Fire & Explosion Strategy

CO_2 Capture Facility

Kårstø, Norway

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1.0 SUMMARY

A Fire & Explosion Strategy is developed to examine the fire and explosion hazards associated with the addition of a Carbon Dioxide Capture and Compression (CCC) Plant forming the Kårstø CO2 Capture Project and to determine the measures required to manage these hazards.

2.0 INTRODUCTION

2.1 GENERAL

The Fire and Explosion Strategy (FES) is a systematic approach to manage fire and explosion hazards associated with the operational phases of the CCC Plant.

2.2 OBJECTIVES

The objectives of the FES are to:

- Provide direction to project management in the management of Fire and Explosion (F&E) hazards associated with this project
- Establish a strategy to ensure that the identified F&E hazards associated with the operational phases of the development are addressed.

The occupational hazards associated with construction, transportation, installation, commissioning, start-up and operations are not addressed in this strategy.

3.0 ABBREVIATIONS

AFP	Active Fire Protection
AIT	Auto-Ignition Temperature
BLEVE	Boiling Liquid Expanding Vapour Explosion
CCC	CO2 Capture and Compression
CCPP	Combined Cycle Power Plant
CO2	Carbon Dioxide
CR	Control Room
DCS	Distributed Control System
EDP	Emergency De-Pressurization
EER	Escape, Evacuation and Rescue
EIV	Emergency Isolation Valve
ESD	Emergency Shut-Down
F&E	Fire and Explosion
F&G	Fire and Gas
FEED	Front End Engineering Design
FES	Fire & Explosion Strategy
FP	Flash Point
FPZ	Fire Proofing Zone

FW	Fire Water
HSE	Health, Safety and Environment
HVAC	Heating, Ventilating and Air Conditioning
MEA	Monoethanolamine
NC	Normally Closed
NFPA	National Fire Protection Association
PFP	Passive Fire Protection
PSD	Process Shut-Down
PTW	Permit-To-Work
SAS	Safety and Automation System
UPS	Uninterrupted Power Supply
VESDA	Very Early Smoke Detection and Alarm

4.0 DEFINITIONS

Throughout this FES, the following terms are defined as follows:

Fire load heat load from a fire for a specified time period

Explosion load time dependant pressure or drag forces generated by violent combustion of a flammable atmosphere

5.0 REGULATIONS AND STANDARDS

Plant design, construction and operation shall comply with all statutory national laws, regulations, standards and permits within the area of health, safety and environment as administered by the Norwegian Labour Inspection Authority (AT), the Petroleum Safety Authority (PTil) and the Pollution Control Authority (SFT) respectively as well as Kårstø site specific requirements.

The control, instrument and electrical equipment shall be engineered, built, mounted and documented in accordance with, but not limited to Fichtner-Gassnova document number 10112936-FI-B-CON-0242-06 "Appendix E1.2, Design, Codes and Standards."

6.0 PROJECT OVERVIEW

It is the intention of the Norwegian Government to develop a carbon dioxide capture and compression (CCC) project in association with an existing 420 MW gas-fired combined cycle power plant (CCPP), which is located at the Gassco facility in Kårstø, Norway.

The CCC Plant has a CO2 capture target of at least 85% of the CO2 contained in the flue gas from the CCPP. The CCC Plant will deliver liquefied CO2 to the battery limit of the CCC Plant.

The CCC Plant consists of the following systems:

- Flue gas diversion – where the flue gas is extracted from the existing CCPP stack to the CCC Plant;
- Flue gas cooling – the flue gas must be cooled to be processed efficiently in the amine system. Cooling is to be to saturation temperature before entering the absorber towers;
- CO2 Absorption – two absorbers remove the CO2 from the flue gas using an amine solution;
- Heat Integration – this system recovers heat from internal streams to enhance the energy efficiency of the facility;
- CO2 Stripping – the amine is regenerated for reuse by liberating the CO2 from the amine solution;
- Amine reclamation – this system removes heat stable salts from the amine solution, generating a waste stream;
- Amine storage – concentrated amine and lean (35 wt%) amine are stored and injected in to the absorption system to maintain the amine solution concentration;
- CO2 Compression and drying – the CO2 is dried and liquefied to meet the CO2 specifications.

Construction operations will occur in a sequence that will involve flue gas duct tie in preparation during normal operations of the CCPP plant.

7.0 SCOPE AND METHODOLOGY

7.1 SCOPE

The scope of this FES includes all equipment in the CCC Plant FEED stage from the flue gas tie-in at the CCPP facilities to the CO2 export point.

