ASSIUT HYDROCRACKING COMPLEX (AHC)
ANOPC

FUNCTIONAL SPECIFICATION FOR SAFETY DESIGN (SAFETY PROCESS DESIGN CRITERIA)

Modifications to previous issue are marked with a right border

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1 GENERAL

A Safety Process Design Criteria has been developed with the intent to clarify some design criteria related to safety to be adopted as part of the process design activities. Other safety design criteria can be found on applicable regulation and standard valid for the project.

The present document, contains the minimum safety requirements for AHC units, but additional safety requirements derived from the safety studies developed in this engineering phase could be discussed and, in any case, added.

The safety design criteria under the scope of the present document are applicable only to:

- New units;
- Revamped units, on a case-by-case analysis and under judgment of contractor only.

The design criteria given in present document are not applicable to the existing facilities in the ASSIUT Refinery.

The aim of present document is to reduce the risk associated to the facility:

- Reducing the likelihood leakage by either: quality controls during process design, overpressure protection, protection of piping by mechanical failure as result of vibration, sizing of piping to avoid hammering and surge, minimizing number of flanges, specifying adequate safety integrity level for safety instrumented systems, avoiding significant design temperature exceedance (both embrittlement and over temperature),
- Reducing the consequence by either: plant layout, isolation of ignition/leak sources, spacing between units and equipment, bounding of liquid storage, escape way provision, fire protection, firefighting, fire and gas detection and alarm, automatic system to isolate and depressurize, proper hazardous area classification and selection.

For layout distance and spacing refer to document “Design Specification for Piping Design I-Basic Specification” coded as 079254C-0000JSD-1300-002.

For standard codes applicable to the project, refer to Basic Design Data document coded as 079254C-0000JSD-0000-001.

2 HAZARDOUS MATERIAL

Hazardous materials are solids, liquids, or gases that can harm people, other living organisms, property, or the environment. They are often subject to chemical regulations. They include materials that are radioactive, flammable, explosive, corrosive, oxidizing, asphyxiating, bio-hazardous, toxic, pathogenic, or allergenic.

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The following definitions shall be considered with respect to hazardous material comprised in facilities part of the AHC Project and for which specific design requirement is given in terms of safety design in present functional specification:

- **Hazards related to Flammability:**

  Flammability is defined as the ease with which a material will ignite, either spontaneously (pyrophoric), from exposure to a high temperature environment (autoignition) or to a spark/open flame.

  In the industrial facilities, many substances having flammable or combustible characteristics are present. The risk is associated to the possible combustion by air or oxygen and the energy released. The following definitions shall be considered:

  Combustible liquid: any liquid that at normal ambient condition is below its closed cup flash point.

  Flammable liquid: any liquid that at normal ambient condition is at or above its closed cup flash point.

  Flammable gas: a gas o vapor which can form an ignitable mixture with air.

  Liquefied flammable gas: a flammable gas that is liquid at process conditions in which is handled.

  Combustible fluid: Comprises combustible liquid, flammable liquid, flammable gas, and liquefied flammable gas.

- **Acute Toxic Hazards:**

  Acute toxic Hazards are related to fluids that can produce acute risk for inhalation, such as H_2S and NH_3 for AHC facilities.

  Hydrogen sulfide: gaseous streams handling H_2S concentration in vapor phase equal or greater than 5% weight or liquid streams containing H_2S such that after flash to atmosphere more than 5% weight liquid is vaporized and the flashed gaseous stream contains H_2S in excess of 5% in weight, are considered as fluids that can produce damage to the health.

  Ammonia: gaseous streams handling NH_3 concentration in vapor phase equal or greater than 5% weight or liquid streams containing NH_3 such that after flash to atmosphere more than 5% weight liquid is vaporized and the flashed gaseous stream contains NH_3 in excess of 5% in weight, are considered as fluids that can produce damage to the health.

Exposure to Hazardous Materials is regulated by Safe Exposure Limits mentioned in the Egyptian Environmental Law, N° 4-1994. Hazard Identification Study will be performed during this project stage.

