DEP SPECIFICATION

ACTIVE FIRE PROTECTION SYSTEMS AND EQUIPMENT FOR ONSHORE FACILITIES

DEP 80.47.10.31-Gen.

February 2011

(DEP Circular 51/11 has been incorporated)

(DEP Circular 38/12 has been incorporated)

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DESIGN AND ENGINEERING PRACTICE

DEM1

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TABLE OF CONTENTS

1. INTRODUCTION 5
1.1 SCOPE 5
1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS 5
1.3 DEFINITIONS 5
1.4 CROSS-REFERENCES 8
1.5 SUMMARY OF MAIN CHANGES 8
1.6 COMMENTS ON THIS DEP 10
1.7 DUAL UNITS 10

2. ENGINEERING, SPECIFICATION, AND INSTALLATION 11
2.1 DESIGN AND ENGINEERING SCOPE 11
2.2 ACCEPTANCE TESTING 11

3. DETECTION 12

4. WATER-BASED SYSTEMS 12
4.1 FIRE WATER DISTRIBUTION 12
4.2 FIRE WATER SPRAY SYSTEMS 20
4.3 WATER DRENCHING 25
4.4 SPRINKLER SYSTEMS 25
4.5 WATER MIST SYSTEMS 25
4.6 STEAM SYSTEMS 25

5. FIRE FIGHTING FOAM SYSTEMS 26
5.1 FOAM CONCENTRATE STORAGE FACILITY 26
5.2 FOAM STATION 27
5.3 FOAM APPLICATION SYSTEMS 28

6. DRY CHEMICAL SYSTEMS 31

7. GASEOUS SYSTEMS 31
7.1 CARBON DIOXIDE EXTINGUISHING SYSTEM 31
7.2 CLEAN AGENT EXTINGUISHING SYSTEM 31
7.3 NITROGEN EXTINGUISHING SYSTEM 31

8. REFERENCES 32

APPENDICES

APPENDIX 1 EARTH BUNDWALL BASIN FOR FIRE WATER STORAGE 35

APPENDIX 2 LINE-UP OF FIRE WATER PUMPS AND MAINS - FIRE WATER PRESSURE CONTROL 36

APPENDIX 3 TYPICAL SKETCH OF FIRE WATER DISTRIBUTION SYSTEM 37

APPENDIX 4 TYPICAL SPRAY SYSTEM FOR FIRE PROTECTION OF EQUIPMENT 38

APPENDIX 5 TYPICAL AUTOMATED SPRAY SYSTEM FOR FIRE PROTECTION OF EQUIPMENT 39

APPENDIX 6 TYPICAL SPRAY NOZZLE ARRANGEMENT FOR PUMPS 40

APPENDIX 7 TYPICAL SPRAY NOZZLE ARRANGEMENT FOR HORIZONTAL VESSELS AND HEAT EXCHANGERS 41

APPENDIX 8 TYPICAL SPRAY NOZZLE ARRANGEMENT FOR VERTICAL VESSELS AND COLUMNS 42

APPENDIX 9 TYPICAL (FULL COVERAGE) SPRAY SYSTEM FOR SPHERICAL TANKS 43

APPENDIX 10 SPHERICAL TANK SPRAY SYSTEM (FULL COVERAGE) DETAILS 44

APPENDIX 11 TYPICAL HEADER ARRANGEMENT ON TANK ROOF 45

Documents
Document Sharing Hub

Full document details: SHELL 80.47.10.31 0

APPENDIX 12 **TYPICAL SPRAY NOZZLE ARRANGEMENT ON TANK ROOF SUPPLY HEADERS** **46**

APPENDIX 13 **TANK SPRAY NOZZLE TYPICAL ARRANGEMENT** **47**

APPENDIX 14 **TYPICAL FOAM INDUCTION UNITS** **48**

APPENDIX 14.1 **TYPICAL FOAM SKID INCORPORATING WATER DRIVEN PROPORTIONING UNIT** **49**

APPENDIX 15 **FOAM-WATER SPRAY SYSTEM FOR LOADING GANTRIES** **50**

APPENDIX 16 **TYPICAL FOAM CONCENTRATE STORAGE FACILITY** **51**

APPENDIX 17 **TYPICAL FOAM STATION** **52**

APPENDIX 18 **TYPICAL WATER DRENCHING SYSTEM** **53**

APPENDIX 19 **TYPICAL WATER DEFLECTOR FOR WATER DRENCHING SYSTEM** **54**

APPENDIX 20 **TYPICAL PERFORMANCE CRITERIA TEMPLATES** **55**

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Document Sharing Hub

Full document details: SHELL 80.47.10.31 0

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for active fire protection systems and equipment for onshore facilities.

