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TAHRIR PETROCHEMICALS

# Addendum 1- Environmental and Social Impact Assessment (ESIA)

## Tahrir Petrochemicals Complex, Economic Zone, Ain Sokhna, Egypt


455-EJ6195 – 00-EN-Rep-004

18.03.2015

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## Disclaimer



**PROJECT 455-EJ6195 - ADDENDUM 1- ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)**

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# ABBREVIATION LIST

| | |
|---|---|
| ESIA | Environmental and Social Impact Assessment |
| IFC | International Finance Corporation |
| OPIC | Overseas Private Investment Corporation |
| RO | Reverse Osmosis |
| TPC | Tahrir Petrochemicals |

# CONTENTS



## Tables



## Appendices

# 1. OPIC GENERAL COMMENTS ON TAHRIR PETROCHEMICALS ESIA

This section presents Overseas Private Investment Corporation (OPIC) general comments on the Tahrir Petrochemicals Environmental and Social Impact Assessment (ESIA) Report (Rev. 01) as well as response as shown in Table 1-1.

**Table 1-1 Tahrir Petrochemicals ESIA Report Comments and Reply**

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| 1 | Section 3.8.3/Page 89 | Air Emissions: the report covers the stacks emissions compared to relevant regulations in a comprehensive manner, however, the process emissions (VOC's, etc.) are not presented in the same manner. | Table 3-25 (page 89) presents the COPC concentrations of the continuous emissions generating from the process during the normal operations (Production Process) compared with the most stringent relevant applicable national and international limits.<br>However, the detailed information regarding any other emissions will be available at the detailed design phase and it will comply with the IFC and OPIC guidelines. Also, the different emissions of the relevant equipment that will be procured will comply with IFC and OPIC requirements. | |
| 2 | Section 3.8.1/Page 75-76 | Wastewater: the wastewater quality is not presented, however, relevant standards are. We can either present the effluent quality compared to the standards, or mention that the standards will be part of the ITB issued for contractors to assure WWTP design compliance with such. | The treated effluent wastewater quality standards will be part of the ITB issued for contractors to assure that the WWT and SWT units design shall comply with the applicable legislations.<br>Applicable legislations are already presented in Section 2.1.2 (Table 2-8: Permissible Limits for Reuse of Treated Wastewater).<br>It is worth noting that Section 3.7.7: Wastewater Treatment /Final Disposal System states that "*Both WWT and SWT are designed in a manner to produce treated wastewater that meets environmental legal requirements for reuse in irrigation.*" | |

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| | | | Similar statement was presented in Section 3.8.1: Liquid Effluents "*Table 3-21 shows the wastewater flows generating from the ISBL operations and directed to the wastewater treatment Units, namely WWT and SWT at the U&O main plant site (A1) where it is treated to meet re-use in irrigation legal requirements*".<br>However, the detailed information regarding effluents will be available at the detailed design phase and it will comply with the IFC and OPIC guidelines. Also, the different effluents of the relevant equipment that will be procured will comply with IFC and OPIC requirements | |
| 3 | Section 3.8.2/ Page 79-86 | Waste Management: for hazardous material to be disposed, it is expected to have hydrocarbons in it and this should be treated before disposal to landfill. We shall state this in details. | WorleyParsons already provided the available information as part of the ESIA study as follows:<br>• Section 3.8.2: Solid Wastes details the different solid waste streams to be generated during both the construction and operation phase.<br>• Table 3-23: List of Solid Wastes during Operation Phase (page 80-86) presents the disposal method for the different solid wastes generating during the operation phase; including but not limited to hazardous wastes.<br>• In Table 3-23, it has indicated that *"Hazardous Waste to be treated and disposed of at Al Naseriah Landfill*". | *More details for the Waste management are presented as per Schedule 24 Project Execution Plan.* |

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| | | | • In addition, the same Section (page 79) states that "*It is worth mentioning that …hazardous wastes will be disposed of at Al Naseriah approved hazardous wastes landfill…. The handling of the different wastes will be through a licensed waste handling contractor to be assigned at the early stage of Complex start-up.*"<br>• Additionally, details on the Al Nseriah Landfill are presented in Section 4.8.5 (page 188). | |
| 4 | Section 3.8.2/ page 76-79 | Dredging: dredged matter will be either disposed to a designated offshore area (in that case a survey for the area should be presented) or dewatered onshore in basins, water filtered and taken back to the sea after filtration, etc. (in that case we need to present some conceptual details). In general, the disposal matter needs some details/tuning. | WorleyParsons already provided the available information at this early stage of the project (Pre-FEED) as part of the ESIA study as follows:<br>• Section 3.8.2 (page 76) states that "*Part of the dredged material will be stockpiled at a dedicated and well-prepared stockpiling area North of Sokhna-1 (McDermott) Port where it is dewatered. The clarified water resulting from the dewatering process will be reused in land spraying for dust control during the construction phase as applicable*". | |

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| | | | • *"The dewatered/ dried dredged material will be sampled to determine its composition and whether it contains any hazardous substances. Based on the analysis results, the final destination/disposal methods will be determined. In case of detecting the presence of any hazardous substance, the dredged materials will be appropriately handled by a licensed contractor and disposed of at an appropriate disposal facility, namely Al Naseriah. On the other hand and in case of not detecting the presence of hazardous substance, the dredged material shall be reused as far as practical and the remaining material (if any) will be disposed to an approved waste disposal facility. Another part of the dredged material will be disposed of at an open-water dedicated disposal area."*<br>• It is worth noting that a detailed bathymetric survey that includes the open-water dredged material disposal area shall be conducted at a later stage of the project, namely detailed design. Similarly, the conceptual design of the onshore disposal area facilities shall be part of the detailed design stage. | |
| 5 | Section 3.8.2/ page 76-79 | Dredging process/procedures need some details. | Please refer to Response No. 4 | |

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| 6 | Section 3.7.2/ page 57 | Firefighting systems/procedures/layout shall be presented. | WorleyParsons already provided the available information at this early stage of the project (Pre-FEED) as part of the ESIA study as follows:<br>• Section 3.7.2: Firewater System which states that "*Firewater system will be provided for both ISBL (P1, P2 and A1) as well as Tank farm. Adequately sized storage tanks will be utilized for this purpose. Looped, underground firewater piping distribution system will be provided. The system will supply an extensive network of hydrants, fire monitors, elevated monitors, hose reels, and foam hose reels.*<br>• *Firewater mains will be strategically located, ensuring that firewater is always available to each area from a minimum of two directions.*<br>• *Additionally, fixed firewater spray (deluge) systems, designed and installed in accordance with NFPA 15 will be provided. Each water spray system will be automatically actuated by a pneumatic/hydraulic heat (fire) detection system consisting of pressurized air/water piping and sealed fusible element sprinkler heads located near the protected equipment. Manual actuation will also be possible from the deluge valve location; from multiple locations around the protected equipment; and from the main control room. Seawater shall be only used for firefighting purpose on Jetty.*" | *The technical specifications for the fire protections area A1, A5 A7a/b A11 document is attached (Appendix 1).* |

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| | | | • Furthermore, Table 3-15 Water Storage Tanks (page 66) shows the relevant information regarding the firewater storage tank.<br>Additionally, FIRE PROTECTION CONCEPT document is presented in Appendix 1.<br>However, the detailed information regarding firefighting systems will be available at the detailed design phase and it will comply with the IFC and OPIC guidelines. Also, relevant equipment will be procured to comply with IFC and OPIC requirements. | |
| 7 | Section 3.1/page 36 | Status of the project site to show that there are no one living there, designated industrial area, etc. supported by photos.<br>- | This item is already covered as part of Section 4.6.2: Ecological Field Survey which includes the detailed description of the proposed Complex area and supported by photos.<br>Furthermore, the following items are related to the proposed Complex location description/status and are already presented in the ESIA Report:<br>- Section 3.1: Project Location "*The Complex Main Plant is located in the Economic Zone, Ain Sokhna ….. Additionally, the proposed complex has a dedicated storage area (Tank Farm) located at Sokhna 1 (McDermott) Port.*" | |

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| | | | - Figure 3-2: Overall Plot Plan Layout<br>- Section 4.3.5: Land Use that includes Figure 4-25: Land Use at Project Area, as well as general description of the proposed project area that states that "*The proposed project is located within the Economic Zone…. The industrial zones in Sokhna area host different array of industries, which include fertilizers (nitrogenous and phosphate fertilizers), petrochemicals, building materials, ceramics, steel flat sheets, and other industries*"<br>- Section 6.2.4: Ecology and Biodiversity "*The proposed Main Plant site is located within an industrial zone (Economic Zone); furthermore, the Tank Farm and the marine terminal facilities are located within Sokhna1 (McDermott) Port.*"<br>- Section 6.3.4: Ecology and Biodiversity "….as the proposed Complex site is located within an area which is designated as an industrial zone that already has a low biodiversity value ….."<br>- Section 6.3.5: Human Environment "It is worth mentioning that the Main Plant is located at a designated industrial area (Economic Zone); furthermore, there are no permanent residential settlements in the vicinity of the proposed project area." | |

| No | Section/ Page | Comment | Response | Remarks |
|---|---|---|---|---|
| | | | - Section 6.4.5: Human Environment " The proposed Complex site is currently unoccupied and the different components of the Complex are located at a designated industrial area (Economic Zone) and operating marine terminal facility (Sokhna 1 Port) and thus no relocation or resettlement will occur."<br>- Additional photos of the Main Plant area are presented in a separate attachment (Appendix 2). | |

# 2. LABOUR HOUSING DESCRIPTION

## 2.1 Construction Phase

Labour accommodation during construction phase will be provided onsite with an adequately prepared labour camp complying with the World Bank Directives and Regulations is governing for the labour accommodation.

The specification establishes the requirements for the new camp to accommodate the Consortium's personnel. It covers design, construction and furnishing of the camp.

Operation of the entire camp facilities including supervision and management, maintenance and housekeeping, coordination of catering and all staff required therefore shall be the responsibility of the EPC Contractors and overseen by Carbon Holdings. More details will be made available prior to the start-up of the construction phase[1].

It is worth mentioning that environmental impacts of labour on-site accommodation and housing during construction phase have been covered in the ESIA report in *Section 6.2.2: Land-Soil* and *Section 6.23: Water- Groundwater*. The environmental impact assessment showed that the impact of labour on-site accommodation and housing is generally classified to be of **Minor** significance (Additional details are presented in *Table 6-6* of the ESIA Report).

## 2.2 Operation Phase

There will be no onsite labour accommodation during the operational phase of the project.

[1] Additional details for the Construction Camp can be provided from Schedule 22 “CONSTRUCTION CAMP REQUIREMENTS”.

# 3. SEAWATER OUTFALL SPECIFICATION

A dedicated desalination plant located at the Sokhna 1 (McDermott) Port area will provide the proposed Complex with its water demands. The desalination plant will utilize Reverse Osmosis (RO) technology. Water required for the proposed Complex will be supplied from seawater by the dedicated intake structure, directed to the desalination plant where the seawater is properly treated to meet the applicable legal limits and processes requirements.

The seawater desalination unit is designed to support the different Complex demands; including but not limited to; cooling water makeup ,firewater, potable water, service water and demineralized water. The dedicated outfall will discharge to the marine environment in a manner that meets the applicable legal requirements.

An intake/outfall model was conducted in order to assess the environmental impact and check the environmental compliance of the outfall operation among other objectives. The results of this model indicated that the proposed desalination plant outfall discharge is meeting the relevant environmental requirements both national and international in terms of temperature and salinity.

It's worth mentioning that the comprehensive design combined with state of the art water treatment technologies, using the global strength of the supply chain and the commitment of local experienced resources is certain to provide excellence in project delivery.

GE Water is one of the leading global solution providers and has the largest portfolio of water and wastewater treatment technologies in the world. GE Water has brought together this broad expertise in seawater desalination using water ultrafiltration, reverse osmosis, Electrodialysis and Electrodeionization technologies to provide a unique and exceptional design for Tahrir Petrochemicals proposed desalination plant.

The detailed Specifications of the seawater outfall effluent will be available at the detailed design phase and it will comply with discharge to marine environment applicable guidelines of IFC and OPIC in addition to the local Egyptian requirements. In general, all the emissions and/or effluents, as applicable, of the different procured equipment as part of the proposed project will comply with IFC and OPIC relevant guidelines.

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# Appendix 1 - Firefighting Relevant Documents

# FIRE PROTECTION CONCEPT

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|---|---|---|---|---|---|---|
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| | | | | | | |
| X | 02 | 06.03.2014 | Kaufmann | R. Huber / ENS2 | | To-do list #127/128 |
| X | 01 | 12.03.2013 | R. Huber / ENS2 | Bretschneider | Huber | |
| **Status** | **Issue** | **Date** | **Prepared** | **Reviewed** | **Approved** | **Remarks** |

## Contents

Attachment:

# 1 Validity and Purpose

This FIRE PROTECTION CONCEPT provides the minimum requirements for ISBL Facility EPC Contractors design for the Tahrir Petrochemical Complex ISBL Facility project. This FIRE PROTECTION CONCEPT shall be used as reference and guideline during project execution.

This FIRE PROTECTION CONCEPT is valid for all ISBL Facility EPC Contractors.