3 PROCESS SAFETY SYSTEM

Each facility that processes, transports or otherwise handles hazardous material shall be provided with safety systems designed to take the process, or specific equipment in the process, to a safe pre-determined condition, (i.e. to shutdown, to isolate, de-energize, and depressurize unit, train, unit section or equipment) through a system of valves, piping, sensors, logic solvers, and actuating devices, in order to stop the hazardous condition, reduce the consequence of leakage and, when needed, to eliminate potential ignition sources.

Depressurizing system is required to reduce the potential of equipment or piping mechanical failure during uncontrolled reactions, or to minimize the risk of catastrophic equipment failure in case of prolonged fire exposure (potential of a boiling liquid expanding vapor explosion – BLEVE), or to reduce the released inventories of hazardous materials in case of leakage.
Depressuring systems should comply with API 521 requirement (refer to paragraph 3.3 for other details).

Process Safety systems, associated logic and alarms shall be designed such that they are segregated from, and totally independent of, other regulatory control and monitoring systems, such that any fault in the control system will not lead to the contemporaneous fault in the process safety system.

3.1 Architecture of the Shutdown Systems

Shutdowns functions shall be developed in the form of a hierarchical series of shutdown levels: unit, unit section (circuit), equipment.

The Shutdown Systems includes the following functions:

- One level for Plant Emergency Shutdown (Individual Process / Utility Unit / Section Shutdown – Level 1) which is mostly related to significant process safety related issues as large fires, explosion, toxic dispersion, etc.

- One level for equipment Emergency Shutdown (Individual Hazardous Equipment Isolation – Level 2) which is mostly related to individual equipment process safety related issues as leakage of liquefied flammable gas, products above their auto-ignition temperature, mechanical damage resulting into spills of hazardous material, etc.

- One level for equipment Shutdown and not belonging to emergency condition (Equipment upset Protection – Level 3). The protection of the equipment is intended as limiting the damage to the asset (e.g, vibration on fan motor axes).

The shutdown levels are described below.

Emergency Shutdown Level 1: this is the individual Unit / Section Shutdown, that is provided where the need to isolate hazardous inventory or to stop process exists. For this project, Emergency Shutdown Level 1 will be implemented only for high pressure units.

It is activated by:

- Dedicated button located in Main Control Room.
- Specific process or utility parameter upset in the concerned process function or unit (mainly applicable to Licensed Unit and associated dangerous condition related to process, temperature, composition or to the lack of layer of protection such as cooling medium, nitrogen, etc.).

The actions are:

- Closure of the related unit zone battery limit emergency isolation valve.
- Activation of Emergency Shutdown Level in the concerned Unit / Section.
- Initiation of depressuring systems in the concerned unit or circuit part of the relevant hazardous zone, when dictated by Licensor.
- Shutdown of specific process function by activation of the Emergency Shutdown Level 2 or 3 on some equipment within the same unit under emergency condition as well as in other units when required.

The Emergency Shutdown Level 1 handles also depressuring system within the zone, section or entire unit. Except the case described above the depressuring system is not activated automatically by the initiator listed above, but any depressuring system is activated by a dedicated button located only in Main Control Room.

The actions are:

- Closure of the related hazardous zone battery limit emergency isolation valves.
- Activation of Emergency Shutdown Level 1 in the concerned zone, section or entire unit.
- Initiation of the relevant depressuring system or systems.

Emergency Shutdown Level 2: this is the Hazardous Equipment Isolation System that is provided where the need to isolate hazardous inventory in the concerned equipment exists. It is used to isolate individual equipment or small circuit, to prevent or minimize the development of hazardous condition, and to stop the release of hazardous fluids in the event of fire or loss of containment.
It is activated by:

- Emergency Shutdown Level 1 or Depressuring system in the concerned zone, section or entire unit.
- Dedicated button located in Main Control Room
- Dedicated button located on field in location accessible during the emergency but close to the concerned equipment.

The actions are:

- Closure of related equipment Emergency isolation valve or valves.
- Shutdown of related machinery (pump/compressor).

Emergency Shutdown Level 3: this system is provided for equipment upset protection upon process (level, temperature, pressure, flow, composition) parameter upset and upon other equipment related parameter upset (e.g. position, vibration, speed, etc.). The system is activated by the parameter upset itself; on a case by case basis, these systems can be activated also by push button located in Main Control Room / Local Control Building or by Emergency Shutdown Level 2 in the concerned hazardous zone.