For clarity, a distinction is made between the process of determining and selecting the most appropriate fire protection measure (case-by-case justification of fire safety provisions, including tolerability of risk level) and the hardware requirements (how each fire protection system is to be designed and engineered).

This DEP is intended to be used for the design and engineering of the fire protection systems once the most appropriate fire protection philosophy and fire protection measures for optimising the fire safety of onshore plants have been decided by applying DEP 80.47.10.30-Gen.

Although primarily intended for new construction, this DEP may also be applied for existing plants when fire protection systems need upgrading. When modifications and extensions to existing plants are envisaged, fire protection aspects may be considered and existing facilities improved where necessary.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated January 2010; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to onshore oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

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The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
Active fire protection	A "dormant" fire protection system that needs to be activated in order to perform its function.
Fire safety assessment	The process of analysing and evaluating hazards. It involves both causal and consequence analysis and requires determination of likelihood and severity.
Combustible materials	Materials such as wood, paper, rubber and plastics.
Deluge system	An automated **water spray system** where the water distribution piping is equipped with open spray nozzles for discharging over an area.
Drenching System	A fixed “free-flowing” water discharge device connected by piping to a reliable water source.
High back pressure foam maker	Sometimes called a high backpressure foam generator (HBPG), this foam maker is designed to produce air foam under pressure. This device is required for subsurface and semi-subsurface foam injection.
Fire area	A plant (surface) area where a sustained and intense fire is considered credible.
Fixed foam system	Permanent, complete installation including the foam station, distribution piping, and foam application system.
Flammable product	For this DEP, all liquid hydrocarbon products handled in plants shall be classed as flammable product. See also **combustible product** and **flammability**.
Flammability	NFPA 704 defines flammability as the degree of susceptibility of materials to burning. NFPA 325 identifies the flammability rating of a large number of substances.
Flammable range	The range of flammable vapour or gas-air mixture between the upper and lower flammable limits. Also, incorrectly, referred to as Explosive Range.
Foam maker	Device in which air is mixed with the foam solution to produce the required air foam consistency. A foam maker may be fixed and/or integral to the discharge outlet device, or portable.
Foam station	Permanently located system consisting of a foam concentrate storage vessel, pump(s), water driven proportioner, piping and controls, designed to deliver foam solution to a foam application system.

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Term	Definition
Monitor	Device, normally portable, fixed, trailer-mounted or truck-installed, to which a large throughput nozzle is attached to allow the operator to direct the fire-fighting agent as required.
Mobile equipment	Equipment that can be immediately moved to another location when required.
Over the top Foam System	The discharge of foam into a tank from foam maker(s) situated at or near the tank top. (Also called **Topside foam application)**
Passive fire protection	A fire protection system that performs its function without relying on the requirement of activation.
Prevailing wind	The direction from which the wind is most likely to blow, based on local meteorological observations.
Semi-fixed foam system	Permanent installation consisting of a foam application system connected to distribution piping that terminates at a safe distance. Mobile or portable foam producing equipment shall be transported to the scene and connected to the distribution piping. A foam maker may be part of the portable or permanently installed equipment.
semi-subsurface foam injection	The discharge of foam at the liquid surface in a tank by means of a foldable hose, through a rupture disk from an inlet near the bottom of the tank to avoid intimate contact between foam and the liquid.
Spray system	A fixed pipe system connected to a reliable firewater source and equipped with spray nozzles for discharge directed at a specific piece of equipment or surface area to be protected.
Sprinkler system	A fire protection system consisting of at least one automatic water supply and a distribution piping system equipped with sprinklers for discharge over an area to be protected. Sprinkler system types include wet-pipe, dry-pipe, pre-action, deluge, and combined dry-pipe/pre-action.
Subsurface foam injection	The discharge of foam into a tank near the tank bottom (above the water layer) allowing the foam to travel through the product to the surface.

1.3.3 Abbreviations

Term	Definition
AFFF	Aqueous Film Forming Foam
ANSI	American National Standards Institute
BLEVE	Boiling Liquid Expanding Vapour Explosion
BS	British Standard
CCTV	Closed Circuit Television
DEP	Design and Engineering Practice

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Term	Definition
EDP	Emergency De-pressuring
ESD	Emergency Shut-Down
FAR	Field Auxiliary Room
FGS	Fire and gas system
FIT	First Intervention Team
FM	Factory Mutual
FRED	Fire, Release, Explosion, Dispersion
gpm	US Gallons per minute
HBPG	High Back Pressure foam Generator
HCM	Hazard Consequence Modelling
IPF	Instrumented Protective Function
ISGOTT	International Safety Guide for Oil Tankers and Terminals
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MESC	Material and Equipment Standards and Code
MIL	Military Standard (USA)
NFPA	National Fire Protection Association
NGL	Natural Gas Liquids
ROV	Remotely Operated Valve
TSO	Tight Shut Off
UL	Underwriter's Laboratories

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (8).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2010. The following are the main, non-editorial changes.