# 2 Definitions

Unless the context clearly indicates the contrary, the following terms as used in this Project Coordination Plan shall have the following meanings and, where the singular is used, the plural shall also be implied where the context requires.

| | |
|---|---|
| **Owner** | Tharir Petrochemical Company (TPC), including Carbon Holdings as acting party for TPC |
| **Olefin Complex** | The Tahrir Petrochemical Complex project consisting mainly of the construction of an naphtha cracker, derivate units (Benzene extraction, Hydro-Dealkylation, Butene-1 unit and Butadiene extraction), PE- plants and respective offsites and utilities. |
| **ISBL Facility** | The process part of the Complex consisting of a naphtha cracker, derivative units (Benzene extraction, Hydro-Dealkylation unit, Butene-1 unit, Butadiene extraction unit), a PE-plant (comprising of three trains) and process related intermediate tankage. |
| **Owner's Representative** | According to section 3.2 of the Contract Forster Wheeler shall act as project management consultant for Owner to support planning and building of the Complex. |
| **Owner's Representative** | According to section 3.2 of the Contract Worley Parsons acting as consultant for preparation of ESIA and Obtainment of Environmental Authority Permits |
| **HSE** | Health, safety and environmental protection. |
| **Consortium** | EPC Contractors, Linde Engineering and SK E&C as a joint and severally liable consortium performing engineering, procurement and construction services for Owner directly contracted by Owner for the ISBL Facility. |
| **Proposal Phase** | The first project phase where Owner develops the overall Project and Consortium develops the proposal for EPC Turnkey Lumpsum contract. |
| **ISBL EPC Phase** | The second project phase where the Consortium performs engineering, procurement of material, construction, pre-commissioning and commissioning of the ISBL Facility until Provisional Completion of the Complex. |
| **Site** | Construction site for ISBL Facility including temporary facilities and related fabrication sites. |

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|---|---|
| **Linde** | Linde Engineering as Consortium lead and EPC contractor for naphtha cracker, derivate units and intermediate tankage in Consortium |
| **SKEC** | SK E&C as EPC contractor for PE plants in Consortium |
| **Combustible Material** | Materials that will burn in normal air. |
| **Combustible Liquid** | Liquids that have a flashpoint at or above 38°C (100°F), for details refer to 8.1. |
| **Flammable Liquid** | Liquids that have flash point below 38°C (100°F) for details refer to 8.1 |
| **Fire-Scenario Envelope (FE)** | A three-dimensional space into which fire - potential equipment can release flammable or combustible fluids capable of burning long enough and with enough intensity to cause substantial property damage. This includes structural failure, prevention of orderly shutdown, or release toxic chemicals. |
| **Fireproofing** | Coatings or rigid materials applied to protect structures or equipment against rapid heating, thus delaying the time to failure per Underwriters Laboratories Inc. (UL 1709). |

# 3 Abbreviations

Shall and must: means mandatory requirement

| | |
|---|---|
| AHJ | Authority Having Jurisdiction |
| AFFF | Aqueous Film Forming Foam |
| AR-AFFF | Alcohol Resistant Aqueous Film Forming Foam |
| API | American Petroleum Institute (US) |
| ASD | Aspiration Smoke Detection system |
| BDS | Block in and Depressurization System |
| CCR | Central Control Room |
| CS | Carbon Steel |
| ESD | Emergency Shut-down |
| EWSD | Early Warning Smoke Detection |
| F&G | Fire and gas Detection System |
| FHA | Fire Hazardous Area |
| FM | Factory Mutual |
| LPG | Liquefied Petroleum Gas |
| NFPA | National Fire Protection Association (US) |
| P&ID | Piping and Instrumentation Diagram |
| SS | Stainless Steel |

| | |
|---|---|
| PFP | Passive Fire Protection |
| UL | Underwriters Laboratory |
| VEWSD | Very Early Warning Smoke Detection |

# 4 Normative References, Codes

The content of this document is and the whole fire fighting system shall be in accordance with the latest edition of Codes and Standards published by the National Fire Protection Association (NFPA), and the guidelines published by the American Petroleum Institute (API).

All materials and devices used for fire fighting shall be designed, manufactured, tested and inspected in accordance with the Authority Having Jurisdiction.

Reference is made, but not be limited to, applicable parts of the following Codes, Standards and Recommended Practices.

## 4.1 API – American Petroleum Institute

- API 2001 Fire Protection in Refineries
- API 2021 Management of Atmospheric Storage Tank Fires
- API 2030 Application of Fixed Water Spray Systems for Fire Protection in the Petroleum Industry
- API 2218 Fire Proofing Practices in Petroleum and Petrochemical Processing Plants
- API 2510 Design and Construction of LPG Installations
- API 2510A Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities

## 4.2 NFPA – National Fire Protection Association

- NFPA 1 Fire Prevention Code
- NFPA 10 Standard for Portable Fire Extinguishers
- NFPA 11 Standard for Low-Expansion Foam
- NFPA 11A Standard for Medium- and High-Expansion Foam Systems
- NFPA 12 Standard on Carbon Dioxide Extinguishing System
- NFPA 13 Standard for the Installation of Sprinkler Systems
- NFPA 14 Standard for the Installation of Standpipes and Hose Systems
- NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection
- NFPA 16 Standard for the Installation of Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems
- NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 24 Standard for the Installation of Private Fire Service Mains and their Appurtenances
- NFPA 30 Flammable and Combustible Liquids Code
- NFPA 58 Liquefied Petroleum Gas Code
- NFPA 59A Standard for the Production, Storage and Handling of Liquefied Natural Gas
- NFPA 214 Standard on Cooling Water Towers
- NFPA 231 General Storage
- NFPA 750 Standard on Water Mist Fire Protection Systems
- NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems

## 4.3 UL – Underwriters Laboratories

- UL 1709 Rapid rise Fire Tests of Protection Materials for Structural Steel

## 4.4 GE Global Asset Protection Services (GAP Guidelines)

- GAP 2.5.2 Oil and Chemical Plant Layout and Spacing

# 5 Referenced Documents

- Fire Area / Fire Zone Drawing &AA-S-ZA 1005
- Fire Hazardous Area Drawing &AA-S-ZA 1004
- Fire Fighting Equipment Drawing &AA-S-ZA 1003
- Fire Water Demand Report &AA-S-LX 1008
- Fire and Gas Detection Concept &AA-S-PC 1009
- Drainage & Effluent Treatment Concept &AA-S-PC 1012

# 6 Layout Considerations

Fire Protection considerations will be one guiding main requirement for the plot plan layout. Location, spacing and arrangements of all facilities and equipment will be defined under consideration of active and passive fire protection and fire fighting aspects.

Facilities and equipment will be arranged in a way that in the event of fire and explosion, adjacent facilities or equipment will not be endangered and the potential for personnel exposures will be kept to a minimum.

Plot plan layout, equipment arrangements and recommended minimum spacing of process equipment will be based on requirements of GAP 2.5.2 "Oil and Chemical Plant Layout and Spacing".

Reduction in the spacing distance will require case by case evaluation for requirement to provide additional safety features, as e.g. fireproofing, automatic water spray systems, emergency shut down facilities and/or additional fire fighting equipment.

## 6.1 Clearance Distances and Access

In case the plant will be divided into more than one Fire Zone, adjacent Fire Zones shall be separated by a distance of at least 15m. This separation area may include major pipe racks, roadways etc.

Access roads for fire fighting trucks will be routed directly to the plant. Roads will form a ring around process plant limits. Access to the individual process-, storage- building- and utility areas within plant limits should be connected directly to the ring road. Dead ends should be avoided. Access for fire fighting trucks and fire man should always be possible from two directions.

# 7 Design Basis

The specification covers all process, storage and utility areas.

The fire protection system is designed assuming there is an adequately equipped and well trained fire brigade in the complex or an external (public) fire brigade is available shortly.

The fire protection facilities are designed considering one major fire in the plant and simultaneous occurrence of a mayor fire in the tanks farm.
Depending on its dimensions the plant will be divided into several fire areas / zones.

The main objectives of the fire protection system are:

- cool equipment, to prevent escalation and to limit damages
- control fires and prevent spreading of the fire

(1) A primary objective of the fire protection systems is fire control. The primary objective of the fire brigade is final extinguishment.

(2) Due to the risk of re-ignition and explosion, gas fires are normally not extinguished until the supply of the gas has been shut off.

(3) In the event of fire, adjacent endangered equipment must be cooled with fire water.

(4) Exposure protection within process areas is normally achieved by monitors, hydrants, hose reels, deluge systems and mobile equipment.

(5) The plant layout and the location of readily accessible hydrants and monitors enable a suitable protection from different sides and safe distances.

(6) Deluge Systems will be provided in the tank area (depending on tank construction).

(7) In process areas deluge systems will only be foreseen where access of other fire fighting facilities is limited.

(8) The active and passive fire protection system will include the following depending on the plant requirements:

- Fire water mains, hydrants, hydrant monitors, post indicator valves
- Fixed water deluge systems
- Fixed water sprinkler systems
- Fixed gaseous extinguishing systems
- Water Mist Systems for Alkyls, Emergency Generators e.g.
- Hose reels, hose cabinets
- Passive Fire Proofing at steel structures, electrical and / or mechanical equipment
- Buildings fire protection
- Portable and wheeled fire extinguishers

(9) The fire protection facilities will be supported by other protection systems like

- Fire and Gas Detection System (The fire alarm system is described in the “Fire & Gas Detection Concept”).
- Block-in and Depressurization System BDS
- Explosion Protection Strategy
- Air Coolers will be shut-down automatically by means of heat detectors in case of a fire.

# 8 Fire Hazardous Area

A fire hazardous area is defined as:

- a 10 m horizontal radius around fire potential equipment and containments (bunds / pits), that could feed a sustained fire.
- areas inside bunds, walls e.g. containing fire potential equipment will be defined as fire hazardous areas independent of their size.
- vertical extension is up to a height of 8 m above grade or 8 m above elevated floors where flammable materials can be accumulated.

Connection lines between units do not cause a fire hazardous area.

The extension of Hazardous Areas will be shown in a “Fire Hazardous Area Drawing” &AA-S-ZA 1004.

## 8.1 Fire Potential Equipment

Equipment being a potential source for a sustained fire is defined as Fire Potential Equipment, if there is no possibility to stop the draining or effusion from the equipment e.g. by emergency-shutdown-valves, and if the equipment:

- contents of more than 2 t of flammable liquids, combustible liquids or flammable, liquefied gases.
- receives more than 5 m³/h flammable liquids, combustible liquids or flammable liquefied gases from a source with more than 2 t content.

**Flammable liquids** have a flash point below 37.8°C and vapour pressure not exceeding 276 kPa at 37.8°C or liquids which are heated up to their flash point or above as defined by the Code of Federal Regulations (CFR), Title 29, Part 1910.106.
If liquids are handled above their auto-ignition temperature, they will be considered as flammable liquids.

Flammable liquids can be further classified as follows:

- Class IA Liquid – Flash point below 22.8°C and boiling point below 37.8°C
- Class IB Liquid – Flash point below 22.8°C and boiling point at or above 37.8°C
- Class IC Liquid – Flash point above 22.8°C but below 37.8°C

**Combustible liquids** have flash points at or above 37.8°C as defined by the Code of Federal Regulations (CFR), Title 29, Part 1910.106..

Combustible liquids can be further classified as follows:

- Class II Liquid – Flash point at or above 37.8°C and below 60°C
- Class IIIA Liquid – Flash point at or above 60°C and below 93°C
- Class IIIB Liquid – Flash point above 93°C

In general liquids with a flash point above 93°C are considered as non-flammable.

**Flammable Liquefied gases** are e.g. LNG, propane, butane, propylene and butylenes and their mixtures.

Typical Sources of release:

- flanges and fittings
- drains and vents
- stuffing box
- gaskets
- sealing systems

## 8.2 Non-fire potential equipment

Equipment containing non-combustible liquids, gases or vapours will not be considered as fire potential equipment.

Welded Piping will not be considered as a source of fire hazard.

# 9 Active Fire Protection

## 9.1 Fire Water Systems

The most important fire fighting medium is water. It is used to:

- extinguish fire directly,
- produce foam with special agents (suitable for sea water and desalinated water),
- cool non-affected equipment to prevent damage or ignition,
- solve and condensate inflammable gases,
- establish water walls to limit the dispersion of gases.

The fire water shall be free of materials which could influence the function of fire fighting devices, e.g. particles which possibly clog the nozzles or chemicals which influence the foam.

The fire water system mainly consists of:

- fire pumps / jockey pumps / fire water tank
- fire water ring with main and branch supply lines
- hydrants and monitors
- deluge systems

A “Fire Fighting Equipment Drawing” &AA-S-ZA 1003 will be prepared.

## 9.2 Fire Water Supply and Distribution

The plant will be divided into Fire Areas and sub-divided into Fire Zones covering the entire plant area.

A drawing showing all Fire Areas and Fire Zones will be provided ("Fire Area/Fire Zone Drawing" &AA-S-ZA 1005)

### 9.2.1 Fire Areas

Fire Areas are defined as areas, which are bounded by the limits of a credible fire escalation event. A fire area may include one or more fire zones as appropriate.

### 9.2.2 Fire Zones

In order to have a useful subdivision of the fire areas, the fire areas may be divided into fire zones. The fire zones in open plant sections should be determined by equipment segregation.

Each building is an individual fire zone even if located in a fire zone of an open plant section.

The following area or facility is considered as a single fire zone:

(1) In the process area, all equipment located in an area separated from adjoining areas by at least 15m. This separation may include major pipe racks or roads.

