	1	5	5					
		Failure of Cold CH ₂ Cl ₂ in E-2332	Possible collapse of tank V- 2311 and release of contents to environment.	PAH/HH-2319								
				One tank is online while other is under discharge								
25N.19.	Less pressure in S-2308	1. No credible causes										
25N.20.	Less pressure in S-2309A/B	1. No credible causes										
25N.21.	Less pressure in V-2311A/B	1. Malfunctioning of PV- 2319A/B	1. Imploding of the tank V- 2311A/B release of contents to environment.	PALL-2319	1	4	4					
		High evacuation rate from tank V-2311		PVRV-2303A/B								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
25N .22.	High level in S-2308	1. More flow from P-2314	1. High level in S-2308	LAH/HH-2320A/B	1	5	5					
		Strainer choking of P-2319		Overflow to waste water regeneration system								
25N .23.	High level in S-2309A/B	1. No Credible causes										
25N .24.	High level in V-2311 A/B	1. High flow from u/s Malfunctioning of LT- 2322A/B	1. Overfilling of tank into vapor space and getting discharge at the vent possible collapse of tank Health Hazard.(Carcinogenic)	LAH/HH-2322A/B	1	5	5					
				Back-up level gauges LG-2321A1/A2/B1/B2								
				Intermittent operation								
				Vessel volume large								
				LAL-2320A/B	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
25N .25.	Low Level in S-2308	1. Low flow from P-2314 and P-2318 Malfunctioning of LV- 2320A	1. Cavitation and dry running of P-2319 A/B fluctuation in flow to Dryer S-2309A/B	U loop seal at the bottom outlet of S-2308 FAL/LL-2323								
25N .26.	Low Level in S-2309A/B	1. No credible causes										
25N .27.	Low Level in V-2311 A/B	1. Low flow from u/s Malfunctioning of LT- 2322A/B High discharge from P-2320A/B	1. Cavitation and dry running of pump P-2320 A/B	LALL-2322A will activate interlock I-31401 to trip the pump P--2320A/B	1	5	5					
25N .28.	Other Than Flow/ Contamination/ Composition/ Concentration- Different chemical	1. CaCl ₂ in S-2309A/B getting exhausted	1. High moisture in product, No serious consequences	1. Analysis of moisture is done in every shift								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
25N .29.	More/ Less pH	1. Not Applicable										
25N .30.	Agitator Failure	1. Not Applicable										
25N .31.	Power Failure	1. No credible cause identified										
25N .32.	Utility Failure	1. No credible cause identified										
25N .33.	Mechanical Failure / Leakage-Tube leak in E-2332	1. Corrosion Mechanical damage	1. Cold CH ₂ Cl ₂ will enter V- 2311A/B Product contamination	Analysis of product is done once per shift to check its quality and contamination. Annual inspection and Hydro test done depletion of cold CH ₂ Cl ₂ from the closed	1	4	4					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				circuit loop being monitored (Cold CH ₂ Cl ₂ tank-V-2822)								
25N.34.	Mechanical Failure / Leakage-Tube leak InE-2331	1. Mechanical damage	1. Cold CH ₂ Cl ₂ will enter into S- 2308 affecting product quality	Full GC analysis of product from S-2308 carried out twice per shift. Annual inspection and Hydro test is done	1	4	4					
25N.35.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
25N.36.	Startup/Shutdown Hazards	1.	1.	SOP available for Startup/Shutdown								
25N.37.	Sampling Hazards	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
25N .38.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
25N .39.	Other	1. No credible cause identified										
25N .40.	Other- Loss of containment 1.P-2320A/B	1. Seal Failure	1. Discharge of CCl ₄ into atm	P-2320A/B (Single mechanical seal of better quality) is provided	3	4	12					
25N .41.	Other- Loss of containment Failure of bottom flange of V-2311A/B	1. Mechanical failure	1. Discharge of CCl ₄ in atm Severe health hazard	Dyke wall is provided to contain entire volume of V-2311 A/B leakage from one vessel .	2	4	8					
25N .42.	Other- Loss of containment 1.P-	1. seal failure	1. discharge of CCl ₄ into atm	P-2318A/B and P-2319A/B (Single	3	4	12					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 25.

P&IDs: 1308-7001-L313

1308-7001-L314

Node Description and Intent: CCl₄ Drying and Product checking system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	2318A/B and 2.P-2319A/B		2.Environmental Hazard	mechanical seal of better quality) is provided								