Old section	New section	Change
	General	Process safety requirements ("SHALL [PS]") updated
	General	Throughout entire DEP informative wording being deleted and moved to DEP 80.47.10.31-Gen Informative. This has related to reduction in text and sub sections compared to original DEP.
	1.3.3	Abbreviation FGS “Fire And Gas System Added” to be aligned with DEP 32.30.20.11-Gen
	3	Where possible are all Fire and Gas detections System information, design details, further guidance removed from this DEP. For design requirements for fire & Gas detection systems this DEP makes references to DEP 32.30.20.11-Gen
	4.1.1	6th paragraph changed SHALL [PS] into shall

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Old section	New section	Change
	4.1.1	10th paragraph changed SHALL [PS] into shall
	4.1.3 (b)	1st paragraph changed SHALL [PS] into shall
	4.1.4	3rd paragraph changed SHALL [PS] into shall
	4.1.4	6th paragraph changed SHALL [PS] into shall
	4.1.5	UL listed hydrants added as alternative for Shell Standard Drawing Design Hydrants.
	4.1.5	3rd paragraph changed shall into should
	4.1.5	5th paragraph Winterisation added as alternative for burried fire mains.
	4.1.5	10th paragraph changed SHALL [PS] into shall
	4.1.5	11th paragraph changed SHALL [PS] into shall
	4.1.6	5th paragraph changed SHALL [PS] into shall
	4.1.6	14th paragraph changed SHALL [PS] into shall
	4.1.6	17th paragraph changed SHALL [PS] into shall
	4.2.1 (d)	Extra explanation added about filter efficiency
	4.2.1	2nd paragraph changed SHALL [PS] into shall
	4.2.1	6th paragraph changed SHALL [PS] into shall
	4.2.1	11th paragraph changed SHALL [PS] into shall
	4.2.1	12th paragraph changed SHALL [PS] into shall
	4.2.5	8th paragraph changed SHALL [PS] into shall
	4.2.6	11th paragraph changed SHALL [PS] into shall
	4.3	3rd paragraph changed SHALL [PS] into shall
	4.6	2nd paragraph changed SHALL [PS] into shall
	4.6	5th paragraph changed SHALL [PS] into shall
	5.1	1st paragraph changed SHALL [PS] into shall
	5.1	2nd paragraph changed SHALL [PS] into shall
	5.1.1	5th paragraph changed SHALL [PS] into shall
	5.2	3rd paragraph changed SHALL [PS] into shall
	5.2.3	3rd paragraph changed SHALL [PS] into shall
	5.2.4	1st paragraph changed SHALL [PS] into shall
	5.3.1	2nd paragraph changed SHALL [PS] into shall
	5.3.1	4th paragraph changed SHALL [PS] into shall
	5.3.1	4th paragraph changed SHALL [PS] into shall
	5.3.1	7th paragraph changed SHALL [PS] into shall
	5.3.1	7th paragraph changed SHALL [PS] into shall
	5.3.2	2nd paragraph changed SHALL [PS] into shall
	5.3.2	3rd paragraph changed SHALL [PS] into shall

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Old section	New section	Change
	5.3.2	3rd paragraph changed SHALL [PS] into shall
	7.3	1st paragraph changed SHALL [PS] into shall
	Appendix 14	Removed from this DEP, now incorporated in DEP 32.30.20.11-Gen "Fire, gas and smoke detection systems"
	Appendix 14.1	Removed from this DEP, now incorporated in DEP 32.30.20.11-Gen "Fire, gas and smoke detection systems"
	Appendix 15 – Appendix 21	Renumbered due to deletion of Appendix 14 and 14.1

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal http://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

Amended per
Circular 51/11
Dual units have been incorporated throughout this DEP.

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

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2. ENGINEERING, SPECIFICATION, AND INSTALLATION

NFPA 25 should be consulted for guidance on selected details.