The activation of any Emergency Shutdown will not impede the operation of fire protection or suppression systems, deluge systems, sump pump associated to drainage system or dumping circuit, or critical utilities such as instrument air, nitrogen, steam/boiler feed water, cooling water and fire water.

3.2 Determination of the Safety Integrity Level

The components of the Shut Down and Depressurizing systems shall be designed such as the reliability of the Safety Instrumented Function (SIF) will be in accordance with Safety Integrity Levels as per IEC-61511.

The SIL defines a minimum level of reliability in terms of Probability of Failure on Demand (PFD). Such failure probabilities are:

SIL	PFD
1	$\geq 10^{-2}$ to $< 10^{-1}$
2	$\geq 10^{-3}$ to $< 10^{-2}$
3	$\geq 10^{-4}$ to $< 10^{-3}$
4	$\geq 10^{-5}$ to $< 10^{-4}$

SIL 4 may be not feasible to be implemented. If a classification leads to SIL 4, further study should be performed, aimed to rearrangement of the section or installation under analysis. The purpose of the SIL Classification is to define the level of the performance (or availability/reliability) required for each specific Safety Instrument Function (SIF). Each SIF comprises an initiating element (process sensor), a logic solver (PLC/DCS), a final element (shutdown valve, machinery). For each SIF, the frequency of demand and safety consequences (including personnel health, environmental consequence, and asset damage or production loss) is used to determine the related Safety Integrity Level (SIL) required.

A SIL classification study based on Layer Of Protection Analysis (LOPA) will be performed in the next Project Stage (EPC Phase).

3.3 Emergency Isolation Valves

Isolation of equipment and plant units or sections is achieved through Emergency Isolation Valves. Emergency Isolation Valves are used to isolate possible releases of hazardous material. The provision of emergency isolation valves is linked to the risk associated to inventories, more hazardous equipment, and operation.

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Use of power operated Emergency Isolation Valves is required in the cases included in the following table. In all other cases, Emergency Isolation Valves could be manual (providing that valve is specified fire tested). Valves type will be selected depending on the fluid and operating conditions of the process stream.

Power-Operated EMERGENCY ISOLATION VALVE

Valve Class	Power-Operated
Class 150	204 mm (8-inch) valves and larger
Class 300	152 mm (6-inch) valves and larger
Class 600	102 mm (4-inch) valves and larger
Class 900 and above	25 mm (1-inch) valves and larger
In All Classes	Any EMERGENCY ISOLATION VALVE located at a platform whose level is more than 4.5 m above grade.
In All Classes	Any EMERGENCY ISOLATION VALVE used for isolation of pump or compressor where the valve is located within 7.5 m of the associated protected equipment.
In All Classes	Any EMERGENCY ISOLATION VALVE used for: - process heater main fuel line or pilot fuel gas header.
In All classes	Emergency Isolation Valves used for block plot limit isolation
In All classes	Emergency Isolation Valves used as part of emergency shutdown system and associated also to process parameter upset protection

Power operated valves are valves operated by hydraulic actuator, pneumatic actuator or electric motor.

Power operated Emergency Isolation valve located inside the areas identified for Fireproofing application, shall fulfill the following design requirements:

- Valve – fire tested;
- Valve actuator – fire proofed (30 minutes resistance);
- Cables – intrinsically fire resistant (running below grade) or provided with means for fire protection (30 minutes resistance).

  Note: valves pneumatically operated, which in case of loss of instrument air go in closed position, do not require means for actuator and cable protection, providing that the valve does not reopen upon process fluid pressure in case the actuator spring loses its strength.

- Power and signal cables to valves electrically operated must preferably run below grade to a point immediately below the valve; all above-ground component of valves electrically operated must remain fully operable up to 30 minutes for fire exposure. Thermal overload relays are not to be fitted (or shall be bypassed) to valve actuator electric motor.

With the exception of cases for which hammering phenomena could occur (e.g.: long line to/ from storage or pipelines), power operated (pneumatic type) valve closure time must be:

- ≤ 30 seconds in case of size equal or greater than 14”

- ≤ 20 seconds in case of size less than 14".