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
26N .1.	Low / No flow E-2401	1. Low flow from thermal section Malfunctioning of PV-2219A	1. Change in acid strength Less heat generation	FAL/LL-2215 Regular Analysis of HCl solution at the outlet of V- 2401	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Malfunctioning of FV-2401										
		Malfunctioning of FV-2402										
26N .2.	Low / No flow E-2402	1. Low flow from P-2403 Malfunctioning of FV-2401	1. Change in acid strength in E-2402 and in E-2401	FAIL/LL-2401 Regular Analysis of HCl solution at the outlet of V-2401	1	5	5					
26N .3.	More flow E-2401	1. High flow from thermal chlorination section Malfunctioning of PV-2219A Malfunctioning of FV-2401 Malfunctioning of PV-2401	1. Change in acid strength More heat generation E-2401 High level in V-2401	FAH/HH-2215 Acid cooled by cooling water Regular Analysis of HCl solution at the outlet of E-2401 LAH/HH-2401 FAHH-2406	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		More acid from E-2402 More circulation from P- 2401										
26N .4.	More flow E-2402	1. High flow from P-2403	1. Change in acid strength from E-2402 to E-2401	FAH/HH-2401	1	5	5					
		High flow from T-2402	Change in acid strength in E- 2401	FAH/HH-2402								
		Malfunctioning of FV-2401	High level V-2401	Regular Analysis of HCl solution at the outlet of V- 2401								
		Malfunctioning of FV-2402		LAH/HH-2401								
26N .5.	Reverse flow	1. No credible cause identified										
26N .6.	Misdirected flow	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
26N .7.	As well as Flow	1. No credible cause identified										
26N .8.	High Temperature in E-2401	1. High Temp of HCl gas from Thermal section (S-2203) High temp of HCl from E-2402	1. Less absorption in E-2401 Change in acid strength	TAH/HH-2222 (Thermal section) Regular Analysis of HCl solution at the outlet of E- 2401	1	5	5					
26N .9.	High Temperature in E-2402	1. More flow of unabsorbed HCl gas from E-2401	1. Less absorption in E-2402 Change in acid strength	Regular Analysis of HCl solution at the outlet of E- 2401	1	5	5					
26N .10.	Low Temperature in E-2401	1. Low Temp of HCl gas from Thermal section (S-2203)	1. Change in acid strength, No serious consequences	Regular Analysis of HCl solution at the outlet of E- 2401								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Low temp of HCl from E-2402										
26N .11.	More pressure in E-2401	1. Malfunction of PV-2401	1. Possible damage to graphite tubes of E-2401	Tube side discharge to tank V-2401, Operating at near 0.25kg/cm ² pressure Pressure balancing line is provided from V-2401 to T-2402	1	5	5					
26N .12.	More pressure in E-2402	1. More unabsorbed HCl gas from E-2401	1. Change in acid strength E-2402	Regular Analysis of HCl solution at the outlet of E-2401 E-2402 tube side is connected to E-2401 which discharging HCL solution to	1	5	5					

 GFL GUJARAT FLUORO CHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Propaganda with the Sun	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				V-2401 (Operating at 0.25kg/cm2 pressure)								
26N .13.	Less pressure in E-2401	1. Malfunctioning of PV-2401	1. No serious consequences									
26N .14.	Less pressure in E-2402	1. No credible causes	1. No serious consequences									
26N .15.	High level in V-2401	1. More flow from E-2401 tripping of pump P-2401	1. Overfilling of V-2401 into vapor line and escaping to T- 2402 Hammering Possible damage to graphite tubes	LAH/HH-2401 P-2401 trip alarm is provided	2	5	10					
26N .16.	Low Level in V-2401	1. Low flow from E-2401 More evacuation from P- 2401	1. Cavitation and dry running of pump P-2401A/B	LAL/LL-2401	1	5	5					
26N .17.	Other Than Flow/ Contamination/	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	Composition/ Concentration											
26N .18.	More/ Less pH	1. Not Applicable										
26N .19.	Agitator Failure	1. Not Applicable										
26N .20.	Power Failure	1. No credible cause identified										
26N .21.	Utility Failure	1. No credible cause identified										
26N .22.	Mechanical Failure / Leakage-Tube leak E-2401	1. Cooling water can enter HCl side	1. Dilution of HCl solution	Regular Analysis of HCl solution at the outlet of E- 2401	1	4	4					
26N .23.	Mechanical Failure / Leakage-Tube leak E-2402	1. Cooling water can enter HCl side	1. Dilution of HCl solution	Regular Analysis of HCl solution at the outlet of E- 2401	1	4	4					
26N .24.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
26N.25.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
26N.26.	Sampling Hazards	1. No credible cause identified										
26N.27.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
26N.28.	Other	1. No credible cause identified										
26N.29.	Other- Loss of containment 1.P-2401A/B	1. seal failure	1. Discharge of HCl into atm Can cause serious injury	P-2401A/B (mechanical seal of better quality) is provided	2	4	8					
26N.30.	Other- Loss of containment 1.E-2401	1. Failure of glass lining Bottom flange leak	1. HCL acid will spill over outside Severe Corrosion to flooring and structures	1. None	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 26.

P&IDs: 1308-7001-L401

Node Description and Intent: HCl Absorber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		2. Bottom flange leak	1. Severe Corrosion to flooring and structures									

Project: 1. HAZOP Study for CMS-1 Plant

Node: 27.

P&IDs: 1308-7001-L402

Node Description and Intent: Organic Stripper System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
27N .1.	Low / No flow in T-2401 and T-2402	1. Low flow of process water	1. Change in HCl strength at outlet of T-2402	PAH/HH-2402	1	5	5					
		Low flow of air in T-2403	Increase in pressure	FAL/LL-2402								
		Low flow of un absorbed HCl gas from E-2402		Regular Analysis of HCl strength at V-2401								
		1. Low flow of air		PAL/LL-2402	1	5	5					

 GUJARAT FLUORO-CHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 27.

P&IDs: 1308-7001-L402

Node Description and Intent: Organic Stripper System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
27N .2.	Low flow in E-2403(Electric heater)		1. Less stripping of organics in T-2403,Affecting HCl product quality Low pressure in the system High air temp	Regular analysis of HCl product for contamination being done Tripping of electrical heater through TE-2405(I-40210)								
27N .3.	More flow in T-2401 and T-2402	1. More process water flow Malfunctioning of FV/FT- 2402 More flow of un absorbed HCl More air flow into T-2403	1. High pressure Possible dilution of HCl in V- 2401	PAH/HH-2402 FAH/HH-2402 Regular Analysis of HCl strength at V-2401	1	5	5					
27N .4.	More flow in E-2403(Electric heater)	1. High flow of air	1. More air flow in T-2043	PAH/HH-2402	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 27.