(2) In the tank storage area all equipment located inside one common dike or located in a distance less than required according to NFPA 30.

Changes in Plot Plan layout during Detail Engineering will be checked carefully if they are influencing the layout of the fire zones.

### 9.2.3 Fire Water Demand

The fire water demand will be determined based on the largest single fire water demand from the respective area requirements in process units, tank area or building.

The fire water demand estimate for a single fire zone shall include the operation of all deluge systems in this fire zone plus two (2) monitor in operation.

The detailed fire water demand calculation will be shown in the "Fire Water Demand Report" &AA-S-LX 1008 which will be prepared during Engineering. In this report for every single fire zone the detailed water consumption of each deluge system, monitors and hydrants will be shown.

### 9.2.4 Fire Water Supply

Fire water will be supplied at plant battery limits by OTHERS (U&O).

The fire water system shall be able to provide fire water for at least 4 – (6) hours (API RP 2001, 6.2.1.4) with a pressure of at least 12 barg at the tie-in at max. flow rate of 3000 m³/hr.

(1) The fire water will be supplied by two independent tie-in points.

(2) The fire water system shall a permanently pressurized system. If there is no fire water consumption, the jockey pump shall provide a uniform pressure on the fire water main system.

(3) In the case that sea water is used as back-up, the entire fire main system shall be flushed with fresh water after use.

(4) The reliability of the fire water supply should be such that loss of any one source does not result in a loss of more than 50% of the flow requirements of the system

### 9.2.5 Fire Water Tank

By OTHERS (U&O).

### 9.2.6 Fire Water Pumps

By OTHERS (U&O)

Independent from any failure scenario 100% fire water supplies must be ensured.

### 9.2.7 Fire Water Distribution

(1) The main fire water ring will be installed around the whole plant with, depending on the size of the plant, several branch lines in order to get a better water distribution. The fire water system will be installed underground below the maximum frost penetration. The diameter (minimum 8”) of the fire water ring main depends on the required flow rate, pressure drop and topology.

(2) The fire water ring main will be sized by network calculation under the condition that the fire water flows through the sections of the fire water main with one portion being out of operation. For estimated run of fire water lateral, the Hazen-Williams "C" values will be 120 for carbon steel pipes and 150 for "Plastic"-pipes.
The diameter of the main fire water line will be determined by a hydraulic calculation to fit the requirements by using approved calculation program.
The system will be designed so that with an inlet pressure of 12barg at the tie-in points a min. pressure of at least 10,3barg at the most remote consumer can be fulfilled.

(3) The minimum connection to the fire water consumers is 4”.

(4) The fire water velocity in the underground pipe should not exceed 3.5m/s.

(5) Main fire water ring and main branches should have the same diameter.

(6) The fire water system is a dedicated system and not used for other purposes (e.g. cleaning)

(7) The distribution system is designed as underground system. Fire water lines shall not be laid under buildings.

(8) Piping material for the fire water lines shall be in accordance with Project Piping Material Specifications. All steel piping shall be adequately corrosion protected. Aboveground piping shall be painted in accordance with project pipe marking and identification specifications.

(9) Underground piping installed in areas accessible to heavy traffic and at road crossings will be installed to meet the allowable stresses recommended by the manufacturer.

(10) All permanently filled piping above the frost penetration depth will be heat traced.
Adequate reliability of power supply for heat tracing will be considered.

(11) A sufficient number of PIVs (Post Indicator Valves) operable from grade will be provided so if a single portion of the grid fails, the grid can still supply not less than 50% of the fire water requirement for each area through adjacent sections. Typically, PIVs will be located at grid intersections, near the centre of long lines, at supply branches to automatic sprinkler systems, water spray systems and at main fire water pump feeds.

(12) The pipe length between two isolation valves should not exceed 300 m.

(13) PIVs will be installed in firewater mains so that not more than five to seven consumers (hydrant, deluge, monitors etc.), serving a single risk area are out of service at any time in the event of outage of part of fire water mains.

(14) A PIV will be installed in firewater laterals feeding more than two consumers.

(15) A block valve shall be provided in the branch pipes from fire water main to the building water fire fighting system.

(16) Guard posts will be provided where fire hydrants, monitors, deluge skids or PIVs are subject to vehicle damage.
These guard posts will be made from four 4"inch schedule piping, filled with concrete, and set in concrete, the top at least 0,9m above grade and the bottom at least 1,2m below grade.

### 9.2.8 Fire Water Run-off

Applicable requirements for contaminated fire water to be clarified.

Handling of (potentially contaminated) fire water run-off is described in the waste water and drainage concept.

### 9.2.9 Hydrants

Hydrants are water extraction points for the fire brigade; they are connected to the fire water ring.

(1) Wet-barrel pillar type fire hydrants with aboveground block-valves will be installed alongside roadways.

(2) Hydrants will be equipped with two 2½” hose connections and one 4” pumper connection. All hose connections should be American NST fire department connections if US manufactured fire trucks used.

(3) Each hydrant connection will have a water supply capacity of minimum 60 m³/h at a pressure of 7 bar (g) regulated by a self-regulating pressure valve.

(4) The minimum connection to the fire water network is 6".

(5) The hydrants will be installed approximately every 45 m (API RP 2001) around high hazard areas (process area), every 60 m around medium hazard areas (e.g. storage tank). The maximum distance in low hazard areas (e.g. admin area) between two hydrants should not exceed 80 m.

(6) The distance between a fire hydrant and a building, structure or hazardous equipment that is to be protected should be at least 15 m (API RP 2001).

(7) The distance of hydrants from roadways should not be less than 1.5 m and not more than 5 m. The pumper connection shall face the road.

(8) Where sleeper ways or large drainage ditches may hinder access between hydrant and process areas or tank diked areas, access ways or walkways across such obstructions will be provided near the hydrants.

(9) The distance between hydrants and main pipe racks should be at least 4.5 m.

(10) In regions with ambient temperatures below freezing point, fire hydrants will be of self-draining type.

### 9.2.10 Fire Hose Boxes

Hose boxes equipped with at least 2 hoses (2½") with a minimum length of 20 m, jet nozzle, tools, etc. will be provided at each third hydrant.

(1) Two (2) 2½" inch fire hoses of 20 m lengths with 2½" inch NST coupling

(2) One (1) 1½" inch fire hoses of 20 m lengths with 1½" inch NST coupling

(3) One (1) 2½" inch water jet/fog combination stream nozzle with shut off feature and capacity 570 lpm at 7 barg

(4) One (1) 2½" x 1½" inch two-way connector wye connector with two (2) independent 1½" valves

(5) One (1) hose wrench

(6) Lettering "FIRE HOSE BOX" in XXXXXXX language by white in stencil

In process areas, where flammable liquids are handled, the hose boxes will be additionally equipped with foam application equipment.

### 9.2.11 Dry Fire Water Risers

Dry risers will be provided to facilitate the supply of water (or foam solution) to landing valves in multi-story structures.

(1) The inlet to the dry riser will be located within one hose length distance of a hydrant connection.

(2) Risers will be installed near stairways (both main and emergency access routes).

(3) Minimum size for the riser will be 6".

(4) A two-way flapper valve ("collecting breaching") will be permanently installed at ground floor level at a height of approximately 0.8m above finished ground level.

(5) Two hydrant valves are required 0.7 meters above floor level near each landing (single arrangements as minimum will be required for office buildings).

(6) Riser inlets and outlets will be equipped with standard hose connection similar to those existing elsewhere on the complex.

(7) Low point drain valves will be integrated in the piping.

(8) An automatic vent is required at the highest point.

(9) Hose boxes equipped with at least 2 hoses (2½") with a minimum length of 20 m, jet nozzle, tools, etc will be provided at each coupler.

### 9.2.12 Fire Monitors

Fire water monitors with adjustable jet-to-fog nozzles are used for immediate intervention to cool equipment, control and extinguish fires. Furthermore monitors are used to catch gas clouds.

(1) Fire Monitors connected to the fire water ring are available as single monitor or monitor / hydrant combination.

(2) Monitors are provided at strategic locations around the protected items. The protected equipment should be preferably reached by two monitors or by one monitor and another protection facility like hydrants or deluge systems.

(3) The jet throw of a monitor is defined as nominal 40 m effective in horizontal or 35 m in vertical direction when using straight stream nozzle under no wind conditions at a minimum pressure of 7 bar(g) with a water supply capacity of 120 m³/h.

(4) Larger capacity monitors may be necessary for particular applications.

(5) Monitors will be specified for 360° horizontal rotation and minimum +70° and -15° rotation in vertical direction. Locked position will be possible.

(6) Monitors are generally manually.
Remote operated monitors will be used if access in case of fire is limited.

(7) In exceptional cases where buildings and racks, will influence the efficiency, elevated monitors for a better fire water coverage might be foreseen. For elevated monitors the vertical down range will be adapted and a remote operability is recommended.

(8) Remotely controlled monitors will be electrically powered by an uninterrupted power supply from the emergency power supply system.

(9) The distance between a fire monitor and a building, structure or hazardous equipment that is to be protected should be at least 15 meters (API RP 2001). The distance of monitors from roadways should not be less than 1.5 m. The distance between monitors and main pipe racks should be at least 4.5 m.

### 9.2.13 Foam Application

Foam application facilities are installed at hydrants and monitors, which are protecting equipment that contains flammable liquids. Foam will be supplied by fire brigade via trailer, barrels, and canister.

Fixed Foam System with Foam tanks and Foam Generators will be foreseen for the intermediate tanks farm.

Foam carts will be provided in pool fire areas where required. Foam carts consists of wheeled foam tank, foam inductor / proportioner, hoses and foam nozzle.

Foam spreads on the horizontal surface and extinguishes fire by keeping away the air and cooling fuel.

Foam types are depending on type of burning media and general conditions.

Foam concentrate consumption rates: The consumption rates shall be based on the percentage concentrate used in the system design in a range of 1 % - 6 %

Type of foams:

- Protein
- Aqueous film-forming foam (AFFF
- Film-forming fluorprotein (FFFP)
- Alcohol-resistant (AR-AFFF)

Expansion rate of foams:

- 1:4 – 1:20 Low expansion foam
- 1:20 – 1:200 Medium expansion foam
- 1:200 – 1:1000 High expansion foam

Foam agent can be provided:

- By the fire brigade (fire truck)
- Locally from fixed tank (foam generator)
- Locally by semi fixed foam canister (monitor / hydrant with ejector stored in hose box)

### 9.2.14 Deluge System

Deluge systems are recommended for:

- Equipment containing more than 5 m³ fire potential liquids or liquefied gases
- Pumps which feed fire potential liquids or liquefied gases
- Oil systems

(1) The detail design of the deluge system will be done in accordance with NFPA 13 and NFPA 15.

(2) Fixed deluge systems will be provided for fire exposure protection to reduce the heat radiation at the equipment by a nearby fire.

(3) The main task of a deluge system is to cool the surface of heat affected equipment to prevent structural damage or loss of containment.

(4) The main reason for a deluge system is to compensate a limited accessibility of cooling water from monitors and hydrants in case of pool fires engulfing the object.
It should be preferably installed at storage tanks, large hydrocarbon containing equipment or items with limited access for monitors or mobile fire fighting facilities, e.g. pressure vessels below structures.

(5) Fixed deluge systems are to be designed as dry systems but permanently connected to the fire water network, which will be operated by a deluge valve.

The equipment provided with a deluge system will be listed in detail in the "Fire Water Demand Report" prepared during engineering.

#### 9.2.14.1 General Design Principles for Deluge Systems

(1) The water spray system consists at least of an automatically operated isolation valve, block-valves, strainer, test and drain line, by-pass valve and block valves, a dry riser (minimum diameter 1 inch) and minimum one spray ring including spray nozzles (for details refer to sketch below).
The Test and Drain line downstream the deluge valve can also be used for manual injection of foam concentrate by the site fire brigade.

Equal distribution has to be ensured. The hydraulic calculations will be performed in accordance with NFPA 15.
Strainers will be installed to avoid blockage of the spray nozzles.

Within critical process area deluge valves will be connected with two tie-in's, located on different sides of an PIV, to the underground system.

(2) The deluge system can be activated:

- manually directly at deluge valve
- remote activation in the control room
- automatic activation
  The deluge valves for water spray systems will be automatically actuated by operation of pilot heads (sprinklers) on a hydraulic release line / pneumatic activation. Pilot Sprinklers for hydraulic activation will be rated for actuation at 100°C.

(3) A signal from a pressure switch downstream of deluge valve and block valve will be routed to the MIMIC Panel for status monitoring and display of alarm.

(4) All parts of the deluge system where an electrical supply is required will be supplied from an uninterrupted power emergency supply.

(5) Double protection by water spray and fire proofing will not be considered.

(6) Fire equipment like deluge valves, water spray nozzles, detectors, etc. should be standardized in line with the existing faculties at plant site (if applicable).

(7) The minimum discharge pressure on the most remote located nozzle shall not be less than 2barg.

(8) For hydraulic calculation a Hazen-Williams coefficient of 120 shall be used for designing the water spray system.

(9) A drain valve will be provided at the lowest point of each deluge system/piping.

(10) Piping material for fire water spray line will be in accordance with Piping Material Specification. To prevent plugging of the nozzles due to corrosion particles the system components shall be corrosion resistant. As a minimum requirement the piping within the water spray system shall be of hot dip galvanised carbon steel.

(11) Piping will be designed to withstand a working pressure of not less than the design pressure of the fire water main.