EMERGENCY ISOLATION VALVEs are required as follows:

(a) Pump (no sealless type)
EMERGENCY ISOLATION VALVE shall be provided in the pump suction piping (preferably on suction vessel nozzle), when:
- the upstream circuit contains 8 m^3 or more of liquefied flammable gases or hydrocarbons handled above 250°C or above its auto-ignition point;
- the liquid leakage will result in rapid liquid de-inventory and resulting upstream equipment toxic gas phase blowout;
- when pump suction valve is power operated, in addition to the suction power operated valve emergency isolation valve, an emergency isolation valve shall be provided at pump discharge on case by case analysis if both following condition apply:
  - the discharge pressure is above 35 barg OR the check valve at pump discharge is provided with bypass for warm-up purpose
  - the inventory in the pump discharge circuit exceeds 8 m^3 or more of liquefied flammable gases or hydrocarbons handled above 250°C or above its auto-ignition point.

(b) Vessel (drum, filter, column, exchanger)
EMERGENCY ISOLATION VALVE shall be provided on the liquid vessel outlet line (preferably on vessel nozzle), on all lines not provided with a normally closed valve at vessel nozzle, when the vessel liquid inventory above the relevant line nozzle is greater than 15 m^3 of liquefied flammable gases or hydrocarbons handled above 250°C.

(c) Compressor
EMERGENCY ISOLATION VALVE shall be provided in the compressor suction and discharge piping when equipment power is 150 kW or more and when the equipment handles material pertaining to flammability or toxicity hazards.

(d) Fired heater-boiler.
Each process heater shall be provided with a power-operated EMERGENCY ISOLATION VALVE in each main fuel line and pilot fuel gas header.
For boilers, safety shutdown is accomplished by the burner management system (BMS) controlled safety shutdown and vent valves. For boilers, no other EMERGENCY ISOLATION VALVEs are required.

In order to minimize the consequence of a fire in case of tube rupture in a fired heater:

- A motor operated emergency isolation valve shall be installed at the inlet of a fired heater, unless other means to shut down the heater are provided; motor operated emergency isolation valve shall not be implemented in case overpressure protection of upstream equipment is provided through heater. The provision of motor operated isolation valve instead of pneumatic operated isolation valve is intended to minimize spurious closure;
- Check valve on heater outlet may be considered on case by case analysis.

(e) Block plot limit

Plot limit emergency isolation valves shall be placed on all hydrocarbon and toxic lines entering or exiting the block plot, with the exception of lines to be used during the emergency (e.g: flare header).

If on a line passing the block plot an emergency isolation valve is already present inside the concerned block for one of the above cases (a) to (d), the emergency isolation valve at plot limit is not required and the other one is sufficient (e.g: when the power operated emergency isolation valve is provided upstream a pump which delivers the product outside the block plot limit after cooling in exchanger a second power operated emergency isolation valve at plot limit is not required).

When a line, without any other interconnection, passes from one process block (source block) to a second one (destination block), the plot limit emergency isolation valve can be provided at one plot limit only of those two blocks, in order to avoid to have two emergency isolation valves in series with only piping in between; however the block plot limit isolation logic of both source block and destination block shall close such valve. In these cases the preferred location of emergency isolation valve is at source block; if for process reason the necessity to keep open the line from source unit exists the location of emergency isolation valve shall be at destination block and the source block shall be provided with systems to automatically divert the flow to alternative destination.

Notes:

- Block means a process/utility unit or a group of process/utility units surrounded by roads,
- The block comprises only one unit when the unit can operate independently from other adjacent unit and in case a road exists in between,
- The block comprises more than one unit when all these units cannot operate independently from the others present in the block,
- The concept of block does not apply to the storage area.

(f) Storage.

Storage vessels containing flammable liquid or combustible liquid above its flash point or liquefied flammable gas or toxic fluid shall be provided with EMERGENCY ISOLATION VALVEs on nozzles having the capability to release the large inventory present in the storage. EMERGENCY ISOLATION VALVEs are not required for instrument connections.

All power operated emergency isolation valves are operated via the SIS-ESD (Safety Instrumented System – Emergency Shutdown) system. Power operated emergency isolation valve closure is associated to operator intervention by actuation button after detection of leakage or fire.