P&IDs: 1308-7001-L402

Node Description and Intent: Organic Stripper System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			Increase in pressure Lower hot air temp.									
27N .5.	Reverse flow from T- 2403 to Electric heater and blower	1. Tripping of air blower No air flow	1. HCl gas and liquid can enter electric heater and blower causing severe corrosion	NRV on air line to U loop seal of 1000mm height.	1	5	5					
27N .6.	Misdirected flow	1. Gas from V- 2401 can back up into D-2401	1. Pressure equalization between D-2401 and V-2401	Equalization line is provided	1	5	5					
27N .7.	As well as Flow	1. No credible causes										
27N .8.	High Temperature in T-2401 and T-2402	1. More flow from E-2402 and T-2403	1. Possible damage to Shell and possible damage to tower packing	None	2	4	8					
27N .9.	High Temperature in E- 2403(Electric heater)	1. High current in electric heater Low air flow	1. High air temp	High air temp (TE-2405) will activate interlock I-40201 to trip air blower.	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 27.

P&IDs: 1308-7001-L402

Node Description and Intent: Organic Stripper System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
27N .10.	Low Temperature in T-2401 and V-2402	1. No credible causes										
27N .11.	Low Temperature in E-2403 (Electric heater)	1. Failure of electrical heater High air flow	1. Less tripping in T-2403 affecting product quality	1. None	1	5	5					
27N .12.	More pressure in T-2401 and T-2402	1. Malfunctioning of PV-2402 Low process water flow More air flow in T-2403	1. Possible leakage of in shell made of PP+ FRP	PAH/HH-2402 FAL/LL-2402	2	4	8					
27N .13.	More pressure in E-2403	1. Inadvertent closure of isolation valve on air line to T-2403	1. Increase in pressure in blower discharge, this may cause serious damage to blower.	PSV provided on blower discharge								
27N .14.	Less pressure in T-2401 and V-2402	1. Malfunctioning of PV-2402	1. No serious consequences									

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 27.

P&IDs: 1308-7001-L402

Node Description and Intent: Organic Stripper System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		less air in T-2403										
27N.15.	Less pressure in E-2403	1. Tripping of air blower	1. Less air flow into T-2403, affecting HCl product quality	None	1	5	5					
27N.16.	High level in T-2401 and T-2402	1. No credible causes as U loop seal is provided at bottom outlet.										
27N.17.	High level in E-2403(Electric heater)	1. No credible cause identified										
27N.18.	Low Level in T-2401 and V-2402	1. 1. No credible causes as U loop seal is provided at bottom outlet.										
27N.19.	Low Level in E-2403(Electric heater)	1. No credible cause identified										
27N.20.	Other Than Flow/Contamination/	1. No credible cause identified										

 GUJARAT FLUOROCHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 27.

P&IDs: 1308-7001-L402

Node Description and Intent: Organic Stripper System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
	Composition/ Concentration											
27N .21.	More/ Less pH	1. Not Applicable										
27N .22.	Agitator Failure	1. Not Applicable										
27N .23.	Power Failure	1. No credible cause identified										
27N .24.	Utility Failure	1. No credible cause identified										
27N .25.	Mechanical Failure / Leakage	1. No credible cause identified										
27N .26.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
27N .27.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
27N .28.	Sampling Hazards	1. No credible cause identified										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 27.

P&IDs: 1308-7001-L402

Node Description and Intent: Organic Stripper System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
27N .29.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
27N .30.	Other	1. No credible cause identified										
27N .31.	Other- Loss of containment from T-2402 and T- 2403	1. Tower material PP+FRP can crack on exposure to sunlight (UV Rays) opening of bottom flange	1. Discharge of HCl into the atm	1. None	3	4	12					

 GFL GUJARAT FLUORO-CHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 28.

P&IDs: 1308-7001-L403

Node Description and Intent: HCL Scrubber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
28N .1.	Low/No flow in T-2404	1. Low flow of emergency release of HCl gas Low flow of caustic solution	1. Escape of un-neutralized HCl gas from T-2404	FAL/LL-2405 on caustic circulation line	1	5	5					
				FSLL-2405 will activate the interlock SD-9 which will auto start spare pump P-2405A/B								
				XCV-2401 will open to admit process water								
28N .2.	Low flow in V-2405	1. Low flow from T-2404	1. Drop in level in tank V-2405 Possible cavitation and dry running of P-2405A/B/C	Tank volume is large (100m ³) to take care of drop in level	1	5	5					
28N .3.	More flow in T-2404	1. High flow of emergency release from different locations	1. More HCl will be neutralized in T-2404. No serious consequences	SOP is in place to take care of high flow of HCl gas.	1	5	5					
				TAH/HH-2402								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 28.

P&IDs: 1308-7001-L403

Node Description and Intent: HCL Scrubber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		through VG-4 header. High flow of caustic solution	high solution temp at bottom	TSHH-2402 will activate the interlock SD-9 which will auto start spare pump P-2405A/B								
28N .4.	More flow in V-2405	1. High flow from T-2404	1. High level in V-2405 Overflow from tank causing Corrosion on the flooring Possible damage to tank roof due to hammering .	Overflow line provided from tank to sewer.	1	5	5					
28N .5.	Reverse flow	1. No credible cause identified										
28N .6.	Misdirected flow Mixing of caustic circulation and cooling water in E- 2406	1. Gasket leak in E-2406 (Plate type exchanger)	1. Caustic solution can enter cooling water side and increase in Ph. steeply	PH analyzer is provided on cooling tower with alarm.	1	4	4					

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 28.