7.2 METHODOLOGY

Hazard management activities will be integrated with design activities in each phase of the CCC project. The following activities will be carried out during the FEED stage:

- F&E hazards associated with the project will be defined for subsequent evaluation;
- A strategy for managing the identified F&E hazards will be developed that includes coarse assessment in accordance with the methodology outlined below and setting performance standards for the safety systems.

During detailed engineering phase, it is expected to design to the strategy and achieve the required performance criteria and validate that the F&E hazards have been managed in accordance with this FES.

8.0 FIRE AND EXPLOSION HAZARDS

For the purpose of this FES, the CCC Plant is categorized into three main sections/areas:

- Flue gas tie-in area (blower and quench section);
- CO2 compression and drying section;
- Amine process and storage areas.

8.1 FLUE GAS TIE-IN SECTION

The potential for F&E in the blower and quench section is minimal due to nature of process materials being water and flue gas.

8.2 CO2 COMPRESSION & DRYING SECTION

The potential for F&E at the CO2 compression and drying section is minimal due to nature of the process and the materials handled. However, there is a potential for fire involving lube oil skids of the CO2 Compressors.

During detailed engineering, the F&E assessment shall ensure that potential fire involving lube oil skids are mitigated.

Potential for hot surface ignition of atomized lube oil shall be assessed and mitigation measures incorporated into the design (e.g. rate-of-rise heat detection, pilot line detection activates automatic suppression system, insulation, layout, etc.)

A rapidly developing asphyxiating atmosphere can develop with non-flammable materials that are extremely cold (e.g. liquid CO2). However, available research indicates that a BLEVE type of event is unlikely to occur with supercritical CO2. While there may be a rapid release with some pressure rise, such an event will not be followed by vapour cloud explosion, as could be the case with flammable liquids.

The bulk of the supercritical CO2 (pressurized at a specific temperature range so that it is liquid rather than gas) is stored in the CO2 Surge Drum V-106 and the plant is provided with a depressurization valve to depressure V-106 and associated equipment. The venting CO2 is routed to the Absorber stacks to mix with the exiting flue gases to ensure buoyancy necessary to disperse the CO2.

During detailed engineering, the F&E assessment shall ensure that the risk of depressurization is mitigated as low as reasonably practicable.

8.3 AMINE PROCESSING & STORAGE SECTION

The main fire hazards for the CCC Plant arise from the amine processing and storage areas, which can be sub-divided into the following process sections:

- CO2 absorption
- Heat integration

- CO2 stripping
- Amine reclamation
- Amine storage

NFPA 704 characterizes MEA as having moderate fire hazard potential (i.e. the material must be exposed to relatively high ambient temperatures before ignition can occur). In addition, the MEA used in process area is 35-38% solution, which considerably reduces F&E potential.

DLI 361 information and the MSDS for MEA characterize MEA as having serious potential health hazards. Short exposure could cause serious temporary or residual injury even with treatment, or could cause death. The potential health impacts of MEA are not addressed in this document and will be assessed in other project deliverables.

Detailed F&E assessment shall be carried out during detailed engineering to assess stream properties in the above process sections for potential F&E considering equipment layout, material properties, credible leak scenarios, potential ignition, prevention and mitigation measures, etc.

9.0 CONTROL OF IGNITION

9.1 OBJECTIVES

The objective of ignition control systems is to minimize the likelihood of ignition of combustible material following a loss of containment.

9.2 FUNCTIONAL REQUIREMENTS

The complete elimination of ignition sources is generally not practicable with current technology.

In the case of electrical equipment, for example, intrinsically safe circuits are available only for very low power systems. Power circuits for electric motors, lighting, etc. cannot be made intrinsically safe, and so the approach has to be one of assuring, by design, a low probability of ignition, the probability being commensurate with the likelihood of a flammable atmosphere being present.

In other cases, the probability of ignition cannot be reduced by design. Welding, for example, is necessarily a high temperature process, and the approach here must be to implement procedures that prohibit the use of welding equipment in the presence of flammable material.

Potential for ignition is minimized, as all outdoor equipment is suitable for zone 2 group IIA and temperature class T2 hazardous area classification as minimum. Equipment and piping surface temperature is well below AIT of MEA (410 °C).

Grounding and bonding will be considered in the design. Other sources of ignitions are controlled by procedure (e.g. PTW).