For power operated emergency isolation valve provided as per above point (a), (b) (c), (d), (f) two activation buttons shall be provided for each power operated emergency isolation valve: the first at field and the second at control room. The field actuation button shall be located preferably upwind and at least 15 m from the relevant protected equipment or from the edge of the relevant containment dike/basin if provided. Activation button shall be located in accessible location and provided with label indicating the purpose and the equipment protected.

Each plot limit emergency isolation valve shall be activated by two activation buttons: the first local and the second at control room; however, the block plot limit complete isolation shall be achieved

also by an additional common activation button located at control room only, such button shall determine the closure of all block plot limit emergency isolation valves and all other power operated valves present in the block. The local activation button for plot limit emergency isolation valve shall be located preferably upwind at least 15 m from any equipment in the concerned block. Activation button shall be located in accessible location and provided with label indicating the purpose and the equipment protected.

Preferably, all power operated emergency isolation valve should not have a bypass system. In case the bypass system is required to allow slowly pressurization of the downstream circuit, a 1" bypass valve in parallel with the power emergency operated valve can be used but it shall be indicated as car-sealed closed during normal operation.

Closure of power operated emergency isolation valve can be associated also to process parameter upset; for example, the closure of a power operated emergency isolation valve located on outlet line of a vessel can be activated also by the low-low level protection on the same vessel to minimize the possibility of loss of level.

3.4 Depressuring Systems Criteria

General note: for loops comprising compressors, the depressuring rate shall be checked versus the maximum depressuring rate advised by the compressor vendor, since damage to O-rings due to explosive decompressions may result if the depressuring rate is excessive.

Fire case

In case of fire, an emergency depressurisation shall be considered:

- For sections containing hydrocarbon and/or hydrogen including unwetted vessel(s) at fire conditions, and normally operating at a pressure higher than or equal to 17 barg (250 psig), from normal operating conditions down to 50 percent of the vessel design pressure.

Duration: 15 minutes.

- During Detail Engineering Phase the depressurisation criteria above shall be reviewed if calculated thickness of equipment is different from 25.4 mm (1") considered in API 521. If the thickness is below 25.4 mm (1"), the duration of depressurisation shall be reduced.

Depressurization shall be done manually by operator from a push button (only one push button in Control Room).

Leak case

In case of leakage, an emergency depressurisation shall be considered for sections, including large equipment like column, reactor or separator containing hydrocarbon and/or hydrogen, operating at a pressure higher than or equal to 17 barg (250 psig), from normal operating conditions down to 7 barg (100 psig).

Duration: 15 minutes.

Depressurization shall be done manually by operator from a push button (only one push button in Control Room).

Uncontrolled exotherm in reactors

Considering the possibility of uncontrolled exotherm in the reactor, Licensor shall specify an emergency depressurization system.

In HCKU, the high-speed depressurization in addition to low speed depressurization shall be specified. Low-speed depressurization will be performed in order to down to 50 percent of the vessel design pressure in 15 minutes, while high-speed depressuring rate shall have the maximum peak flow rate at initial condition of 21 bar/minute.

4 PRESSURE RELIEF SYSTEMS, FLARING AND VENTING

Discharges from pressure safety valves, depressuring valves and process vents shall preferably be collected and routed to flare systems or to other abatement equipment to ensure that no hazardous material, including harmful and corrosive material, is relieved to the atmosphere. Particularly relieve to atmosphere of hazardous vapor/gases is not allowed unless the connection to the flare system and/or abatement measures becomes hazardous (e.g. high oxygen content in the stream not allowing relief to flare). In such case, the atmosphere release location shall be verified against any associated hazard (dispersion, radiation).
During generalized refinery emergency scenarios such as loss of electrical power, cooling water system failure or instrument air failure, several relief valves discharge simultaneously to flare system leading to very large flow of gas burnt by flare. In order to reduce the total load to flare system during generalized emergency scenarios, the provision of appropriate instrumented system (transmitters, logic solver and valves) will be evaluated during flare system design.

5 EQUIPMENT AND LINE ISOLATION

5.1 Positive isolation

Positive isolation of equipment and lines shall be provided to ensure safe maintenance on circuits which are connected to systems that could be source of hazard and to avoid dangerous contamination/mixing of material.