P&IDs: 1308-7001-L403

Node Description and Intent: HCL Scrubber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
28N .7.	As well as Flow	1. No credible cause identified										
28N .8.	High Temperature in T-2404	1. High temp of emergency release gases	1. As maximum gas temp can reach 100degC it can damage the tower shell.	TSHH-2402 will activate interlock SD-9 to auto- start spare pump P-2405	3	2	6					
28N .9.	Low Temperature in T-2404	1. No credible cause identified										
28N .10.	More pressure in T-2404	1. Sudden inflow of large quantity of Emergency release	1. Increase in pressure in T-2404 Less neutralization resulting in release of HCl gas into atm	1. None	3	3	9					
28N .11.	Less pressure in T-2404	1. No credible cause identified										
28N .12.	High level in T-2404	1. Malfunctioning XCV-2401	1. Overfilling of the tower causing damage to tower	U-loop seal on the outlet line	1	5	5					

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 28.

P&IDs: 1308-7001-L403

Node Description and Intent: HCL Scrubber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
28N.13.	High level in V-2405	1. Same as high flow in V- 2405	1. Same as high flow in V-2405	Same as high flow in V- 2405								
28N.14.	Low Level in T-2404	1. Low caustic circulation Malfunctioning of FT- 2405	1. High temp in tower Possible damage o tower (made of PVDF lined FRP)	FSLL-2405 will activate SD-9 which will auto start spare pump P-2405 U-loop seal provided outlet to maintain minimum level.	1	5	5					
28N.15.	Low Level in V-2405	1. Same as Low flow in V- 2405	1. Same as Low flow in V-2405	Same as low flow in V- 2405								
28N.16.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
28N.17.	More/ Less pH	1. Not Applicable										
28N.18.	Agitator Failure	1. Not Applicable										
28N.19.	Power Failure	1. Power failure in CMS plant	1. Escape of large quantity of HCl gas from T-2404	Emergency power is	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 28.

P&IDs: 1308-7001-L403

Node Description and Intent: HCL Scrubber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				provided to P-2405A/B/C								
28N.20.	Utility Failure	1. No credible cause identified										
28N.21.	Mechanical Failure / Leakage	1. No credible cause identified										
28N.22.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
28N.23.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								
28N.24.	Sampling Hazards	1. No credible cause identified										
28N.25.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
28N.26.	Other- Loss of containment 1.P-2405A/B/C	1. Seal leak	1. Caustic solution will leak out This will require leaking pump to	SD-9 will result in 1 auto start of stand by pump P- 2405	1	5	5					

 GFL GUJARAT FLUORO-CHEMICALS SAFETY THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 28.

P&IDs: 1308-7001-L403

Node Description and Intent: HCL Scrubber System

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			stopped and stand by to be started.									
28N .27.	Other- Loss of containment T-2404	1. Vent Release Rupture of Tower shell, due to mechanical damage Rupture due to exposure to sunlight (containing UV rays)	1. Caustic solution and HCL gas (in case of emergency)will be released in atm	1. None	2	4	8	13. Prevent Exposure of T-2404 to direct sunlight .	1	4	4	
28N .28.	Other-loss of containment V-2405	1. Bottom flange leak Tank rupture Tank overflow	1. Spillage of caustic solution onto the flooring and drain can get into storm water drain and go outside factory premises	Dyke valve drain valve is provided checked for alkali proof tiling/brick lining	1	4	4					

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Propaganda with the Best Technology	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
29N .1.	Low flow in V-2402A/B/C/D	1. Low flow from T-2403	1. Low level in V-2402 2. Cavitation and dry running of pump P-2402	LAL/LL-2402A/B/C/D Low level LALL-2402 will activate interlock I-40501 to trip P-2402A/B	1	4	4	102. Interlock I-40501 is presently bypassed. Proper scheme should be explored to include I-40501 inline.	1	4	4	
29N .2.	Low flow in V-2404	1. Low flow of process water and caustic	1. Low level in V-2404 Possibility of cavitation P-2404 A/B	P-2404 is used for circulation with in the tank (intermittent operation)	1	5	5	103. Proper SOP should be in place to ensure adequate level in V- 2404	1	4	4	
29N .3.	More flow in V-2402A/B/C/D	1. High flow from T-2403 High flow from P-2401 () Intermittent)	1. High level in V-2402 Overflow from tank	LAH/HH-2402A/B/C/D Tank volume (50m ³) is very large. Residence time 20hrs Normal level in tank is 50% SOP is in place	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				Dyke wall provided with acid proof lining								
				Intermittent operation								
29N .4.	More flow in V-2404	1. High flow of caustic from P-2705A/B High flow of process water into washing tower T- 2401	1. High level in V-2404 Overflow from tank causing possible collapse of tank	1. None	2	5	10					
29N .5.	Reverse in V-2402A/B/C/D	1. Waste liquid from other streams can flow back from ETP header, when P-2402 is not running	1. Contamination of product in V-2402A/B/C/D	1. None	1	5	5					
29N .6.	Misdirected flow V- 2402A/B/C/D	1. Mal-operation of circulation	1. Product quality affected	LAH/HH-2402A/B/C/D	1	5	5					