(12) The protected equipment inside the process area will be covered with a water rate in accordance with “NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection”.

(13) Where only heat radiation is possible, the spray rate can be adjusted to the expected thermal radiation flux.

(14) Spherical or horizontally cylindrical surfaces below the vessel equator can not be wetted by rundown of water. Additional water spray nozzles will be installed to reach the surface below the vessel equator.

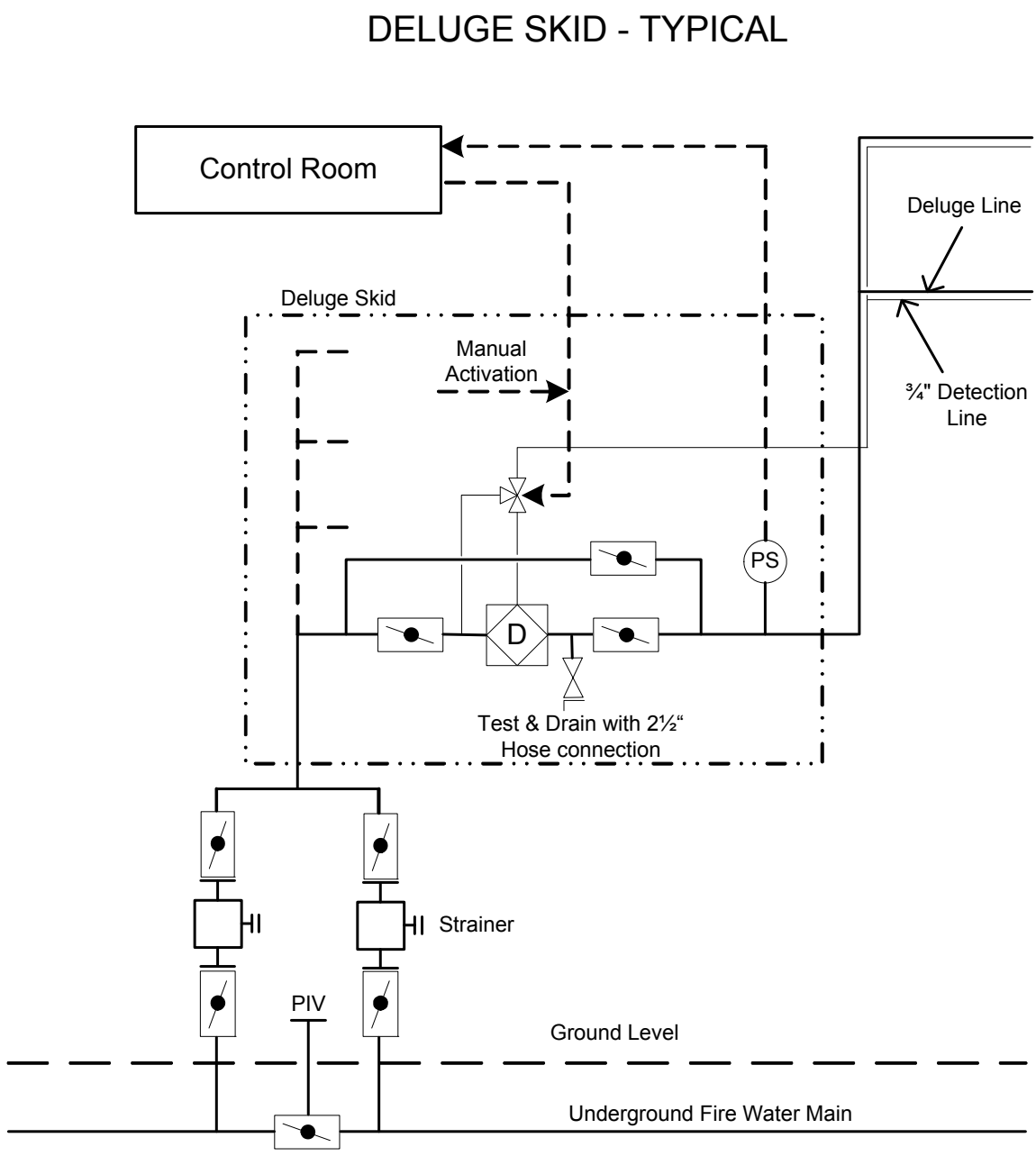
(15) The roof of low pressure and atmospheric storage tanks is preferably protected by at least two nozzle rings. The top nozzle ring of the shell has to be installed in a way that even the upper part of the cylindrical part is wetted. The distance between nozzle and surface will ensure an equally wetted area. Preferably the water will be sprayed onto the surface in an angle of approximately 120°. Design will be according to API 2030.

(16) To safe water and to reduce the system demand, the deluge systems for big tanks can be divided into 2 or 3 independent segments. Only the segment influenced by an adjacent fire will be activated.

(17) The deluge valve will be located at perimeter access way or road sides at least 15m from the equipment or area to be protected and will be grouped up to a maximum of four (4) deluge valves per manifold header.
Deluge valves located less than 15m from protected area will be protected against fire and explosion load by means of shielding walls or protection enclosures.

(18) Deluge valves for protection of storage tanks will be located outside the respective tank dike.

### 9.2.14.2 Deluge Skid – Typical (with hydraulic activation)



### 9.2.14.3 Water Spray Density

(1) For process columns, vertical process or storage vessels, or storage spheres, horizontal process or storage vessels meeting the criteria for fire potential equipment net application rate at all water spray protected items of the process area will be not less than 10,2 lpm/m² of the exposed surface.

(2) For water consumption calculations a margin of 30% should be considered (pressure drop calculations, losses).

(3) Pumps in process and offsite areas handling Class I flammable liquids or Class II combustible liquids at or above their flash points will be sprayed at a minimum fire water application rate of 20,4 lpm/m² of projected area. The projected area will extend 1,2 m out in all directions from the pump and drivers footprint.

(4) Compressors and drivers in hydrocarbon or flammable (e.g. hydrogen) service with a design feed rate greater than 4545 kg/h will be sprayed at a minimum fire water application rate of 20,4 lpm/m² of projected area. The projected area will extend 1,2 m out in all directions from the compressor and drivers footprint.

(5) Shell/tube exchangers handling Class I flammable liquids or Class II combustible liquids at or above their flash points with a diameter greater than 3ft (1m) in diameter should be considered as liquid filled pressure vessels when operated with flammable liquid on the shell side confirming to API 2030.

(6) Plate Fin Heat Exchangers handling Class I flammable liquids or Class II combustible liquids at or above their flash points should be considered as liquid filled pressure vessels.

(7) Water spray systems for double wall tanks, low pressure storage and atmospheric storage tanks will be applied with 4.1 lpm/m².

(8) Water spray systems for spheres will be applied with 10.2 lpm/m².

### 9.2.14.4 Nozzle Spacing

(1) The vertical distance between nozzles shall not exceed 3.7 m according NFPA 15 Annex A where rundown is contemplated for vertical or inclined surface. Spherical or horizontally cylindrical surfaces below the vessel equator cannot be wetted by rundown of water. Additional water spray nozzles have to be installed to reach the surface below the vessel equator.
For cubical apparatus like plate fin heat exchangers the nozzles shall be located as such that all surfaces, especially the underneath is adequately wetted.

(2) Taller items like columns will be equipped with more water spray rings starting at max. 3,7m higher than the upper end of the passive fire protected vessel skirt and followed by another ring approximately every 3.7 m. Only if there is a direct hazard above 12 m (NFPA 15 Annex A) or above the height of the adjacent pipe rack, whichever is higher, it will be equipped by more water spray rings.

(3) The horizontal distance between nozzles shall be such that spray patterns overlap at the protected surface.

(4) In areas where projections will obstruct water spray coverage (e.g. manholes, pipe flanges, etc.), additional nozzles will be installed to maintain the wetting pattern that otherwise would be seriously interrupted.

(5) Spray nozzles and piping will be located and installed to avoid bumping and tripping hazards. At least 2,1m head clearance will be provided.

## 9.3 Mobile and Portable Fire Extinguishers

Mobile and portable fire extinguishers are used to keep starting fires of medium extent under control until the fire brigade arrives. Fire extinguishers will be located throughout the plant, including all buildings. It is important that the correct extinguisher type is selected for each particular type of fire. The following table illustrates the correct extinguisher for each type of fire.

| Extinguisher Type / Fire Class acc. to NFPA 10 | dry powder | $CO_2$ | water | foam | wet chemical |
|---|---|---|---|---|---|
| A – ordinary combustibles | + | | + | + | + |
| B – flammable liquids & gases | + | + | | + | |
| C – electrical equipment | + | + | | | |
| D – combustible metals | (+) | | | | |
| F – cooking oils and fats | | | | | + |

All extinguishers will be positioned at a visible and accessible location which is protected against weather and damage. Preferably they are placed next to exits, escape routes and manually operated fire detectors which are placed indoor and outdoor.

Number and distribution of extinguishers shall be in accordance with NFPA 10 "Standard for portable Fire Extinguishers". Outdoor extinguishers will be equipped with a weather protection cover or box.
The exact number, type and location of extinguishers should be fixed together with client's representatives or client's responsible fire brigade representative if possible.

### 9.3.1 Dry Chemical Fire Extinguisher (Powder Extinguisher)

- 11.3 kg (25lb) Hand-held powder extinguishers with a minimum UL rating of 10-A:80-B:C will be positioned in process plants such that the travel distance (action radius) between the extinguisher and the possible fire hazard is limited. The travel distance shall not greater than15 m for high risk areas and 30 m for areas at normal risk.
  Suitable number of fire extinguishers will be provided and deployed in all elevations of multi-level structures.

- 56,7 kg (125lb) wheeled powder extinguishers will be located at all complex process units operating with great amounts of flammable liquids, e.g. compressor oil units.
- 7.7 kg (17lb) Hand-held powder extinguishers will be positioned inside buildings with

### 9.3.2 Carbon Dioxide Fire Extinguisher

- 4.5 kg (10lb) $CO_2$ Extinguishers (B/C class) will be located inside instrument and power substations

## 9.4 Fire Fighting Systems for Buildings

Depending on the importance of the buildings, the fire risk of the equipment and the manning of the building, different fire fighting systems are possible:

- fire and gas detection system
- extinguishers
- gaseous extinguishing systems
    1. CO2
    2. inert gas
    3. chemical
- water mist

As an alternative for a gaseous extinguishing system a (VERY) EARLY WARNING SMOKE DETECTION ((V)EWSD) can be foreseen. A (V)EWSD will detect smoke earlier than a common type smoke detector.

Two different types of EWSD systems are available:

- In case of ambient air dependent racks and cabinets (opened racks and cabinets with common air-condition), a EWSD consisting of high sensible very early warning smoke detectors above the racks and cabinets will be provided.
- Is a rapidly dispersion of the smoke in case of fire not guaranteed due to type of rack or cabinet (partial closed) a VEWSD system will be provided. This will be realised with an aspiration smoke detection system (ASD). An ASD continually draw samples of air from the equipment or area requiring protection and assess these samples for the presence of smoke and detects smoke much earlier than conventional systems..

In these cases fire fighting by means of CO2 extinguisher will be adequate.

For the buildings / rooms the following systems have to be chosen:

- Central Control Room (CCR) — **VEWSD, extinguishers**

  or

  fire detection system, extinguishers, clean agent
- Ceilings & False Floor — **VEWSD, extinguishers**

  or

  fire detection system, extinguishers, CO2 / inert gas / clean agent
- Cable basement (CCR) — **VEWSD, extinguishers**

  or

  fire detection system, extinguishers, clean agent

| | |
|---|---|
| • Instrument-substation/ RIB (Remote Instr. Build.) | **fire and gas detection system, extinguishers**, CO2 / inert gas **/ clean agent.**<br>or<br>VEWSD, extinguishers |
| • Power-substation | **fire and gas detection system, extinguishers**, CO2 / inert gas **/ clean agent**.<br>or<br>VEWSD, extinguishers |
| • Cable basement-substation | **fire and gas detection system, extinguishers**, CO2 / inert gas / **clean agent**.<br>or<br>VEWSD, extinguishers |
| • Emergency diesel generator | High pressure water mist system with dry piping |
| • Office | fire detection system, extinguishers |
| • Analyzer house | fire and gas detection system, extinguishers |
| • Laboratory | fire and gas detection system, extinguishers |

The design and calculation will be performed by approved suppliers.

**General note:**

An automatic detection will actuate the extinguishing system, shutdown the automatic ventilating system and close openings (doors etc.) by automatic closures. If leakage can not be kept to a minimum, an extended agent discharge will be provided to maintain the design concentration for the required duration of protection.

The total amount of stored gas should cover twice, one main and one reserve supply, the consumption of the largest single protected area to ensure the continuous protection. Both, the main and the reserve supply, will be connected to the system permanently and arranged for easy changeover. The storage will be located as near as possible to the hazards they protect but not where they would create a hazard themselves. Preferably they are stored in a separated room.

Safety items like personnel training, warning signs, audible and visual (pre)discharge alarm, evacuation plans and fire drills should be considered.

All parts from the gas fire extinguishing system where an instrument supply is required will be supplied from an uninterrupted power emergency supply.

### 9.4.1 Carbon Dioxide Fire Extinguishing System

The carbon dioxide fire extinguishing system consists of CO2 high-pressure cylinders (with 100% spare capacity and weighing facility), fixed distribution piping, fixed discharge nozzles and automatic fire detection. At increased requirements of about 2000 kg CO2 it is preferred to store the carbon dioxide liquid in low pressure tanks instead of high-pressure cylinders.