For details about equipment positive isolation, refer to project document “Standard Specification for PID Preparation” coded as 079254C-0000-JSD-0001-002.

5.2 Accessibility

Accessibility to emergency isolation valve (both manual operated and power operated), as well as other valves to be used frequently, shall be ensured.

6 LEAKAGE/RELEASE MITIGATION OR CONTAINMENT

6.1 Steam ring

In the event of flange leak leading to jet fires, steam could be used to control fires. The steam has a smothering effect and it limits the overheating of the flange elements.
Steam rings or steam lances shall be provided on those circuits where the leakage is expected to continue even after the closure of the Emergency Isolation Valve, eventually present in the same circuit, due to the inventory present into the isolated circuit.

Steam ring or steam lances shall be provided on all piping or equipment flanges when all the following apply:

- Flange greater than 10”,
- Design pressure of circuit greater than 80 barg,
- Circuit handles stream in hydrogen service regardless the operating temperature, or circuit handles combustible fluid at operating temperature greater than autoignition temperature.

Steam ring is required where the flange is not accessible by steam lance.

Any steam ring is manually activated, by means of dedicated block valve located at least 15 m from the concerned flange. Steam ring and piping shall have 8 mm diameter drain hole at low points.

6.2 Snuffing steam for fired heaters

Snuffing steam connections shall be provided on fired heaters having liquid combustible fuels or having liquid or mixed combustible fluids into tubes, to allow fire extinguishing in case pool fire occurs into heater.

The associated elements shall be designed taking into consideration the following points:

1. The steam injection valve (automated on-off type) shall be manual operated and it shall be located adjacent to the heater; two push buttons have to be provided, the first local and the second at control room. The local activation button shall be installed at minimum 15 meters from concerned heater. The operation shall be easily accessible during the concerned hazardous scenario, in particular the push button shall be located upwind.

   Push button shall be located in accessible location and provided with label indicating the purpose and the equipment protected.
2. Piping downstream the steam injection valve shall have 8 mm diameter drain hole at low points in order to remove water resulting from condensation of steam which remains in piping downstream the valve after its closure.

6.3 Storage containment

Atmospheric storages pertaining to flammable or combustible liquid shall be located in diked area surrounding the tank as per para 22.11.2 of NFPA 30 “Flammable and Combustible Liquid Code”; such containment shall be at least 110% of the maximum tank capacity.

Diking philosophy shall be done in accordance with NFPA 30 requirements, taking into account that each diked area containing two or more tanks shall be subdivided by intermediate dikes, in order to prevent minor spills from a tank from endangering adjacent tanks within the diked area.

Chemical injection package storage shall be provided by diking as above described. Chemical injection package pump if located far from the chemical storage and not in the same diking shall be surrounded by curb having height of 10 cm and related area shall be drained to appropriate sewer after neutralization.

6.4 Process/utility area containment

Being the process/utility area provided with drainage/sewer system designed to remove the maximum quantity of firewater and rain and being the type of material handled in the process and utility areas, no specific containment/impounding requirement applies in the majority of cases since any release will be collected and rapidly removed by the sewer system into the Water treatment system. However, according to Licensor requirement some process areas could be provided with impounding area to avoid presence of contaminants surrounding areas.

7 BLAST PROTECTION

The building and the equipment are protected primarily from the effect of explosion by spacing. If significant buildings are very close to the process units, adequate degree of blast resistance shall be provided accordingly.

If new buildings are unmanned and if the damage or loss during an explosion scenario will not impede the proper management of the accidental event, they do not require any degree of blast resistance.

8 PERSONNEL PROTECTION

Safety Shower (SS) and Eye Wash (EW) will be provided for chemical packages.
The maximum distance of 15 m between the SS/EW and the relevant package shall be ensured.
In this engineering phase, SS/EW location will be indicated as part of project Unit Firefighting Layouts (DW-1933).
Additional Personnel Protection measures will be identified once the Emergency Plan is developed by Owner or by HSE Construction Contractor during EPC Phase.

Safety shower and eye/face wash unit shall be designed and installed according to standard ANSI/ISEA Z358.1. The safety shower shall be fed by underground potable water pipe; the

aboveground pipe section, directly connected to safety shower and eye/face wash unit shall be hot insulated, and the safety shower and eye/face wash unit shall be equipped with scald valve to avoid that the water temperature become too hot.