 GUJARAT FLUOROCHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Propaganda with the Sun	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		valves, causing liquid from 1 tank being pumped into another tank	Increase in level of second tank with inlet closed.	Analysis of product in tanks done for every batch								
29N .7.	As well as Flow	1. No credible cause identified										
29N .8.	High Temperature in V-2402A/B/C/D	1. No credible cause identified										
29N .9.	High Temperature In - V2404	1. No credible cause identified										
29N .10.	Low Temperature in V-2402A/B/C/D	1. No credible cause identified										
29N .11.	Low Temperature In -V2404	1. No credible cause identified										
29N .12.	More pressure in V-2402 A/B/C/D	1. No credible causes, since										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		tanks are open to atm										
29N .13.	More pressure in V2404	1. Choking of packing in T-2401. Flooding in T-2401 stoppage of circulation pump P-2404	1. Back-up of vent gas into V- 2402	Tank V-2402 is presently open to atm	1	4	4					
29N .14.	Less pressure in V-2402A/B/C/D	1. More evacuation rate	1. Possibility of vacuum generation in tank Collapse of tank	Vessel open to atm	2	5	10	102. Interlock I-40501 is presently bypassed. Proper scheme should be explored to include I-40501 inline.	1	5	5	
29N .15.	Less pressure in - V2404	1. No credible causes										
29N .16.	High level in V-2402A/B/C/D	1. high flow from T-2403	1. Same as high flow in V- 2402A/B/C/D	Same as high flow in V-2402A/B/C/D								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		High flow from P-2401 () Intermittent) Pump tripping P-2402										
29N .17.	High level in - V2404	1. High flow of caustic from P-2705A/B High flow of process water into washing tower T- 2401	1. Same as high flow in V-2404	Same as high flow in V- 2404								
29N .18.	Low in Level V- 2402A/B/C/D	1. Low flow from T-2403 High evacuation rate	1. Same as in low flow in V- 2402A/B/C/D	Same as in low flow in V- 2402A/B/C/D								
29N .19.	Low Level In - V2404	1. Low flow of process water and caustic	1. Same as Low flow in V-2404	Same as Low flow in V- 2404								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
29N .20.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible cause identified										
29N .21.	More/ Less pH	1. Not Applicable										
29N .22.	Agitator Failure	1. Not Applicable										
29N .23.	Power Failure	1. No credible cause identified										
29N .24.	Utility Failure	1. No credible cause identified										
29N .25.	Mechanical Failure / Leakage	1. No credible cause identified										
29N .26.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
29N .27.	Startup/Shutdow n Hazards	1.	1.	SOP available for Startup/ Shutdown								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
29N .28.	Sampling Hazards	1. No credible cause identified										
29N .29.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
29N .30.	Other- Loss of containment 1.V-2402A/B/C/D	1. Bottom flange leakage/Rupture of tank	1. Discharge of acid to atm	dyke wall with acid proof lining is provided	1	4	4					
29N .31.	Other- Loss of containment 1.V-2404A/B/C/D	1. Bottom flange leakage/Rupture of tank	1. Discharge of acid to atm	dyke wall with acid proof lining is provided	1	4	4					
29N .32.	Other- Loss of containment P-2402A/B	1. Seal failure	1. Discharge of HCl acid to atm	Enclosure with acid proof tiling	1	5	5					
			Corrosion to flooring and structures	Seal guard provided to contains spillage.								
			Injury	P-2402A/B (mechanical seal of better								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 29.

P&IDs: 1308-7001-L405

Node Description and Intent: 31% HCl tank system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				quality) is provided								
29N.33.	Other- Loss of containment P-2404A/B	1. Seal failure	1. Discharge of HCl acid to atm Corrosion to flooring and structures Injury	Dyke with acid proof tiling Seal guard provided to contains spillage. P-2404A/B (mechanical seal of better quality) is provided	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
30N .1.	Low / No flow in V- 2822	1. Tripping of P-2821A/B Choking of suction strainer of P-2821A/B	1. Process upset Increase in system pressure in upstream equipment's Loss of process vapors into the atm causing health hazard	MI-P-2821 A/B trip alarm is provided.	1	5	5					
30N .2.	Low flow in E-2821-1 tube side	1. same as low flow in V-2822	1. same as low flow in V- 2822	same as low flow in V- 2822								
30N .3.	Low flow in E-2821-1 Shell side	1. Low flow from compressor system 2. Malfunctioning of LV-2823A/B	1. Low level in shell side Low pressure on shell side High tube side temp	LAL/LL-2823	1	5	5					
				PAL/LL-2823								
				TAH/HH-2824 on tube side.								
30N .4.	More flow in V-2822	1. Process side leaking into cold CH ₂ Cl ₂ from the exchangers,	1. 1. Increase in level of V- 2822 Increase the pressure in V-2822	LAH/HH-2822	1	4	4					
				PAH/HH-2824								
				RV-2825								
				TAH/HH-2823								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		Where process side pressure is higher than cold CH ₂ Cl ₂ system More flow from P-2305	Increase in temp Contamination of cold CH ₂ Cl ₂ with other hydrocarbon such as CH ₃ Cl. CH ₃ Cl contains small amount of HCl also. This may result into corrosion entire cold CH ₂ Cl ₂ system.	Make up from P-2305 is done once in 15 days.								
30N .5.	More flow in E-2821-1 tube side	1. Refer to high flow V-2822	1. Refer to high flow V-2822	Refer to high flow V- 2822								
30N .6.	More flow in E-2821-1 Shell side	1. High flow from R-22 refrigeration system Malfunctioning of LT/LV-2823A/B	1. High level on shell side of E-2821-1 High shell side temp High shell side pressure.	LAH/HH-2823	1	5	5					
				PAH/HH-2823								
				RV-2824								
				TAH/HH-2824 on tube side								
				High level in R-22 compressor								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			High process side temp Overfilling of Shell Side into vapor line going to R 22 compressor	suction KOD will trip compressor.								
30N .7.	Reverse flow	1. No credible cause identified										
30N .8.	Misdirected flow	1. No credible cause identified										
30N .9.	As well as Flow	1. No credible cause identified										
30N .10.	High Temperature in V-2822	1. Failure of R-22 system Process side leaking into cold CH ₂ Cl ₂ from the exchangers, Where process	1. Contamination of cold CH ₂ Cl ₂ with other hydrocarbon such as CH ₃ Cl . CH ₃ Cl contains small amount of HCl also .This may result into	TAH/HH-2823	2	4	8					
				PAH/HH-2824								
				RV-2825								