Non-essential electrical power sources, such as welding and socket outlets, shall be tripped at grouped low gas alarm in the area where combustible gas is detected. Non-essential electrical power sources shall be tripped to eliminate potential sources of ignition under a flammable liquid or combustible gas leak.

Ignition source control shall comply with the requirements of clause 3.6 of Fichtner-Gassnova document number 10112936-FI-B-CON-0240-05 "Exhibit E8.1 – HSE Requirements".

10.0 FIRE AND GAS DETECTION AND ALARM SYSTEMS

10.1 OBJECTIVES

The objective of the fire and gas (F&G) detection and alarm systems is to provide continuous automatic monitoring functions to alert personnel of the presence of a hazardous F&G condition and to allow control actions to be initiated manually or automatically in order to minimize the likelihood of escalation.

10.2 FUNCTIONAL REQUIREMENTS

The F&G detection system shall be designed to cover all areas and to perform the following functions:

- monitor areas for fire or gas releases;
- detect fire at an early stage;
- detect hazardous accumulations of gases;
- detect ingress of smoke and gas into places where they may present a hazard;
- permit manual initiation of alarms.

The F&G system shall alert personnel and shall allow control actions to be initiated manually or automatically to minimize the probability of personnel exposure, explosion and fire. In particular, the function of the F&G system is to:

- notify operator of any F&G alarms;
- control of outdoor blue lights;
- control of red stop traffic lights;
- shutdown of non-essential electrical power; and
- if required, shutdown equipment, (e.g. pumps, compressors, analyzers houses, HVAC, extinguishing agent release etc.). These trip or release signals shall be routed via the ESD system either directly from the F&G system or from the ESD system.

The system shall be designed in such a way that it will be able to function in a fully automatic mode. Supervision of the system shall be possible from a dedicated panel (Critical Action Panel) within the Control Room (CR) of the CCC Plant.

On detection of F&G, the alarm system should be capable of identifying the location of the incident in a clear, unambiguous manner.

All detectors shall be located such that they are accessible for maintenance without the use of scaffolding.

The actions to be taken in response to F&G detection are described in Cause and Effect charts.

F&G detection philosophy, detector location and alarm levels shall comply with provisions described in Fichtner-Gassnova document number 10112936-FI-B-CON-0140-05 "Exhibit E8.1- HSE Requirements."

The F&G system shall comply with the requirements of Fichtner-Gassnova document number 10112936-FI-B-CON-0094-01 "Exhibit E4.4 - General Technical Requirements, Fire and Gas Monitoring and Alarm System."

10.3 FIRE AND GAS DETECTION BASIS

The F&G system has various detectors within the CO2 Kårstø facility battery limits for CO2 release, combustible gas, smoke and fire.

The F&G system status is shown and alarms are annunciated at the DCS operator stations. A manual operator response is required for F&G alarms. Some automatic actions are taken by the system, such as shutdown of ventilation inside a building on combustible gas detection, discharge of extinguishing agent, etc.

In deciding the type and extent of detection required for particular hazards, the following factors will be taken into account.

- the category of combustible materials;
- location of plant or other equipment which could constitute an ignition source;
- hazardous area classification;
- performance of detection devices;
- maintainability of detection devices;
- environmental conditions;
- rate of propagation;
- manned/unmanned areas;
- interfering agents.

When any detection device reaches its alarm setting, it shall raise a latched alarm at the SAS; that is, it shall not be possible to cancel the alarm without manual intervention through the SAS.

Voting principles and system interlocking and actions shall comply with all requirements of Fichtner-Gassnova document numbers 10112936-FI-B-CON-0140-05 "Exhibit E8.1 - HSE Requirements" (clause 3.3) and 10112936-FI-B-CON-0094-01 "Exhibit E4.4 - General Technical Requirements, Fire and Gas Monitoring and Alarm System" (clause 5.5).

10.4 INTEGRITY AND RELIABILITY

All F&G detection devices shall be selected taking into account their response characteristics and the conditions, which may be experienced when detection is required.

All field devices shall be suitable for the area in which they will be located.

Spurious F&G alarms leading to emergency shutdown is unacceptable. Experience with F&G detectors installed in "open" environments in the North Sea shall be used before detector types are selected.

It shall be possible to test and maintain F&G components without loss of function of the detection network.

Detectors shall be self-monitoring (diagnostic) as far as practicable.

10.5 SURVIVABILITY

All F&G systems shall as far as reasonably practicable be fully functional during and after design F&E incidents.

It is accepted that field devices will be vulnerable to direct flame impingement. Field cabling shall be fire resistant and located as far as possible to avoid blast effects.