A vent during carbon dioxide discharge to avoid excessive overpressure is to be provided. The need of a vent during discharge will be confirmed by calculation.

The discharge of carbon dioxide in fire extinguishing concentration creates serious hazards to personnel, such as suffocation and reduced visibility during and after the discharge period. Therefore consideration should be taken to:

- the possibility of carbon dioxide drifting and settling into adjacent places outside of the protected space
- where the carbon dioxide can migrate or collect in the event of discharge from safety relief device or of a storage container
- the possibility that personnel could be trapped in or enter into an atmosphere made hazardous by carbon dioxide discharge

Suitable safeguards shall be provided

- to ensure prompt evacuation,
- to prevent entry into such atmospheres,
- for prompt rescue of any trapped personnel.

Audible and visual pre-discharge alarm including time delay (at least 30 s) and appropriate warning signs will be installed inside and outside of those areas where dangerous concentrations of carbon dioxide might accumulate. An alarm or indicator will be provided to show that the system has been in operation and needs recharging.

**Alternatively, a clean agent system can be used instead of a CO2 fire extinguishing system.**

### 9.4.2 Inert Gas Fire Extinguishing System

The Inert Gas (e.g. Argonite®/Inergen®) reduces the O2 content down to approximately 13 – 15 Vol%. This could lead to health damage in case of longer stay time. In case of system activation, the personnel have to leave the room before flooded.

For fire situation, suitable safeguards will be provided to:

- ensure prompt evacuation of hazardous area
- prevent entry into hazardous area
- ensure prompt rescue of any trapped personnel

A vent during discharge to avoid excessive overpressure is to be provided. The need of a vent during discharge shall be confirmed by calculation.

### 9.4.3 Chemical Fire Extinguishing System

The effect of this system is to stop the fire by heat removal. Oxygen is only replaced in a very small extent so that personnel are not endangered by oxygen deficiency. Nevertheless, personnel should leave the fire area because of toxic combustion products.

Types of chemical fire extinguishing system:

- NOVEC 1230

### 9.4.4 Water Mist System

In rooms with mechanical equipment and no electrical equipment, like the emergency diesel generator room, a water mist system will be installed.

The system typically consists of a water tank, $N_2$ or pressurized air bottles and the distribution system with piping and nozzles. The capacity of the water tank and the number of bottles depend on the size of the protected area.

The water mist system will be activated by automatic or remote manual release or by emergency manual release.

The nozzles provide water mist with droplet sizes of 150-250 µm diameter.

The system shall deliver water mist for 5 minutes with a water supply capacity of at least 4 l/min/m².

# 10 Passive Fire Protection

## 10.1 Fire Proofing

Fireproof insulation for supporting steel structures is useful to protect the plant and fire fighting personnel against the effect of support failure in case of fire. Fireproof insulation is only needed within fire hazardous areas (see chapter 7.) and in accordance defined in this chapter.

The fire proofing shall withstand at least a 90 minutes hydrocarbon pool fire acc. to UL1709 (exception: the legs of spheres shall be protected for at least 3 hours).

In order to ensure sufficient structural integrity, the maximum allowable temperature is:

- 538 °C for structures made from steel
- 150 °C for equipment made out of aluminium (e.g. plate fin exchangers)
- 275 °C for vessel skirts
- 300 °C for vessel and piping made from low temperature material
- 400 °C for vessel and piping made from standard carbon steel

Fire proofing will only be provided at steel structures which are not protected by a deluge system. It is redundant to provide both types of protection.

The supporting structures will be protected against pool fires only. Small long lasting jet fires may only cause local damage and do not result in global collapse. Large jet fires exposing critical members do normally not have duration that result in significant damage of several members and subsequently global collapse.

Fire proofing for equipment (vessels, columns) is generally not foreseen.

For equipment made from low melting material (e.g. aluminium plate fin heat exchangers) which is neither installed inside a "coldbox" nor protected by a deluge system, fire proofing will be applied.

## 10.2 Extent of fire proofing

Extent of fire proofing in general will be designed considering the guidelines given in API 2218.

For the extent of the Fire Hazardous Area please refer to chapter 7.

## 10.3 Fire Proofing for Steel Structures

### 10.3.1 General Requirements

Fireproof insulation on steel structures shall comply with the following general requirements:

- Protected items will be covered with fireproofing materials meeting a minimum 1.5 hours rating in accordance with UL 1709.

- Fireproofing will only be foreseen for structures and equipment with special requirements within fire hazardous areas.
- All vertical and horizontal parts of the structure or pipe rack, except of wind or seismic bracing, will be considered as load bearing structural steel and will require fireproofing
- No fire proofing will be foreseen for longitudinal beams or intermediate cross beams which do not support piping or equipment.
- No fire proofing will be foreseen for platforms, runways or stairways.
- The top flange of horizontal beams supporting process equipment, flooring, piping, etc. will not be fireproofed.
- No fire proofing will be foreseen for longitudinal beams or intermediate cross beams which do not support piping or equipment.
- No fireproofing will be foreseen for supporting structures or field supports with a total height of less than 1.5m.
- Fire proofing for piping will be foreseen only in special cases.

### 10.3.2 Multilevel Structures

Fireproofing for steel structures supporting fire potential equipment will be applied from grade up to the highest level at which the equipment is located.

For equipment like reactors or similar vessels which are supported on steel brackets or lugs inside such multilevel structures equivalent fire protection will be foreseen also for these supports **(see Figure 1A).**

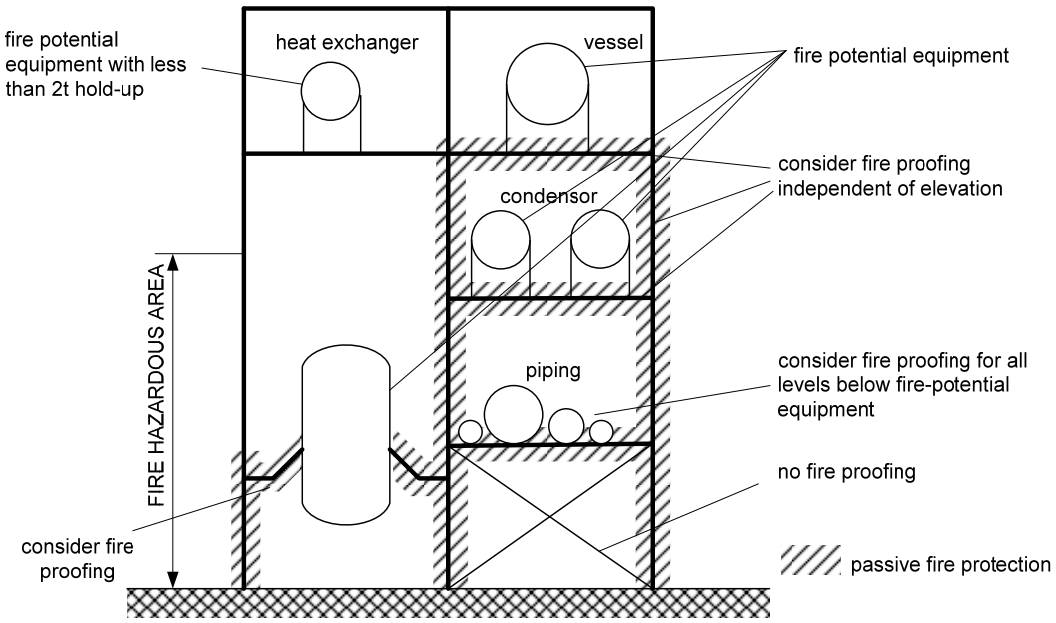



Figure 1A – Multilevel Structure supporting Fire Potential Equipment >2t content

For multilevel structures supporting both, fire potential equipment and non-fire potential equipment, passive fire protection will be applied up to the height of the Fire Hazardous Area above grade or above elevated floors and platforms where flammable or combustible liquids or liquefied inflammable gases can accumulate **(see Figure 1B)**

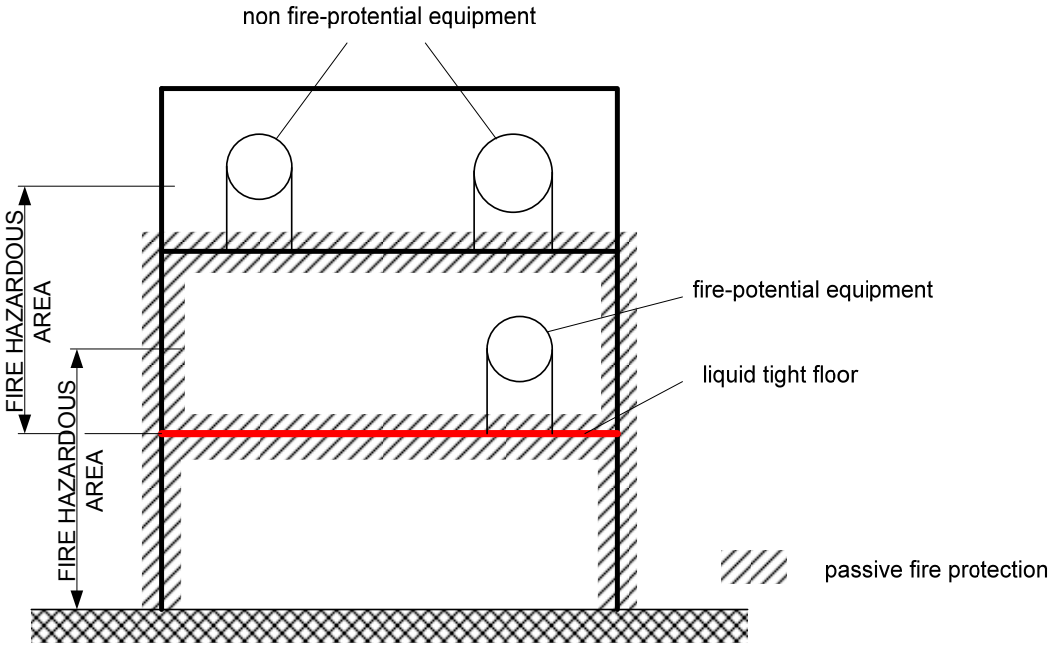



Figure 1B – Structure Supporting Fire Potential and non-Fire Potential Equipment

Fireproofing for steel structures, supporting equipment without fire potential content but exceeding a weight (vessel plus normal content) of 25t total, will be applied from grade up to first level and including the level that is nearest to the 8m elevation above grade if a collapse of the unprotected steel structure will create an escalation potential for the fire scenario
**(see Figure 1C).**

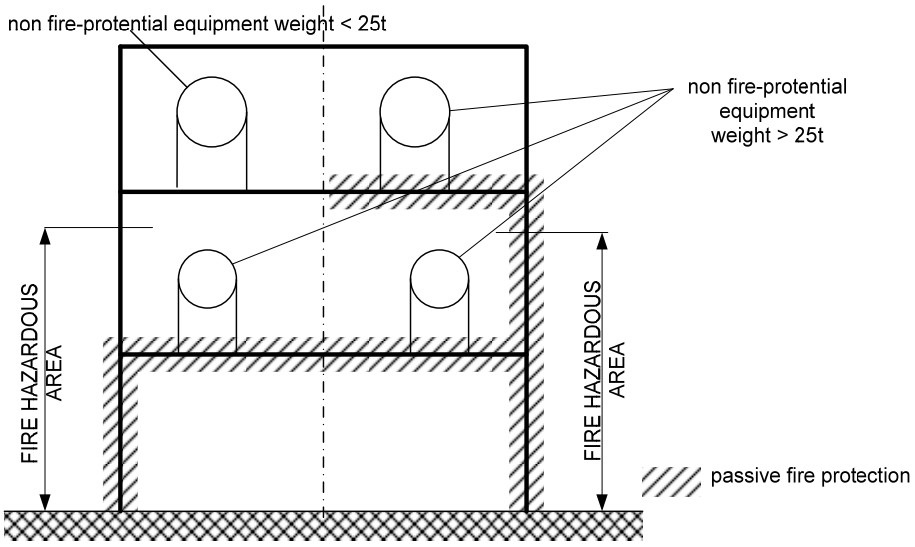



Figure 1C - Structure Supporting non-Fire Potential Equipment > 25t

### 10.3.3 Pipe supports and pipe racks

Fireproofing will be considered for steel structures of pipe racks, up to and including the first level only **(see Figure 2A).**

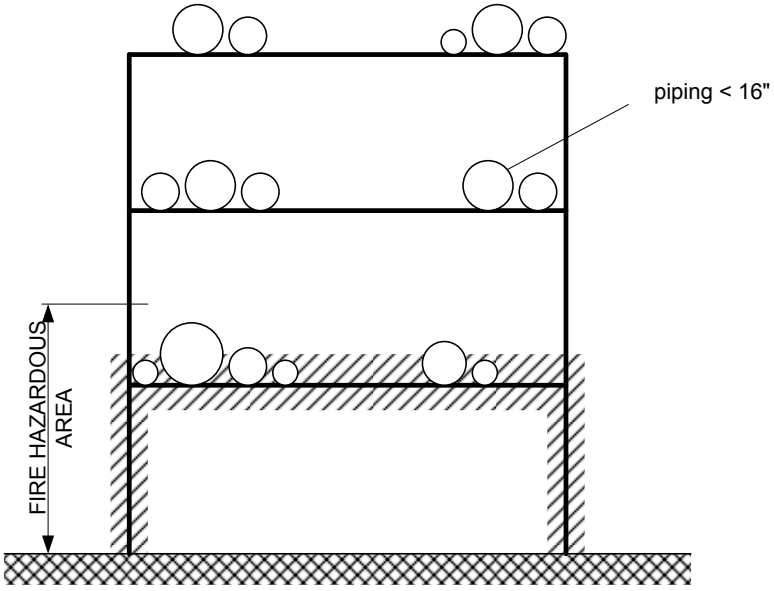



Figure 2A – Pipe rack without Pumps below

Fireproofing will be considered for steel structures of pipe racks from grade up to the height of the Fire Hazardous Area above ground if the pipe rack carries piping with a diameter greater than 16", at levels above the first horizontal beam or if pumps handling fire hazardous materials are located under the pipe rack **(see Figure 2B).**