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		side pressure is higher than cold CH ₂ Cl ₂ system High process side inlet temp in Concerned exchangers where CH ₂ Cl ₂ is used.	corrosion entire cold CH ₂ Cl ₂ system. Increase in pressure Release of CH ₂ Cl ₂ vapors into atm, CH ₂ Cl ₂ is carcinogenic.									
30N.11.	High Temperature top in E-2821-1 tube side	1. Same as high temp in V-2822										
30N.12.	High Temperature in E-2821-1 Shell side	1. High temp in tube side High pressure on shell side	1. Reduction in R-22 compressor capacity, Which may affect refrigeration heat duty. High discharge temp of R-22 compressor	TAH/HH-2824 PAH/HH-2823 R-22 compressor trips on high temp and high pressure.	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
30N .13.	Low Temperature in V-2822	1. No credible cause identified										
30N .14.	Low Temp in E-2821-1 tube side	1. Same as low temp for V-2822										
30N .15.	Low Temp in E-2821-1 Shell side	1. Low pressure on shell side	1. No serious consequences									
30N .16.	More pressure in V-2822	1. same as high flow in V-2822	1. Increase in temp	PAH/HH-2824	2	4	8					
			Contamination of cold CH ₂ Cl ₂ with other hydrocarbon such as CH ₃ Cl .	RV-2825								
			CH ₃ Cl contains small amount of HCl also .This may result into corrosion entire cold CH ₂ Cl ₂ system. Release of traces of CH ₂ Cl ₂ vapors into atm. CH ₂ Cl ₂ is carcinogenic	TAH/HH-2823								

 GFL GUJARAT FLUORO-CHEMICALS VALUE THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
30N .17.	More Pressure in E- 2821-1 tube side	1. High flow from P-2821A/B	1. Same as high pressure in V-2822									
30N .18.	More Pressure in E- 2821-1 shell side	1. Malfunctioning of PV/PT- 2823 High level in Shell side Tripping of R-22 compressor	1. Increase in R-22 compressor discharge pressure	PAH/HH-2823 RV-2824	1	4	4					
30N .19.	Less pressure in V-2822	1. No credible causes										
30N .20.	Less pressure in E-2821- 1 tube side	1. Same as for low pressure in V-2822										
30N .21.	Less Pressure in E- 2821- 1 shell side	1. Less evaporation in shell side Malfunctioning of PT/PV- 2823	1. High temp on tube side Low suction pressure of R-22 compressor	TAH/HH-2824 PAL/LL-2823	1	4	4					
				LAH/HH-2822	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
30N.22.	High level in V-2822	1. High make up flow from P-2305 Tube leak from exchanger where process side pressure is higher.	1. Overfilling of V-2822 CH ₂ Cl ₂ liquid can released into atm through vent. Increase in pressure in V 2822 Contamination of cold CH ₂ Cl ₂ with other hydrocarbon such as CH ₃ Cl . CH ₃ Cl contains small amount of HCl also .This may result into corrosion entire cold CH ₂ Cl ₂ system	PAH/HH-2824 and RV-2825 Make-up of V-2822 (Intermittent operation)								
30N.23.	High level in E-2821-1 Shell side	1. Malfunctioning of LV/LT- 2823 Lower evaporation	1. Overfilling of vapor line resulting in flooding of R- 22 compressor suction line	LAH/HH-2823 Compressor will trip on high level in suction KOD.	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
		High flow from compressor section	Hammering and damage to piping									
		Tube leak in E-2821-1										
30N.24.	Low level-in V2822	1. leakage of cold CH ₂ Cl ₂ to process side where the system pressure lower than CH ₂ Cl ₂ system.	1. Process upset in Hydro and Thermal section . Product contamination Contamination of methanol with CH ₂ Cl ₂ in methanol storage tank. Lowering a pressure in V 2822	LAL/LL-2822 PAL/LL-2824 LSLL-2822 will activate interlock number I-82201 which will trip pump P-2821A/B	1	4	4					
30N.25.	Low level in E-2821-1 Shell side	1. Malfunctioning of LV/LT- 2823	1. High temp of cold CH ₂ Cl ₂ Difficulty in skimming oil from R-22 liquid	LAL/LL-2823 TAH/HH-2823	1	5	5					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
30N .26.	Other Than Flow/ Contamination/ Composition/ Concentration- Different chemical	1. CH ₃ Cl can enter cold CH ₂ Cl ₂ system including V- 2822	1. Contamination of cold CH ₂ Cl ₂ with CH ₃ Cl . CH ₃ Cl contains small amount of HCl also .This may result into corrosion entire cold CH ₂ Cl ₂ system	LAH/HH-2822	1	4	4					
				PAH/HH-2824								
				RV-2825								
				TAH/HH-2823								
30N .27.	More/ Less pH	1. Not Applicable										
30N .28.	Agitator Failure	1. Not Applicable										
30N .29.	Power Failure	1. No credible causes										
30N .30.	Utility Failure	1. No credible causes										
30N .31.	Mechanical Failure / Leakage- Tube leak E-2821-1	1. Mechanical damage Corrosion	1. Cold CH ₂ Cl ₂ will enter into R-22 system, affecting refrigeration properties badly	LAH/HH-2823	3	4	12	104. Proper provision should be made to analyses CH ₂ Cl ₂ in R-22 and to detect CH ₂ Cl ₂ leakage using proper analyzers.	1	4	4	