For fire protection systems the scope of work and supply shall include the following as a minimum:

2.1 DESIGN AND ENGINEERING SCOPE

a) Preparation of layouts of the system.

b) Determination of the total fire fighting agent requirement for each system.

c) Hydraulic calculations and dimensioning of all piping sections.

d) Preparation of flow diagrams and line designations.

e) Preparation of piping general arrangement drawings.

f) Preparation of piping isometric drawings.

g) Design and requisitioning of all equipment.

h) Mechanical calculations.

i) Design of pipe length of reduced pipe size (if required for pressure reduction).

j) Layout of supports for early co-ordination with Vendors. If equipment to be protected is already at site/installed, special supports shall be designed to avoid welding at site.

k) Pipe supports.

l) Detailed design of the heat/fire detection and alarm system:

- Layouts;
- Single line diagrams;
- Cause and effect diagram (logic diagrams, matrix and write-up);
- Panel layout.

m) Typical engineered information

i. Plot plan(s);

ii. Piping general arrangement drawings;

iii. Equipment layout drawing(s);

iv. Utility engineering flow diagram - fire water system;

v. Firewater distribution system general arrangement drawing;

vi. Equipment list;

vii. Local codes;

viii. Single line wiring diagrams.

2.2 ACCEPTANCE TESTING

After the system has been mechanically completed the Supplier shall arrange a performance test to confirm that the system performs in accordance with the design requirements.

For integrated fire protection systems - single system consisting of equipment from several proprietary Manufacturers - the overall design Contractor shall assume responsibility for the overall integrity and functionality of the integrated system.

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3. DETECTION

For Fire & Gas Detection systems (FGS) design reference is made to DEP 32.30.20.11-Gen Fire, gas and smoke detection systems.

4. WATER-BASED SYSTEMS

4.1 FIRE WATER DISTRIBUTION

Firewater distribution shall be designed such that firewater may be provided at the required flow rate in all plant sections under all credible circumstances. Non-availability of a section of the firewater distribution main shall normally not affect the firewater availability elsewhere in the plant. Distribution systems should be provided with block valves such that sections may be isolated for maintenance.

4.1.1 Storage

(a) General

The fire safety assessment shall determine the storage capacity and sparing philosophy based on the largest credible fire scenario in the installation.

If an uninterrupted supply of firewater from open water, wells, or a third party fire main cannot be guaranteed at the maximum required water flow rate, pressure and duration, a dedicated firewater storage facility SHALL [PS] be provided. In order to allow inspection and maintenance of water storage facilities, the n+1 principle shall be applied for providing temporary or alternate storage (e.g., cooling water basin, additional tank).

Dedicated fire water storage facilities shall be located off plot in an area, normally within the property fence, and SHALL [PS] be located at least 50 m away from fire areas or according to results of HCM in a safe area away from fire hazard area

(b) Design

Firewater storage facilities may be of the closed or open storage type. The choice is determined by economic and local conditions (e.g. available land area and sub-soil conditions).

(i) Closed storage

Metallic fixed roof tanks are normally more cost-effective than closed non-metallic or concrete tanks. Depending on the selected type, closed metallic storage facilities shall be in accordance with:

- DEP 34.00.01.30-Gen. and,
- DEP 34.11.00.11-Gen. and
- DEP 34.28.00.31-Gen. and
- DEP 34.51.01.31-Gen. or DEP 34.51.01.33-Gen

(ii) Open storage

Three types of open storage may be used: membrane-lined earthen bund wall basin (refer to Appendix 1), concrete basin, and metallic tank. Adequate fencing/railing and appropriate life saving equipment shall be provided.

Basins shall be in accordance with:

- DEP 34.00.01.30-Gen. and
- DEP 34.11.00.11-Gen. and
- DEP 30.10.02.13-Gen.

Open metallic tanks shall be built in accordance with 4.1.1 (b) (i).

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A level instrument shall be installed to give a low level alarm in the main control room at 80% of the maximum filling level. At maximum filling level an overflow shall be provided.

Provisions should be considered for injecting water treatment chemicals to control the growth of algae or bacteria like legionella.

The design, particularly of open type storage facilities, shall cater for possible evaporation losses.

The discharge connection(s) on the storage facilities (e.g., suction to fire pumps, replenishment system) shall include easy-to-clean strainers.

In climates where freezing may occur, provisions SHALL [PS] be made to prevent the water becoming frozen. Such provisions should include a combination of circulation, heating and increased storage capacity to compensate for an ice layer of specified maximum thickness.

4.1.2 Pumps and Drivers

(a) General

The fire safety assessment shall determine the pump sparing (i.e., main pump(s) back-up) philosophy (applying the n + 1 principle), the selection of drivers for the pumps, and the maximum flow rate. The avoidance of common mode failures (e.g., fire in the fire water pump house) shall be addressed in the design.