10.6 DEPENDENCIES

The F&G detection system is dependent on emergency power supplies for its continuing operation.

11.0 EMERGENCY SHUTDOWN & DEPRESSURIZATION SYSTEMS

11.1 EMERGENCY SHUT-DOWN

The objective of the Emergency Shut-Down (ESD) system is to initiate appropriate shutdown and isolation actions to prevent escalation of abnormal conditions into a major hazardous event and to limit the duration of any such events that do occur.

11.2 DEPRESSURIZATION

The CCC Plant contains CO2 at supercritical conditions. In the event of leakage or equipment failure, the released CO2 will reach extremely low temperatures causing

a hazard to surrounding equipment and personnel. Additionally the concentrations of CO2 may reach dangerous levels.

Depressuring facilities are installed after the final stage of the compressor to ensure the plant can be depressured to mitigate the impact of loss of containment. The depressuring rate, valve and piping will require careful design to ensure excessively low temperatures and 'dry ice' formation are avoided.

11.3 FUNCTIONAL REQUIREMENTS

The ESD systems shall be provided for:

- local equipment shutdown (PSD);
- process unit shutdown (ESD 1);
- process shutdown and depressurization (ESD 2).

11.4 SURVIVABILITY

All equipment shall be suitable for the environmental conditions prevalent at the installed location.

Process sensors acting into the SAS are not required to survive fire or explosion impact. The ESD control system will be protected by location. ESD and Emergency De-Pressurization (EDP) valves shall fail to their safe positions on loss of command signals from the ESD control system. ESD and EDP valves shall as far as possible be located to protect their bodies and actuators from damaging impact by fire and explosion.

All ESD and EDP valves and actuators should be located to avoid the potential for impact from heavy objects. Where available ESD valves should be spring return types; if suitable valves are not available with spring return then they shall be provided with a hydraulic/pneumatic accumulator sized for at least three operations (close-open-close). Hydraulic and pneumatic accumulators used to move ESD valves to a safe position shall be located as close to the valve as possible to ensure best possible availability. Pneumatic and hydraulic tubing shall be capable of resisting loads from F&E until they have completed the shutdown sequence. ESD valves shall not be dependent on normal process or pipeline pressures to ensure acceptable closing times.

11.5 DEPENDENCIES

The ESD system is dependent on electrical power supplies. The system will be supplied by either of the main generators and a UPS. On complete loss of power all ESD valves will close and EDP valves open.

12.0 ACTIVE FIRE PROTECTION

12.1 OBJECTIVES

The objectives of the Active Fire Protection (AFP) systems are:

- to control fires and limit escalation;
- to reduce the effects of a fire to allow personnel to undertake emergency response activities or to escape;
- to extinguish the fire where it is considered safe to do so;
- to limit damage to structures and equipment.

12.2 FUNCTIONAL REQUIREMENTS

12.2.1 General

All AFP systems and equipment shall be designed, installed and maintained in accordance with appropriate recognized standards.

The discharge effects from an AFP system shall be considered in the design (e.g. effect on electrical equipment).

All AFP systems and equipment should be marked with easily understood operating instructions.

For manually initiated systems, any time delay for activation and reaching an operational status should not affect the intended function of the system. For automatically initiated systems, a manual release station shall be provided outside the protected area.

Firewater requirements for CCC Plant shall be supplied by the existing firewater network at the CCPP site.

Specification of system components for firefighting shall comply with Fichtner-Gassnova document number 10112936-FI-B-CON-0140-05 "Exhibit E8.1 - HSE Requirements" clause 3.8 (all sub-clauses).

Structural Fires shall not be approached by CCC Plant workers. All buildings are fitted with full fire detection and alarming facilities and/or automatic suppression systems.

The CCC Plant design includes a full perimeter underground fire ring main tied to the Kårstø Site firewater system. P&ID number 25474-000-WF-0010-00001 shows the full details of the ring main and fire hydrant around the facility.

Firefighting employing hydrant based hose stream attack shall not be undertaken by CCC Plant staff. Use of hydrants shall be restricted to the main Kårstø fire brigade and all structural and large scale firefighting activities must be coordinated through main site fire and emergency services. Further definition of the response time and

manpower is to be defined during detailed engineering. It is anticipated and assumed in the fire protection strategy for the CCC Plant that professional firefighting services are available for possible fire events to respond with a trained fire brigade for a fire call in less than five (5) minutes.