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			This may result in shut down of Thermal section and the whole CMS plant Production loss. Increase in level in E-2821-1 shell side									
30N.32.	Mechanical Failure / Leakage-Tube leak E-2821-3	1. Mechanical damage	1. Liquid R-22 can enter vapor side and then into shell side E-2821-1, bypassing LV-2823 A/B Disturbance in level control Possibility of shell side getting overfilled into, R- 22, compressor suction.	LAH/HH-2823 R-22 Compressor will trip on high level in suction KOD.	2	4	8					

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 30.

P&IDs: 1308-7001-L822

Node Description and Intent: Cold CH₂Cl₂ system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
30N .33.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
30N .34.	Startup/Shutdown Hazards	1.	1.	SOP available for Startup/Shutdown								
30N .35.	Sampling Hazards	1. No credible cause identified										
30N .36.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
30N .37.	Other- Loss of containment pump P- 2821A/B	1. Seal Failure	1. Discharge of CH ₂ Cl ₂ in atm	P-2821A/B (mechanical seal of better quality) is provided	3	4	12	77. Explore the possibility of installing a seal-less pump	1	4	4	
30N .38.	Other - High lubricating oil content in R-22 liquid in E-2821-1 Shell side	1. Less oil removal at the discharge of R-22 compressor.	1. Oil coating on the tubes will reduce heat transfer in E-2821-1.	Oil skimming provision has been kept at 2 levels on the shell side.	1	5	5	105. Oil content in R-22 compressor discharge to be analyzed frequently	1	4	4	

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Safeguarding with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 31.

P&IDs: 1308-7001-L407

Node Description and Intent: Sulfuric acid tanks system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
31N .1.	Low / No flow in V- 2701	1. No/Less unloading	1. Low level in v-2701, No serious consequences									
31N .2.	Low/No flow V-2702	1. Low flow from P-2106	1. Decrease in level V-2702	LAL/LL-2702 Intermittent operation	1	5	5					
31N .3.	More flow V-2701	1. High unloading rate from tanker	1. Increase in level in V-2701 and Possibility of overflow of H2SO4	LAH/HH-2701 Dyke wall with acid proof lining provided.	2	4	8	106. High level on V-2701 should trip unloading pump P-2706	2	4	8	
31N .4.	High flow V-2702	1. High flow from P-2106 (Hydro section)	1. Overfilling of tank V-2702 causing spillage of 88% H2SO4. Possible collapse of tank roof of V-2702.	LAH/HH-2702 Overflow line provided Dyke wall with drain valve is provided.	1	5	5	107. P&ID shows overflow line connected to tank roof. To prevent roof collapse due to hammering effect, it is recommended to shift overflow nozzle to the tank shell on the top.	1	4	4	
31N .5.	Reverse flow	1. No credible causes										

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 31.

P&IDs: 1308-7001-L407

Node Description and Intent: Sulfuric acid tanks system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
31N .6.	Misdirected flow	1. No credible causes										
31N .7.	As well as Flow	1. No credible causes										
31N .8.	High Temperature in V-2701 and V-2702	1. No credible causes										
31N .9.	Low Temperature in V-2701 and V-2702	1. No credible causes										
31N .10.	More pressure in v- 2701	1. Malfunctioning of PVRV- 2701	1. Over pressurization of tank resulting in collapse of tank 98% H2SO4 gets discharged into atm	Dyke wall with acid proof lining is provided	2	4	8	108. PVRV set pressure should be tested at least once in year.	2	4	8	
31N .11.	More pressure in v- 2702	1. No credible causes since tank V-2702 is open to atm.										
31N .12.	Less pressure in V-2701	1. High discharge rate from P-2701	1. In extreme case vacuum can	PVRV-2701 is provided	1	5	5	109. P&ID shows silica gel pad in the air inlet port, to	1	4	4	

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 31.

P&IDs: 1308-7001-L407

Node Description and Intent: Sulfuric acid tanks system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
			created resulting in tank collapse					remove moisture from air.(Which can cause dilution of 98% H ₂ SO ₄)It is understood that the silica gel pad has been removed. It is recommended that this pad be Reviewed 108. PVRV set pressure should be tested at least once in year.				
31N .13.	Less pressure in V-2702	1. High discharge rate from P-2702	1. No serious consequences	Tank open to atm .	1	4	4					
		2. Possible creation of vacuum in the tank and collapse	1. No serious consequences	Tank open to atm .	1	4	4					
				LAH/HH-2701	2	5	10			5	5	

	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT			
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 31.