9 FIRE PROTECTION PHILOSOPHY

Present document provides general criteria only. Refer to the following project documents for detailed specifications:

- Firefighting Philosophy: 079254C-0000-JSD-1900-01
- Fire & Gas Detection and Alarm Signaling Philosophy: 079254C-0000-JSD-1950-01
- Fireproofing Philosophy: 079254C-0000-JSD-1980-01

9.1 Passive Fire Protection

Fireproofing shall be used for steel equipment/piping supports and structures when located within a Fire Hazardous Zone and when the collapse of the support or structure is evaluated dangerous in such condition. Similar protection or intrinsic safe systems have to be provided for electrical cable and instrumentation associated to critical systems, where the cable or the instrument is located in or above the Fire Hazardous Zone.

9.2 Active Fire Protection

The main aim of active fire protection is to minimize risk to personnel, installation and environment from fire and explosion hazards. The objectives are:

- To prevent escalation of an incident by cooling equipment which contain combustible /flammable material;
- To limit the effects of heat radiation;
- To segregate one circuit from another.

Fire protection shall be provided by a partial or total combination/selection of the following systems and equipment:

Firewater	Hydrants Hose reels Fixed monitors Deluge systems Water curtains Fire trucks (first intervention and foam delivery) Sprinkler (only for enclosure) Wall hose reels (only for enclosure)
Foam	Foam fire trucks Foam monitors Semi Fixed foam systems for hydrocarbon storage tanks
Extinguisher	Fixed total flooding system (only for enclosure) Portable or wheeled CO_2 extinguishers Portable or wheeled dry chemical extinguishers
Steam (refer to para 6.1)	Steam lances Snuffing steam around high risk flanges
Clean agent	Fixed total flooding system for technical rooms of buildings

Each type of system/equipment shall be selected according to the hazards present.

The fire protection system design shall be based on the principle that there will be only one major fire at a given time.

Process Unit Firefighting

In process area, firewater application is the most effective cooling method. Water is applied to exposed equipment for cooling purposes to minimize further failures and damage until the fire is extinguished, which is usually achieved by shutting off on extinguishing the combustible source.

In case of fire in the process units, depending on the cases and circumstances, the immediate response would be manual by means of fixed systems (hydrant, hose reel, monitor), mobile units, dedicated steam hoses lances. Dedicated fixed system for automatic action (deluge system and water curtain) shall be applied on the most hazardous case.

Water curtains

Water curtains for confining or dissipating a cloud of flammable gas/vapor or isolating certain sections shall be installed. The furnaces and other open flame equipment (boiler,..) which can be engulfed by flammable gas/vapour cloud shall be protected by a water curtain.

Storage area Firefighting

Fires are most often fought with foam application. In addition, water is applied primarily for cooling the exposed surface.

The water requirement to cool the tank may be applied using fixed spray system. Semifixed systems shall be provided for delivery foam inside the tanks (not to be applied in case of fixed roof tank provided with blanketing system).

Building Fire protection

Clean agent shall be installed in technical rooms of process buildings above and below the false floor.

Portable CO_2 extinguishers shall be installed in Control Room / Remote Buildings, Electric substations and in all other buildings.

10 FIRE & GAS DETECTION AND ALARM SIGNALLING PHILOSOPHY

An automatic detection and alarm system for hazardous material leaks shall be studied according to the following principles and objectives:

- Detection of quantity of flammable gas/vapour resulting in probable fire
- Detection of an occurred fire
- Detection of toxic vapours in all zones where they may appear and accumulate
- Warning all people present on the site concerned
- Automatic warning at Control Room / Remote Building, fire station, plant gate and or other location deemed to emergency response action.

A manual alarm system (e.g. telephones, sound-powered telephones, pushbuttons clearly marked and identified) shall be installed in order to enable the personnel to give the alarm from any point of the site.

10.1 Fire detection and alarm in process unit

This chapter covers location of equipment and device to be installed for fire detection and alarm purpose. Field installed equipment shall be in accordance with the hazardous area classification requirements.

The fire detection system in process area consists of the following:

Fire Detection

Fire detection consists of linear heat detection (HD) or flame detection (UV/IR or preferably 3IR).