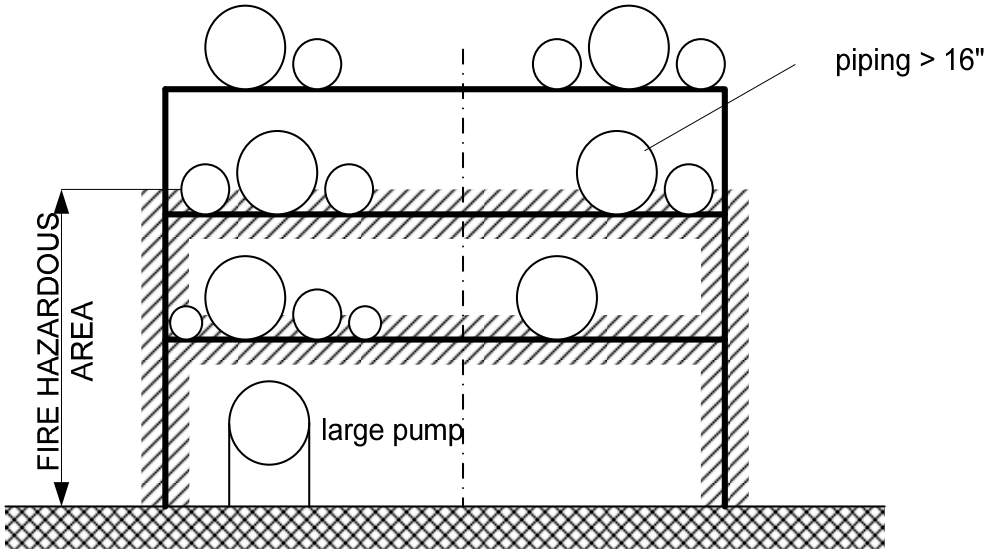



Figure 2B – Pipe rack with large Fire Potential Pumps below

Pipe racks running across open drainage ditches that may receive accidental spills of fire potential media, either the ditch will be covered or fireproofing will be applied to the pipe rack supports located within 10m of the ditch.

If air coolers meeting the criteria for fire potential equipment are installed on top of a pipe rack or equipment structure, fireproofing will be considered for all levels of the pipe rack or equipment structure, including support structure for the air coolers, regardless of their elevation above ground **(see Figure 2C).**
When air coolers not meeting the criteria for fire potential equipment are located above fire potential equipment, fireproofing will be considered for the structural supports located within a 10m horizontal radius of such equipment, regardless of their height **(see Figure 2C).**

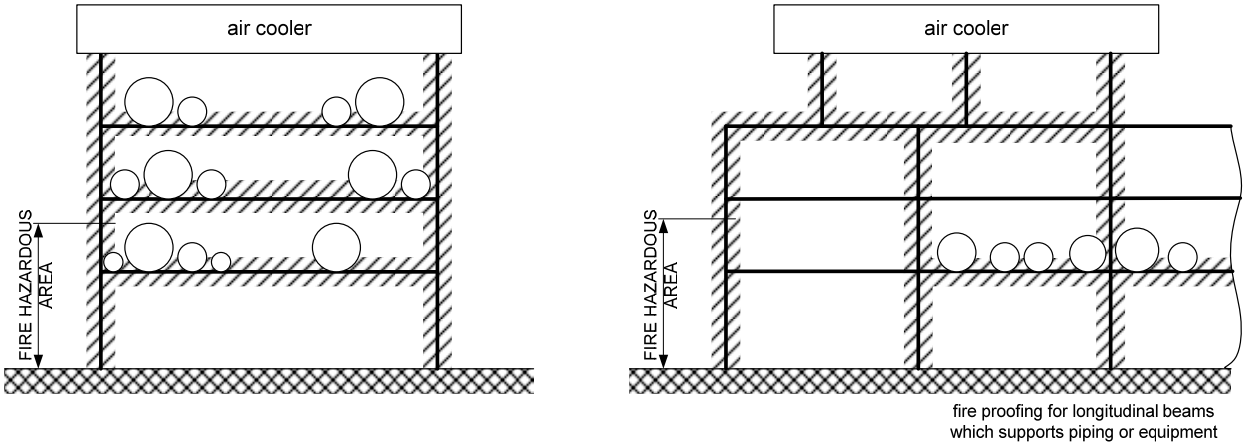



Figure 2C – Pipe rack supporting Air Fin Cooler

Fireproofing will be applied up to the full support height of air coolers containing fire potential media which are located at grade level.

Where piping containing flammable materials, combustible liquids or toxic materials is hung by rod- or spring-type connections from a pipe-rack support member, a “catch beam” will be provided. The catch beam and its support members will be fireproofed **(see Figure 2D).**
Fireproofing will be considered for Field Supports which carries piping with a diameter greater than 16", or important piping such as relief lines, blow-down lines, lines containing toxic materials or pump suction lines from vessels, tanks or columns containing fire potential media which cannot be shut-off from save location or by remote activated valves**(see Figure 2E).**

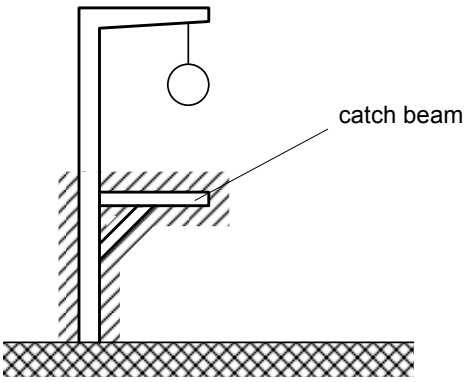



Figure 2D – Interconnection Line with Hanger Support

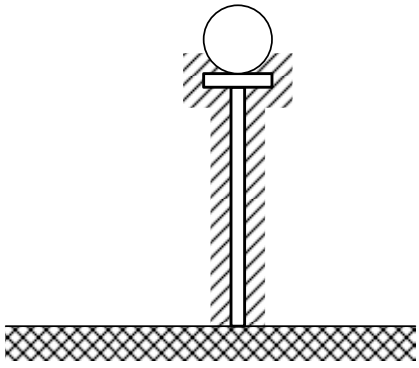


Figure 2E – Interconnection Line Support

### 10.3.4 Flare Lines

Fireproofing will be considered for supports of flare lines if they are within a fire hazardous area.

## 10.4 Fire Proofing of Supports for Vessels and Exchangers

Fireproofing will be applied to steel saddles that support horizontal heat exchangers, vessels e.g. with a diameter greater than 750mm, if the vertical distance between the concrete pylon and the vessel exceeds 300mm.

Outside surfaces of skirts or legs of vertical vessels or columns will be fireproofed to full height of load-bearing support, it they are fire potential equipment according to this specification or will create escalation potential, and if they are located inside a fire hazardous area,.

The inside of skirts for vessels of less than 1.2m in diameter will not be fireproofed.

For brackets or lugs that are used to attach vertical re-boilers or heat exchangers to a column or column skirt, fireproofing will be considered if located inside a fire hazardous area.

If columns or vessels are supported by steel legs, fireproofing of the leg supports to their full-load-bearing height will be considered.

Apparatus made of low melting material like aluminium plate fin heat exchangers, containing medium that could feed a fire will be fire proofed independent of their installation height if not installed inside a "coldbox" or protected by a deluge system.

## 10.5 Steel Supports of Heater/Furnace

Structural members supporting fired heaters above grade will be fireproofed for heaters handling flammable or combustible liquids.
Fireproofing will be considered from the top of concrete piers up to 50mm underneath the furnace plate of the heater.

If structural support is provided by horizontal steel beams beneath the firebox of an elevated heater, fireproofing will be considered for the beams, unless at least one flange is in continuous contact with the elevated firebox.

Structural steel members supporting fired heaters in other services will be fireproofed if located within a fire-scenario area.
These include fired heaters in other-than hydrocarbon services, such as steam superheaters or catalytic cracking unit air heaters, if a collapse would result in damage to adjacent hydrocarbon-processing equipment or piping.

## 10.6 Safety relevant Valves and Cables

### 10.6.1 Passive Fire Protection for Valves

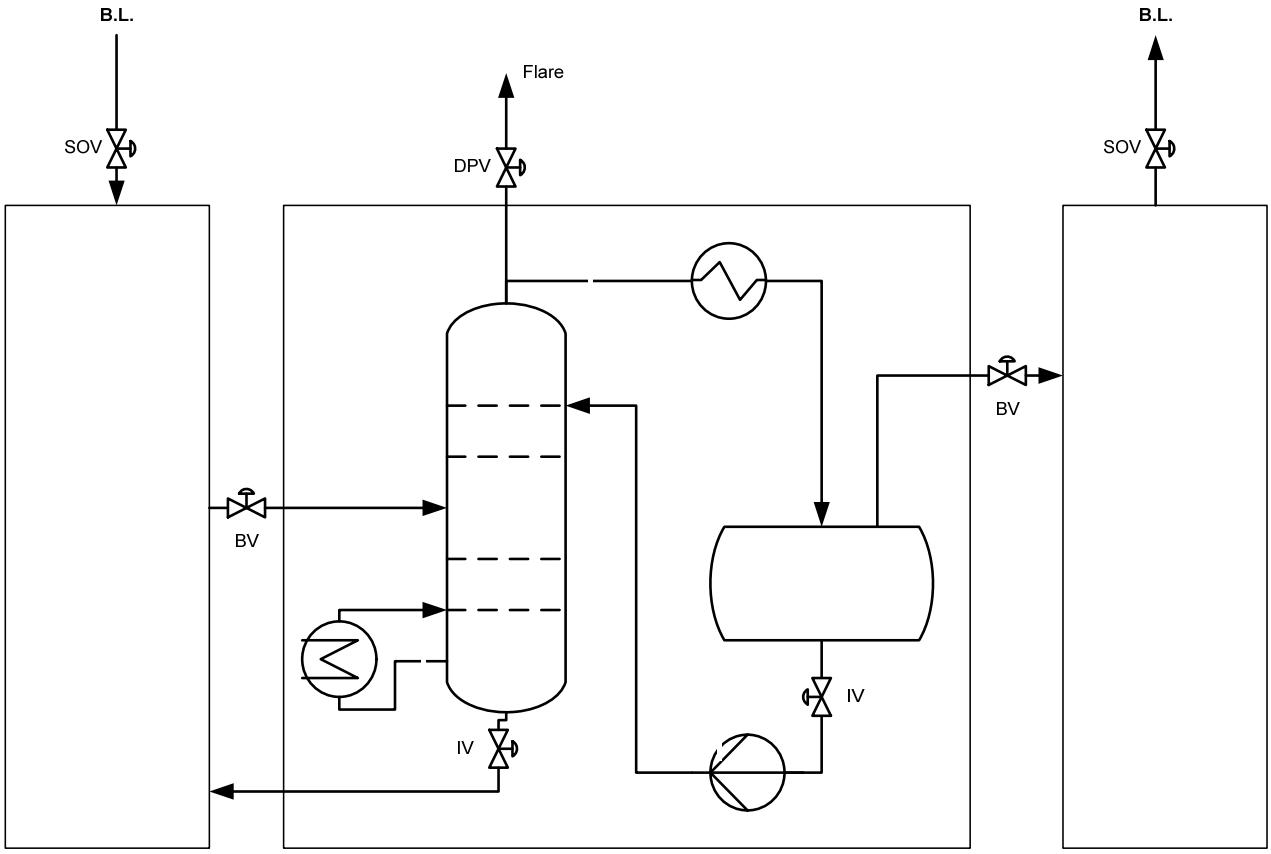
| | | | Passive fire protection requirements | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Inside fire hazardous area | | | | | Above & Outside fire hazardous area | | | | | |
| **valve** | **fail position** | **valve type** | **valve body** | **actuator** | **cable** | **cable support system** | **I-Air buffer[1)]** | **valve body + actuator + I-Air buffer[1)]** | | **cable** | | **cable support system** | |
| | | | | | | | | **above FHA** | **outside FHA** | **above FHA** | **outside FHA** | **above FHA** | **outside FHA** |
| **DPV** | close | CV | 30 minutes | 30 minutes | 30 minutes | 30 minutes | 30 minutes | protected against radiation by galvanized steel plate[2)] | no | IEC 60331 or shielding by galv. steel plate[3)] | no | no | no |
| **BV** | close | CV | 30 minutes | 30 minutes | no | no | n/a | no | no | no | no | no | no |
| | open | CV | 30 minutes | 30 minutes | 30 minutes | 30 minutes | 30 minutes | no | no | IEC 60331 or shielding by galv. steel plate[3)] | no | no | no |
| | in position | electric | 30 minutes | 30 minutes | 30 minutes | 30 minutes | n/a | no | no | IEC 60331 or shielding by galv. steel | no | no | no |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | plate[3)] | | | |
| **SOV** | close | on / off | fire safe type | no | no | | n/a | no | no | no | no | no | no |
| **IV** | close | on / off | fire safe type | no | no | | n/a | no | no | no | no | no | no |

**Remarks:**

Requirement of 30 minutes is given by 10 minutes reaction time to activate the system plus 15 to 20 minutes depressuring time. This time shall be aligned with the project BDS Concept if any.