P&IDs: 1308-7001-L407

Node Description and Intent: Sulfuric acid tanks system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
31N.14.	High level in V-2701	1. High unloading rate from tanker	1. Possibility of overflow of H ₂ SO ₄ Can cause serious corrosion and serious injury.	Dyke wall with acid proof lining provided.				106. High level on V-2701 should trip unloading pump P-2706				
31N.15.	High level in V-2702	1. More flow from P-2106	1. Overfilling of tank V-2702 causing spillage of 88% H ₂ SO ₄ . Possible collapse of tank roof of V-2702.	LAH/HH-2702	1	4	4					
				Overflow line provided								
				Dyke wall with drain valve is provided.								
31N.16.	Low Level in V-2701	1. Tanker non-availability	1. No serious consequences	LAL/LL-2701								
31N.17.	Low Level in V-2702	1. Tripping of the pump P-2106A/B More discharge from P-2702	1. Possible creation of vacuum leading to tank collapse	LAL/LL-2702	1	5	5					
				Overflow line provided								
				Dyke wall with drain valve is provided.								
31N.18.	Other Than Flow/ Contamination/ Composition/ Concentration	1. No credible causes identified										

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 31.

P&IDs: 1308-7001-L407

Node Description and Intent: Sulfuric acid tanks system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
31N.19.	More/ Less pH	1. Not Applicable										
31N.20.	Agitator Failure	1. Not Applicable										
31N.21.	Power Failure	1. No credible causes identified										
31N.22.	Utility Failure-Cooling Water	1. No credible causes identified										
31N.23.	Mechanical Failure / Leakage	1. No credible causes identified										
31N.24.	Mechanical Failure / Leakage	1. No credible causes identified										
31N.25.	Fire / Explosion / Ignition Source	1. No credible cause identified	1.	Systems are established for external fire								
31N.26.	Startup/Shutdown Hazards	1.	1.	SOP available for Startup/Shutdown								

 GFL GUJARAT FLUORO-CHEMICALS SALES THROUGH GREEN-CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Progress with Safe Solutions	
	HSE ref. no.	Doc. No.	Rev.	Date
	728.01.620	728.01.620-RP-HAZOP-CMS-1	A	09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 31.

P&IDs: 1308-7001-L407

Node Description and Intent: Sulfuric acid tanks system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
31N .27.	Sampling Hazards	1. No credible cause identified										
31N .28.	Personal Protection Hazards	1. No credible cause identified	1.	PPEs Systems are established								
31N .29.	Other- Loss of containment 1.V-2701	1. Leakage of bottom flange Collapse of tank	1. 98% H ₂ SO ₄ will get discharge into atm. Can cause serious corrosion and serious injury.	Dyke wall with acid proof lining provided.	2	4	8					
31N .30.	Other- Loss of containment Rupture of unloading hose for tank V-2701	1. Mechanical damage Corrosion due to failure of PTFE lining inside the hose.	1. Spill of 98% H ₂ SO ₄ from tanker to atm, causing serious injury to operating personnel.	Acid proof lining provided for unloading area.	2	5	10	110. An Excess flow check valve should be provided at tanker outlet. this valve will shut when the hose collapses/leaks.	1	5	5	
				No protection to contain the spill from the tanker.								
				NRV provided on suction of P-2706 to prevent H ₂ SO ₄ from								

 GUJARAT FLUORO-CHEMICALS SALUS THROUGH GREEN CHEMISTRY	HAZARD AND OPERABILITY STUDY REVIEW FOR CMS-1 PLANT		 HSE Safeguarding with Safe Solutions	
	HSE ref. no. 728.01.620	Doc. No. 728.01.620-RP-HAZOP-CMS-1	Rev. A	Date 09/01/2025

Project: 1. HAZOP Study for CMS-1 Plant

Node: 31.

P&IDs: 1308-7001-L407

Node Description and Intent: Sulfuric acid tanks system

Ref No	Deviations	Causes	Consequence Without Safeguard	Safeguards	Existing			Recommendations	After Recommendation			Comments
					S	L	RR		S	L	RR	
				backing up from pump discharge.								
31N .31.	Other- Loss of containment 1.V-2702	1. Leakage of bottom flange Collapse of tank	1. 88% H ₂ SO ₄ will get discharge into atm. Can cause serious corrosion and serious injury.	Dyke wall with acid proof lining provided. P&ID shows dyke wall drain with valve	1	5	5					
31N .32.	Other-Loss of containment Rupture of unloading hose at the discharge of P-2702	1. Mechanical damage Corrosion due to failure of FEP lining inside the hose.	1. Spill of 88% H ₂ SO ₄ from tanker to atm, causing serious injury to operating personnel.	Acid proof lining provided for loading area. No protection to contain the spill from the pump.	2	4	8					
31N .33.	Other-Loss of containment P-2701A/B	1. Seal leak	1. Spill off 98% H ₂ SO ₄ into atm, causing possible injury.	Pump area provided with acid proof lining No protection for the seal leak	2	4	8	77. Explore the possibility of installing a seal-less pump	2	4	8	

Annexure-4

Annexure 15

Root Cause Analysis

On 28th December 2024, around 20:00 hrs, there was a gas leak from one section of CMS-1 plant. After detailed study of the incident occurred the root cause of the accident is explained below:

The pipe-line coming from column is fed to reflux drum via heat exchanger E-2207. There is an isolation valve preceded by actual valve and another isolation valve. The bonnet of this isolation valve (before the actuated valve) was found dislodged. The typical probable reasons for failure of this isolation valve are:

1. Embrittlement of valve bonnet-bolts leading to sudden breakage
2. Metallurgical failure of bolt material (microstructure). In the valve manual, provided by supplier, it is mentioned that regular maintenance is not required.

This type of valve failure was never experienced in the past. Hence, Valve bonnet bolt needs to be further investigated to understand the specific mechanism of material failure.

After the incident, immediately safe shutdown was taken considering all critical process parameters. In – process material is kept at hold within plant vessels considering all safety precautions.

There was no generation of any chemical residue/ hazardous and other wastes due to the gas leakage.