Linear heat detection consists of fusible cable and shall be installed around process equipment to activate automatically deluge system when installed.

Flame detectors shall be installed in flammable gas compressor area to detect possible flame occurring by compressors seal.

Heat detection system shall be installed in field in the following areas:

- Flammable gas compressors areas.
- Pumps handling flammable liquid.
- Areas covered by deluge systems.

Normally, two detectors shall be installed. Alarm from one detector send signal to the Control Room, fire station or other location deemed to emergency response action. Alarm from two

detectors shall activate the relevant water spray fixed system and warning at Control Room, fire station or other location deemed to emergency response action.

Manual Call Point (MCP)

Manual call points shall be provided throughout the plant areas, connected in a various loop, relevant to the various units.

The manual call points are installed so that the maximum traveling distance is no more than 60 meters from any point, as per NFPA standard.

Activation of any one manual call point shall send alarm in Control Room, fire station or other location deemed to emergency response action.

10.2 Fire detection and alarm in buildings

Manual Call Point (MCP)

Manual call points are installed outside/inside the buildings and along escape ways (if required) where the personnel are present or could be present for a reasonable period of time for operation or maintenance.

Smoke detection (SD)

The smoke detection system is made by means of optical and addressable type smoke detectors.

They are provided for fire alarm purpose and for activation of Clean Agent fire suppression systems, where those systems are installed.

Detectors for alarm purpose only are connected in common loops depending on the area to be monitored, single zone voting.

Activation of any one detector shall initiate an alarm relevant to the subject area and shall send warning at control room, fire station or other location deemed to emergency response action.

Normally, detectors for alarm purpose and automatic activation are connected in two independent lines in the same area, cross zone voting.

Activation of one detector only shall initiate an alarm only (warning at control room, fire station or other location deemed to emergency response action), while activation of both lines (one detector per line at least) shall initiate an alarm and automatically activate the relevant fire suppression systems.

Heat detection (HD)

Heat detection system to be provided in building where fired equipment (e.g: kitchen) are present.

10.3 Gas detection and alarm

This paragraph covers location of equipment and devices to be installed for combustible and toxic gas detection and alarm purpose in process area and Offsite area.

Combustible gas detection in Process area

Combustible gas detectors, catalytic combustion or infrared point type, shall be installed around compressors handling flammable gas, pumps handling flammable liquid and at critical points where there is danger of large leakage of flammable gas within the process units.

In addition, open path gas detectors will be used around furnaces and boilers to detect flammable gas clouds from process equipment and to actuate water curtains to avoid cloud ignition.

The signals coming from gas detectors shall be sent at control room, fire station or other location deemed to emergency response action for alarm and for activation of relevant optical / acoustical alarm located in field.

Toxic gas detection in Process area

The toxic gas detector shall be installed in process area where are present facilities that process toxic and very toxic fluid. Their location shall be near primary source of leakage as equipment with rotating parts (compressors, pumps) and to circumscribe area as much as possible close to equipment (vessels, exchangers, air fins).

The number of gas detectors shall be optimized by avoiding installing both toxic and flammable gas detectors.

The signals coming from toxic gas detectors shall be sent at control room, fire station or other location deemed to emergency response action for alarm and for activation of relevant optical / acoustical alarm located in field.

Combustible gas detection in Offsite area

Combustible gas detectors, catalytic combustion or infrared point type, shall be installed around storages of liquefied pressurized gases, and at pumping station for pumps handling flammable liquid or liquefied flammable gases.

The signals coming from gas detectors shall be sent at control room, fire station or other location deemed to emergency response action for alarm and for activation of relevant optical / acoustical alarm located in field.

10.4 Gas detection and alarm in buildings

All buildings with air conditioning system shall have one combustible and one toxic gas (if potentially toxic gas is present) detector installed in the suction ducts, and the detectors signal shall be able to stop the air suction and put the HVAC in recirculation mode.

10.5 Alarm System Devices

Alarms horn and strobe light for flammable and alarm horn and strobe light for toxic gas will be provided in strategic place throughout the plant to advice locally the alarm zone involved in gas dispersion. General sirens are also provided in the plant in strategic position to alert personnel in case of fire.