**DPV** - Depressuring Valve
**BV** – Block-in Valve
**SOV** – Shut-off Valve e.g. at Battery Limit, Import-, Export- or Pipelines.
**IV** – Inventory Valves located at liquid outlet of equipment with very large inventory
**CV** - Control Valve
1) - including interconnecting piping. Media temperature inside shall be keep within operational limits **/05/**
2) - galvanized steel plate of at least 1,6mm thickness, extending the valve/actuator footprint at least 1,5m in each direction
3) - galvanized steel plate of at least 1,6mm thickness, extending the horizontal cable tray at least 1,5m at both sides **/05/**




### 10.6.2 Actuators

Actuators (pneumatic and hydraulic) and buffer vessels or e-motor drivers which shall move and keep valves in FAIL SAFE position will be passive fire protected according to the table above.

The selected protection system shall be proven by acceptable tests or calculations to keep the temperature of the actuator within operating limits.

### 10.6.3 Electrical Power / Instrument Cable and Cable Support Systems of Safety Relevant Systems

Electrical, instrument, and control systems located in fire hazardous areas and used to activate equipment needed to control a fire or mitigate its consequences will be protected from fire damage.

| This includes instrument and power cables connected to: | **Inside Fire Hazardous Area** | | **Above Fire Hazardous Area** | | **Outside Fire Hazardous Area** | |
|---|---|---|---|---|---|---|
| | cables | cable support systems | cables | cable support systems | cables | cable support systems |
| ➢ Safety relevant Valves | ref. to table 10.6.1 | ref. to table 10.6.1 | ref. to table 10.6.1 | ref. to table 10.6.1 | ref. to table 10.6.1 | ref. to table 10.6.1 |
| ➢ Remote Controlled Fire Monitors | at least 60 minutes | at least 60 minutes | at least 60 minutes | at least 60 minutes | no | no |
| ➢ Deluge Valves for Fire Water | at least 60 minutes | at least 60 minutes | IEC 60331 or shielding by galv. steel plate | no | no | no |
| ➢ Fire & Gas Detectors | cables acc. to IEC 60331 | Fire proofing for main cable support systems | IEC 60331 or shielding by galv. steel plate | no | no | no |
| ➢ Fire & Gas Alarm Devices like Horns, Flash Lights etc. | cables acc. to IEC 60331 | Fire proofing for main cable support systems | IEC 60331 or shielding by galv. steel plate | no | no | no |

### 10.6.4 Junction Boxes of Safety Relevant Systems

Junction Boxes in fire hazardous areas containing cabling of safety relevant systems which shall be fire proofed for a certain period of time will be passive fire protected including their supports.

The protection system selected will be proven by acceptable tests or calculations to keep the temperature inside the junction box within operating limits.

### 10.6.5 Pneumatic and Hydraulic Instrument Lines / Buffers of Safety Relevant Systems

Pneumatic and hydraulic instrument lines, if needed to keep the valve in the designated position will be protected for the same reasons, and by the same methods, as those described above for electrical cable.

The protection system selected will be proven by acceptable tests or calculations to keep the temperature of the Lines / Buffer and the media within operating limits.

## 10.7 Fire Proofing Type

The type / temperature curve, the fire proofing is designed for will be in accordance with UL 1709.

There are several types of fire proofing, e.g. dry-fix, spray-on epoxy based or cement.

**Any use of passive fire protection material (PFP) shall be in full compliance with the respective vendor's certificates and application manual.**

- Dry-fix insulation will typically be used for vessels, piping and valves. Insulation material will be non-combustible, non-toxic and water tight/water repellent. The materials will not release toxic or corrosive gases when exposed to fire. For the weather protection, stainless or galvanized steel jacketing will be used.
- Spray-on passive fire protection will be used as material for fire proofing of structural steel, secondary steel, vessel skirts, pipe supports, un-insulated piping, vessels, columns and equipment like air buffer drums. Spray-on PFP is an epoxy based intumescent coating system reinforced with mesh. The temperature of surfaces to be fire proofed should be within the limits specified by spray-on material manufacturer. Inspection requirements will be considered when the kind of fire protection is defined.
- Cement based spray-on material is suitable in areas where weight and thickness is not a crucial factor. Preferably this will be used for supports of columns and pipe racks within process units. For prefabricated units, cement based protection is not suitable. It is sensitive to vibrations, which may occur during transportation.
- Concrete based passive fire protection is suitable in areas where weight and thickness is not a crucial factor. Preferably this will be used for pipe racks within process units. For prefabricated units, concrete based protection is not suitable. It is sensitive to vibrations, which may occur during transportation.
- Fire protection enclosures comprising of closely fitted insulation panels around the equipment to be protected. The panels consist of ceramic fibre layers encapsulated between stainless steel sheets. The panel sizes, materials, insulation infill and skin thickness are specifically selected to suit the given design requirements. Passive fire protection enclosures will typically be used to protect valves. Therefore the enclosures consist of removable boxes in order to allow maintenance and inspection of the valves.
- A flexible composite mattress / pillow system featuring multiple layers of ceramic fibre at various densities can be applied as passive fire protection for instance on cable trays. The composite is compressed to approximately half of its free thickness and held in compression by nylon pins. The specific composite for each application is dependent upon the time and temperature requirements, geometry and mass of protected equipment and site conditions such as ambient temperature, fuel sources and air flow, etc.

Design and selection of appropriate passive fire protection system is within the responsibility of the concerned departments.

# 11 Fire and Gas Detection System

The fire and gas detection system is described in the "Fire and Gas Detection Concept" &AA-S-PC 1008.

# TECHNICAL QUALIFICATION FOR FIRE PROTECTION OF AREAS A1, A5 A7a/b AND A11

# INDEX

# 1 INTRODUCTION

The scope of the note is to define and qualifies the technical design choices followed the fire fighting systems of Tahrir Petrochemicals Project Utilities and Offsite's located in Ain Sokhna – Egypt.

# 2 SAFETY DISTANCES CONSIDERATION

The safety distances from units and equipments have been defined according to G.A.P. 2.5.2 "OIL AND CHEMICAL PLANT LAYOUT AND SPACING ".

Where safety distance have been derogated and reduced, additional loss control measures, such as fire proofing, automatic firewater spray systems have been foreseen as allowed by G.A.P. 2.5.2 itself.

Actually thanks to the envisaged massive fire protection measurements, it has been possible to optimize the plants layout configuration having benefits from technological, process and cost saving points of view.

# 3 FIRE FIGHTING SYSTEM FOR BUILDINGS

## 3.1 Clean agent system

Clean agent system will be provided to protect the plants substations and field instrument rooms - FIR (or remote instrument buildings – RIB-s).
In particular clean agent coverage will be foreseen for:

- The cable basements
- Electrical power rooms / UPS

The extinguishing agent will be NOVEC 1230.

The clean agent system will start automatically upon activation of smoke detectors. Manual operation will also be foreseen from local push buttons and at the cylinders.

The Gas extinguishing system shall be design to avoid any automatic activation with the presence of people.

The total amount of stored gas will cover twice, one main and one reserve supply (100% spare), the consumption of the largest single protected area to ensure the continuous protection.

The automatic operation, including the shutdown of the ventilating system and all other possible actions required will be possible only if at least n° 2 smoke detectors indicate an alarm (voting logic 2ooN), so as to minimize the risk due to false alarms.

The activation of this system shall alarm to the Main Control Room.

The entire design of the systems will be developed in accordance with NFPA 2001 standards on Clean Agent Fire Extinguishing Systems.

### 3.2 High Expansion Foam System

High expansion foam system according to NFPA 11 will be provided to protect the Chemical Storage Building.

### 3.3 Dry Chemical System

Dry chemical system according to NFPA 17 will be provided to protect Additive and Catalyst Storage Buildings.

### 3.4 Sprinkler System

Sprinkler system according to NFPA 13 will be provided to protect the Workshop & Warehouse O&U, PE.

### 3.5 Hose Reel Station

Hose reel stations housed in dedicated boxes, will be provided in process and non-process buildings. They shall be equipped with :

- Two (2) 2½" NST fire hoses of 25 m
- One (1) branchpipe nozzle with valve fog/full stream
- One (1) hose wrench

### 3.6 Portable and wheeled fire extinguishers

Other room like offices room, analyzer room and laboratory will be protected by means of fire and gas detection system, $CO_2$ and dry powder fire extinguishers.

Wheeled dry powder and/or wheeled foam extinguishers will be located close to the oil transformers bays. Actually fire fighting protection of oil transformers will be foreseen only by fire extinguishers.

Number and distribution of fire extinguishers shall be in accordance with NFPA 10 "Standard for portable Fire Extinguishers". Outdoor extinguishers will be equipped with a weather protection cover or box.
$CO_2$, foam and dry powder portable extinguishers will be provided respect to the fire classes of the combustible and flammables materials.

# 4 FIREWATER PROTECTION FOR AREA A1 AND INTERMEDIATE TANK FARM A11

## 4.1 Firewater network

The underground firewater network will consist of ring mains encircling the plant units. The underground lines will be routed to avoid being beneath building and major equipment.

Isolation valves with post indicator will be used to isolate segments of the loop in the event of equipment damages or pipe leakage or maintenance.

Isolation valves will be provided at each node (N-1 sectional valves for N lines) and at least every 300 m or maximum every 5 (five) fire fighting utilities (hydrants, monitors, etc.)

Wet hydrants will be installed approximately every 60 m around medium hazard areas and 80 m around low hazard areas.

Hydrants will be equipped with two 2½" hose connections and one 4" pumper connection.

Hose boxes equipped with 2 hoses (2½") with a minimum length of 20 m, jet nozzle, tools, etc. will be provided at each third hydrant.

Manual firewater monitors shall be designed for 2000 lpm and equipped with fractioned jet nozzle water/foam branch pipe.

Manual water/foam monitors shall be located at a minimum safe distance of 15 m from the nearest hazard and specifically around the storage tanks dikes.

Minimum operating pressure at the fire hydrants and monitors will be 7 barg.

Hose reel stations shall be provided on cooling towers for minor fires, they will be located near access stairs, on fan deck (along access path); with 30 m of non-collapsible rubber hose & with adjustable combination of straight – stream flow nozzle.

## 4.2 Automatic deluge system

Dry pilot head operated water spray and deluge systems will be provided, watering protected areas and equipment.

The systems shall be hydraulically designed according to NFPA 13 and NFPA 15 and considering the listed flow density:

- Pumps, Compressors 20.4 lpm/m²
- Exposure protection of vessels, drums and columns 10.2 lpm/m²
- Area protection 12.2 lpm/m²

**Water spray systems for double wall tanks, low pressure storage and atmospheric storage tanks will be applied with 4.1 lpm/m² according to API 2030.**

Specifically, deluge protection systems will be foreseen to protect:

| AREA | PROTECTED EQUIPMENT | DESCRIPTION | PROTECTED ZONE |
|---|---|---|---|
| A1 | D-1004 | Fuel Oil Tank | Lateral surface |
| | G-1005 A/B/C | Fuel Oil GTs Pumps | Whole surface |
| | G-1006 A/B/C | Fuel Oil Boilers Pumps | Whole surface |
| | B-1002 A/B/C/D | HP Steam Boilers | Whole surface |
| | P-1004 A/B/C/D | Gas Turbines | Lube oil unit |
| | P-1005 A/B | Steam Turbines | Lube oil unit |
| A11-Intermediate Tank Farm | 73-D31 | Butene Tank | Whole surface |
| | 74-D31 | Iso-pentane Tank | Whole surface |
| | 73-P71 | Butene Pumps | Whole surface |
| | 74-P71 | Iso-pentane Pumps | Whole surface |
| | 76-D31 | n-Hexane Tank | Lateral surface |
| | 72-D31 | Raw Pygas Tank | Lateral surface |
| | 72-P71 | Raw Pygas Pumps | Whole surface |
| | 75-P71 | Hexene Pumps | Whole surface |
| | 66-P71 | Mixed C6 Pumps | Whole surface |
| | 77-P71 | PGO/PFO Pumps | Whole surface |
| | 76-P71 | n-Hexane Pumps | Whole surface |
| | 66-D31 | Mixed C6 Tank | Lateral surface |
| | 49-D31-34 | Hydrogen Storage Bullets | Whole surface |
| | 49-Y01 | Hydrogen Compression Unit | Lube oil unit |
| | 71-D32 | Ethane Tank | Whole surface |
| | 59-D31 | Mixed C4 Tank | Whole surface |

| AREA | PROTECTED EQUIPMENT | DESCRIPTION | PROTECTED ZONE |
|---|---|---|---|
| | 77-D31 | PGO/PFO Tank | Lateral surface |
| | 59-P71 | Mixed C4 Circulation Pumps | Whole surface |
| | 76-Y01A | Hexane Truck Loading | Loading Area |
| | 76-Y01B | PGO/PFO Truck Loading | Loading Area |

## 4.3 Water mist system

Emergency diesel generators will be protected by high pressure water mist system. The system typically consists of a water tank, N2 or pressurized air bottles and the distribution system with piping and nozzles. The capacity of the water tank and the number of bottles depend on the size of the protected area.