Incipient fire attack may be undertaken by CCC Plant staff employing portable fire extinguishers for incipient stage fire attack. Proper training shall be provided with regular refresher training. Only those CCC Plant workers who have been trained should be permitted to operate and discharge a fire extinguisher.

A minimum of two (2) CCC Plant workers shall be trained in the maintenance and inspection requirements for the fixed fire protection systems installed in the plant. All inspection activities and documentation shall follow all regulations and codes to ensure system operability under all operation conditions.

All fire protection impairments shall result in immediate remediation of the conditions to reduce the duration of the impairment.

12.2.2 Fire Water Mains

Fire water mains shall be designed to provide an adequate amount of water to the discharge points at the required pressures.

The fire mains will be constantly pressurized.

The fire water main system shall provide a reliable and secure source of supply to all firewater dependent protection systems.

12.2.3 Fixed, Automatic Suppression Systems

The initiation and discharge of any suppression systems (e.g. sprinklers, deluge, water mist, clean agent) will be automatic on confirmed fire detection. All systems shall have the ability to have discharge triggered manually, locally or remotely.

Further evaluation during detailed engineering shall consider the application of specialized, self-contained high momentum water mist extinguishing for fire suppression of specific hazards (e.g. lube oil systems, stationary diesel engine bays).

12.2.4 Gaseous Firefighting Systems

There are no significant F&E risks that warrant installation of total flooding, clean-agent fire suppression systems. Further evaluation during detailed engineering shall consider the application of NFPA 2001 compliant total flooding clean-agent protection for fire suppression of specific hazards (e.g. Local Instrument Room).

False floors and ceilings within buildings may be protected with VESDA incipient fire detection in lieu of AFP. This requirement shall be evaluated in detailed engineering.

12.2.5 Survivability

As far as reasonably practicable, AFP systems shall be located or protected so that they will be able to withstand the dimensioning fire or explosion loading. All power and signal wiring between field installed equipment and the fire alarm control panel and CR shall be fire-rated to ensure integrity of signal and alarm under all foreseeable fire conditions.

12.2.6 Dependency

The AFP systems requiring power supplies will be fed from the main or emergency generators. Gaseous extinguishing system control panels may be supplied by UPS systems.

13.0 PASSIVE FIRE PROTECTION

13.1 OBJECTIVES

The objectives of Passive Fire Protection (PFP) systems are:

- to prevent escalation of fire due to progressive releases of inventory, by separating the different fire risk areas and if necessary by protection of critical equipment such as vessels and ESD valves;
- to minimize damage to the installation by protecting the critical structural members essential to the support of the escape routes;
- to protect personnel in the Mustering Area until safe evacuation can take place;
- to protect any section of the escape routes to the Mustering Area for a pre-determined time to cater for safe escape from the area and allow for emergency response activities;
- to protect any sections of the escape routes from the Mustering Area (temporary refuge) to the locations used for Kårstø site wide muster areas;
- to protect essential equipment from premature collapse under fire conditions.

13.2 FUNCTIONAL REQUIREMENTS

13.2.1 Functionality

The Dimensioning Accidental Load Specification gives guidance on the intensity of fires that can be considered, dimensioning events and which should be considered during design.

13.2.2 Integrity and Reliability

The PFP systems shall be suitable for the prevailing environmental conditions where they are installed.

13.2.3 Survivability

The PFP systems shall be designed to resist minor accidental impacts, which may occur during normal operations.

The PFP systems are designed to resist fire for a limited period. However, fire impact may cause damage to the system (often by design) and such systems must be thoroughly inspected and repaired following any fire incident.

14.0 EMERGENCY POWER SYSTEMS

14.1 OBJECTIVES

The objective of the emergency power systems is to provide a reliable source of emergency electrical power for systems required to operate during or after a major hazard incident.

14.2 FUNCTIONAL REQUIREMENTS

- Emergency power shall be provided in accordance with the requirements of the FES;
- System requiring electrical power to fulfill their functions and to allow safe shutdown and evacuation shall secure emergency power supply of sufficient capacity and duration for a period sufficient for effective management of the plant while the main power is unavailable;
- Facilities shall be provided to allow maintenance of the emergency power system without significantly reducing its functionality;
- Location and design of the emergency power systems shall ensure that they will be able to perform their function under the conditions, which may be experienced when called upon to operate.

The requirements for emergency power supply are envisaged to be provided by a dedicated emergency diesel generator located within the battery limits of the CCC Plant.