The water mist system will be activated by automatic or remote manual release or by emergency manual release.

The nozzles provide water mist with droplet sizes of 150-250 μm diameter.

The system shall deliver water mist for 5 minutes with a water supply capacity of at least 4 l/min/m².

## 4.4 Fixed foam system

Low expansion foam systems will be provided to protect storage tanks.

3% foam and water solution is provided to the low expansion foam systems by means of balanced pressure proportioning systems.

The system operates by passing the required portion of foam concentrate from a positive displacement pump to a Venturi proportioner with the remaining portion recirculating through a diaphragm valve in the return line to a concentrate foam storage tank.

The diaphragm valve senses and balances the pressures in the foam concentrate and water lines to the proportioner. The foam concentrate then enters the proportioner where a built-in orifice regulates the flow of pressurized foam concentrate entering the water stream.

Foam station proportioning systems are manually operated from Main Control Building by means of Motor Operated Valves (MOV). Activation of MOV is also local by means of by-pass around MOV.

The foam pourers discharge foam automatically onto:

- For floating roof (open or covered), the rim seal between the foam dam and the tank wall at

a design application rate of 12.2 litre/minute/$m^2$ of dam area

- For fixed roof tanks, the whole top surface of storage tanks at a design application rate of 4.1 lpm/$m^2$

The pourer comprises of two elements – a Foam Generator that aspirates the foam solution and the foam pourer that distributes the expanded foam on to the rim seal area.

The foam solution supply connection piping runs over the bund wall.

The hydrocarbon storage tanks, protected for the whole roof surface protection, will be:

| PROTECTED EQUIPMENT | DESCRIPTION | NUMBER OF FIXED FOAM SYSTEMS |
|---|---|---|
| D-1004 | Fuel Oil Tank | 01 |
| 76-D31 | n-Hexane Tank | 01 |
| 72-D31 | Raw Pygas Tank | |
| 66-D31 | Mixed C6 Tank | |
| 77-D31 | PGO/PFO Tank | 01 |

**Foam Protection is not foreseen for pressure and low pressure storage tanks.**

## 4.5 Firewater demand and Firewater pumps station

This pumps station will supply firewater to A1, Intermediate Tank Farm, ISBL P1 and ISBL P2. Therefore, the capacity is designed considering the worst fire scenario in one of the four areas.

In A1 the maximum preliminary water demand has been estimated around 1000 m3/h considering the worst fire scenario represented by a fire scenario at the gas turbines area.

More specifically, the estimated maximum firewater flow rate is based on:

- The deluge systems firewater supply of one gas turbines (bearing and lube oil unit)
- The deluge systems firewater supply of the two nearest gas turbines (bearing and lube oil unit)
- Two monitors of 120 m3/h flow rate in operation

In Intermediate Tank Farm the maximum preliminary water demand has been estimated around 3400 $m^3$/h considering the worst fire scenario represented by a Raw Pygas Tank on Fire.

More specifically, the estimated maximum firewater flow rate is based on:

- The deluge systems firewater supply of the tank on fire
- The deluge systems firewater supply to protect the half surfaces (if separated deluge systems) of the nearest storage tanks
- The firewater supply of the foam system which cover the rim storage naphtha tank on fire
- Two monitors of 120 $m^3$/h flow rate in operation

The firewater system is common for areas A1, Intermediate Tank Farm, ISBL P1 and ISBL P2; fed by one pumps station and designed according to NFPA and API.

Pumps station located in A1 (onshore fed with desalinated water):

- Three electric driven firewater pumps – 1140 $m^3$/h – on duty
- Two diesel driven firewater pump – 1140 $m^3$/h – spare
- Two electric driven jockey pumps – 100 $m^3$/h – on duty
- One electric driven jockey pump – 100 $m^3$/h – spare
- One water storage tank in order to ensure six hours of the maximum firewater demand

# 5 FIREWATER PROTECTION FOR AREAS A5 AND A7A/b

## 5.1 Firewater network

The underground firewater network will consist of ring mains encircling the plant units. The underground lines will be routed to avoid being beneath building and major equipment.

Isolation valves with post indicator will be used to isolate segments of the loop in the event of equipment damages or pipe leakage or maintenance.

Isolation valves will be provided at each node (N-1 sectional valves for N lines) and at least every 300 m or maximum every 5 (five) fire fighting utilities (hydrants, monitors, etc.)

Wet hydrants will be installed approximately every 60 m.

Hydrants will be equipped with two 2½" hose connections and one 4" pumper connection.

Hose boxes equipped with 2 hoses (2½") with a minimum length of 20 m, jet nozzle, tools, etc. will be provided at each third hydrant.

Manual firewater monitors shall be designed for 2000 lpm and equipped with fractioned jet nozzle water/foam branch pipe.

Manual water/foam monitors shall be located at a minimum safe distance of 15 m from the nearest hazard and specifically around the storage tanks dikes.

Hose reel stations shall be provided on cooling towers for minor fires, they will be located near access stairs, on fan deck (along access path); with 30 m of non-collapsible rubber hose & with adjustable combination of straight – stream flow nozzle.

Minimum operating pressure at the fire hydrants and monitors will be 7 barg.

## 5.2 Automatic deluge system

Dry pilot head operated water spray and deluge systems will be provided, watering protected areas and equipment.

The systems shall be hydraulically designed according to NFPA 13 and NFPA 15 and considering the listed flow density:

- Pumps, Compressors 20.4 lpm/m²
- Exposure protection of vessels, drums and columns 10.2 lpm/m²
- Area protection 12.2 lpm/m²

**Water spray systems for double wall tanks, low pressure storage and atmospheric storage tanks will be applied with 4.1 lpm/m² according to API 2030.**

Specifically, deluge protection systems will be foreseen to protect:

| AREA | PROTECTED EQUIPMENT | DESCRIPTION | PROTECTED ZONE |
|---|---|---|---|
| A5 | D-5003 A/B/C/D | Naphtha Tanks | Lateral surface |
| | D-5008 A/B | Benzene Tanks | Lateral surface |
| | D-5010 | Hexene-1 Tank | Lateral surface |
| | D-5009 A/B | Fuel Oil Tanks | Lateral surface |
| | D-5006 | Propylene Tank | Whole surface |
| | D-5014 | Ethylene Tank | Whole surface |
| | D-5007 A/B | Butadiene Tanks | Whole surface |
| | G-5003 A/B/C/D | Naphtha Pumps | Whole surface |

| AREA | PROTECTED EQUIPMENT | DESCRIPTION | PROTECTED ZONE |
|---|---|---|---|
| | G-5009 A/B | Benzene Pumps | Whole surface |
| | G-5010 A/B<br>G-5018 A/B | Hexene-1 Pumps | Whole surface |
| | G-5011 A/B/C | Fuel Oil Pumps | Whole surface |
| | G-5006 A/B | Propylene Pumps | Whole surface |
| | G-5023 A/B<br>G-5024 A/B | Ethylene Pumps | Whole surface |
| | G-5008 A/B | Butadiene Pumps | Whole surface |
| | P-5001 A/B/C | IA/PA Compressors (lube oil unit) | Whole surface |

## 5.3 Water mist system

Emergency diesel generator will be protected by high pressure water mist system. The system typically consists of a water tank, $N_2$ or pressurized air bottles and the distribution system with piping and nozzles. The capacity of the water tank and the number of bottles depend on the size of the protected area.

The water mist system will be activated by automatic or remote manual release or by emergency manual release.

The nozzles provide water mist with droplet sizes of 150-250 µm diameter.

The system shall deliver water mist for 5 minutes with a water supply capacity of at least 4 l/min/m².

## 5.4 Fixed foam system

Low expansion foam systems will be provided to protect storage tanks.

3% foam and water solution is provided to the low expansion foam systems by means of balanced pressure proportioning systems.

The system operates by passing the required portion of foam concentrate from a positive displacement pump to a Venturi proportioner with the remaining portion recirculating through a diaphragm valve in the return line to a concentrate foam storage tank.

The diaphragm valve senses and balances the pressures in the foam concentrate and water lines to the proportioner. The foam concentrate then enters the proportioner where a built-in orifice regulates the flow of pressurized foam concentrate entering the water stream.

Foam station proportioning systems are manually operated from Main Control Building by means of Motor Operated Valves (MOV). Activation of MOV is also local by means of by-pass around MOV.

The foam pourers discharge foam automatically onto:

- For floating roof (open or covered), the rim seal between the foam dam and the tank wall at a design application rate of 12.2 litre/minute/$m^2$ of dam area
- For fixed roof tanks, the whole top surface of storage tanks at a design application rate of 4.1 lpm/$m^2$

The pourer comprises of two elements – a Foam Generator that aspirates the foam solution and the foam pourer that distributes the expanded foam on to the rim seal area.

The foam solution supply connection piping runs over the bund wall.

The hydrocarbon storage tanks, protected by rim protection systems according to roof construction typology listed on point 5.4.2 of NPFA 11, will be:

| PROTECTED EQUIPMENT | DESCRIPTION | NUMBER OF FIXED FOAM SYSTEMS |
|---|---|---|
| D 5003 A/B/C/D | Naphtha Tanks | 02 |
| D 5008 A/B | Benzene Tanks | 01 |

The hydrocarbon storage tanks, protected for the whole roof surface protection, will be:

| PROTECTED EQUIPMENT | DESCRIPTION | NUMBER OF FIXED FOAM SYSTEMS |
|---|---|---|
| D 5009 A/B | Fuel Oil Tanks | 01 |
| D 5010 | Hexene-1 Tank | |

**Foam Protection is not foreseen for pressure and low pressure storage tanks.**

## 5.5 Firewater demand and Firewater pumps stations

The maximum preliminary water demand has been estimated around 4000 $m^3$/h considering the worst fire scenario represented by one naphtha storage tank on fire (maximum firewater demand for A5, A6 and A7a/b).

More specifically, the estimated maximum firewater flow rate is based on:

- The deluge systems firewater supply of the naphtha tank on fire
- The deluge systems firewater supply to protect the half surfaces of the two and nearest naphtha storage tanks
- The firewater supply of the foam system which cover the rim storage naphtha tank on fire
- Two monitors of 120 $m^3$/h flow rate in operation

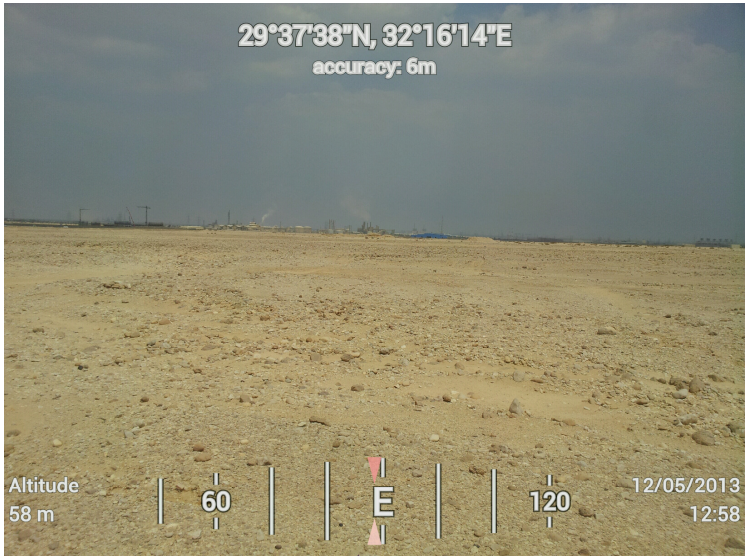
The firewater system is common for areas A5, A6 and A7a/b; fed by two independent pumps stations and designed according to NFPA and API:

- Pumps station located in A5 (onshore fed with desalinated water):
  - One electric driven firewater pump – 1000 $m^3$/h – on duty (first main firewater pump to start)
  - One diesel driven firewater pump – 1000 $m^3$/h – spare
  - One electric driven jockey pump – 100 $m^3$/h – on duty
  - One electric driven jockey pump – 100 $m^3$/h – spare
  - One desalinated water storage tank in order to ensure six hours of the maximum desalinated firewater demand (50% of the total demand as required in the Fire Protection Concept)

- Pumps station located in A6:
  - Three diesel driven firewater pumps – 1000 $m^3$/h – on duty (offshore fed with sea water)
  - One electric driven jockey pump – 100 $m^3$/h – on duty (onshore fed with desalinated water)
  - One desalinated water storage tank for the jockey pump (around 50 $m^3$)

# Appendix 2 - Site Area Photos


29°37'37"N, 32°16'4"E
accuracy: 6m
Altitude
56 m
330
N
30
12/05/2013
12:48


29°37'38"N, 32°16'14"E
accuracy: 6m
Altitude
58 m
60
E
120
12/05/2013
12:58


29°37'37"N, 32°16'4"E
accuracy: 4m
Altitude
63 m
150
S
210
12/05/2013
12:50


29°37'37"N, 32°16'4"E
accuracy: 6m
240
W
300
12/05/2013
12:49


29°37'26"N, 32°16'58"E
accuracy: 8m
Altitude
59 m
0
W
300
13/05/2013
09:36


29°37'29"N, 32°17'19"E
accuracy: 6m
150
S
210
13/05/2013
10:04