15.0 CONTAINMENT AND DRAINAGE SYSTEMS

15.1 OBJECTIVE

The objectives of the containment and drainage systems are to:

- provide measures for containment of spilled material;
- provide measures for proper disposal of liquids including handling of FW;
- prevent escalation of incidents to adjacent areas;
- allow for incident response and control.

15.2 FUNCTIONAL REQUIREMENTS

- Arrangements for control of spills shall be provided in accordance with the requirements of the FES;
- Measures shall be provided for dealing with spills in all areas, which have a source of combustible liquid so as to minimize the risk of fire;
- Hazardous and non-hazardous drains shall be physically separate;
- Hazardous closed drains shall be separate form all open drainage systems;
- The design of the drainage system shall limit the maximum spread of a spill to minimize escalation arising from the spill.

The MEA solvent and water containing MEA shall be drained from the plant at shutdown or from individual equipments for maintenance activities to be performed.

The process design shall ensure that water is retained and reused within the CCC Plant to eliminate routine draining and minimize make-up requirements.

Facilities shall be provided to drain and store Amine from the CCC Plant during operation and shutdown. These facilities enable the plant to be completely emptied of MEA solution during shutdown.

All process and non-process drains shall be reviewed as part of the F&E assessment during detailed engineering.

16.0 PROCESS SAFEGUARDING

The following safeguarding issues should be considered:

- Overpressure of stripper column due to steam leak in reboiler;
- Creation of vacuum in stripper column due to cooling;
- Possible amine contamination of sewer due to heat exchanger leakage;
- Increased amine contents in off-gas due to wash water system failure;
- Initiation of auxiliary boiler shutdown through the ESD system under developing emergency conditions for ignition source elimination.

17.0 CONCLUSIONS

The following conclusions are drawn for the above analysis:

1. Potential for F&E exists only at the amine process and storage areas.
2. Potential for ignition is minimized, as all outdoor equipment is suitable for zone 2 group IIA and temperature class T2 hazardous area classification as minimum.

3. Equipment and piping surface temperature is well below AIT of MEA (410 °C). Design measures such as grounding and bonding will be considered. Other sources of ignition are controlled by procedure e.g. PTW, etc.
4. The most significant fire scenarios arise from pumps MP-105 and MP-106. These pumps have high rated capacity (2175 and 548 m^3/hr respectively) and operate at temperatures that present a possible ignition source to the contained fluid under a loss of containment (e.g. seal failure).
5. Automatic fire suppression is not justified for pumps MP-105 and MP-106 based on operating conditions (operate below AIT of contained fluid).

18.0 RECOMMENDATIONS

1. Revisit this FES during detailed engineering to revalidate and complete further evaluations as necessary.
2. Open and closed drainage arrangements should be examined during detailed engineering.
3. There is a 6" branched drain connection between T-103 and HV-0501 with NC valve and spectacle blind in closed position. Procedural control to ensure that this connection remains closed thus not to compromise protection provided by Emergency Isolation Valve.
4. Location of CR should consider wind direction and avoid having doors opposite to the CCC Plant side.
5. Requirement for providing buildings with HVAC system, positive pressurization, gas/fire detection, AFP system and blast overpressure should be confirmed during detailed engineering.
6. CO2 and O2 deficiency detectors should be considered for buildings as necessary.
7. To minimize potential fire hazards from lube oil skids supplying major equipment (e.g. CO2 Compressor, Flue Gas Blowers), it is recommended that these skids be protected by dedicated, fixed automatic water mist suppression. Specialized heat detection devices (pilot line detection) that activate the suppression system should be incorporated in the design.
8. During detailed engineering the F&E assessment shall analyze fire potential and heat loading from possible fire events and model possible explosive overpressure events.
9. Fixed firewater system design shall be validated during detailed engineering to ensure adequate coverage through hydrants and monitors stations.
10. EIVs are required for MP-105 and MP-106 suction line of the Stripper and Flash Drum respectively. Both vessels operate at temperatures sufficiently high to be considered ignition hazardous and contain significant inventory of 38% MEA. The Stripper is equipped with an EIV (HV-0501) on MP-105 suction line.

11. MP-105 and MP-106 are considered fire hazardous creating a FPZ that extend 6-12 meters around these pumps. Equipment and structural support within these FPZ should be further assessed for application of lightweight cementitious fireproofing during detailed engineering, following F&E modeling to be undertaken during detailed engineering.
12. PFP of structural supports of the Stripper T-103 and Flash Drum V-101 is required. In addition, PFP is recommended for structural support of Absorbers T-101 & T-102 due to their significant MEA inventory.