Firewater shall therefore be provided by at least two pumps, each of which is able to supply the largest required flow rate to the firewater distribution system. An alternative with a higher reliability is the installation of three identical pumps, each able to supply 60% of the largest required flow rate.

The selection of the pump drivers is governed by the requirement of maximum reliability of the overall system. This is directly related to the reliability of the associated utility system (power, steam ad fuel supply) and the instrumentation system.

Pumps, drivers, and appurtenances shall be designed and installed in accordance with DEP 31.29.02.11 -Gen. NFPA 20 may be used as guidance unless full compliance to NFPA 20 is required by local authorities.

Where fixed pumps are not justified or practicable from fire assessment, consideration may be given to the use of mobile, containerised or modular pumps and the above considerations regarding reliability and availability shall still apply. Refer to DEP 80.47.10.32-Gen.

Firewater pumps SHALL [PS] be installed in a location that is considered to be safe from the effects of fire and clouds of flammable vapour, and from collision damage by vehicles and shipping. The pumps should be located as close as possible to the firewater storage or alternative water source. Sprinkler systems or deluge systems may be considered for the protection of enclosed pump houses. Heat detection should be considered if detection is required.

(b) Pump Design

The firewater pumps rated pressure shall be based on a minimum pressure of 10 barg at the furthest take-off point on the distribution system, with the highest water flow demand. Individual pump design capacity should not exceed 1000 m^3/h (4400 gpm) unless suitable pump handling and maintenance facilities are available. If the required pump capacity exceeds 1000 m^3/h (4400 gpm), two or more smaller pumps shall be installed, subject to the n + 1 principle.

Firewater pumps shall be of the submerged vertical type if draining from open water, and of the horizontal, between bearings, type if draining from a storage tank.

If a jockey pump is used to keep the distribution system pressurised, it shall be backed up by a spare (installed) jockey pump; each jockey pump shall have a typical capacity of 15 m^3/h (66 gpm) to compensate for leakage. If the jockey pumps are also to be used for providing plant service water, then they shall have a larger capacity that need to be specified by the Principal. If there are significant (e.g., excess of 10 m

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[33 ft]) differences in elevation of sections of the distribution system, the jockey pump and control system shall ensure sections are not left dry or subject to excessive pressures.

(c) Pump Suction and Discharge Piping

Each pump suction should be provided with an easy-to-clean inlet screen with a local differential pressure indication. If individual pump inlet strainers are difficult to maintain, then each pump discharge line shall be equipped with a strainer having a flushing facility. Each pump discharge line shall be fitted with a check valve, pressure gauge and isolation valve. Provisions shall be made to test each pump individually; the test valves shall have a common return line with a flow metering point.

Each pump shall be connected separately to a common manifold (see Appendix 2). The common discharge manifold should be connected to the fire water distribution system by two separate lines, each of the same size as the distribution piping and each equipped with a block valve.

Piping shall comply with DEP 31.38.01.11-Gen.

(d) Driver

The power rating for all the drivers shall be such that it is possible to start each pump against a closed discharge valve with a fire mains pressure ranging between 2 barg (29 psig) and 16 barg (230 psig).

If only electrical firewater pumps are installed, or if electric power is required to start and control diesel-driven firewater pumps, electrical power SHALL [PS] be from the essential supply system (refer to DEP 33.64.10.10-Gen.).

Diesel drivers shall be installed and field inspected in accordance with DEP 31.29.00.10-Gen. and DEP 61.10.08.11-Gen. Diesel storage vessels (fuel tank) shall be constructed in accordance with DEP 30.10.02.11-Gen and NFPA 20. A clutch shall not be installed between a diesel driver and a firewater pump.

(e) Housing

Pumps shall be accessible to facilitate maintenance, and be provided with hoisting facilities in accordance with the requirements of DEP 31.25.00.10-Gen. In locations where freezing can occur, the fire water pumps shall be installed in a heated housing for protection; for other locations, only a rain/sun cover may be required.

4.1.3 Pressure Control

For normally manned installations the firewater pumps shall always be started manually. Manual starting of each firewater pump shall be possible at the pump, from the control centre and, if necessary, from the emergency centre. Manual stopping of each pump unit shall only be possible at the pump.

The control scheme shall be designed in accordance with Appendix 2, so that should the main firewater pump(s) fail to start manually or, having started, fail to build up the required pressure in the firewater distribution system within twenty seconds, the firewater pump(s) designated as the spare or back up shall automatically start.

(a) Normal (Stand-by) Operating Condition

During normal operation, the main fire water pump(s) shall be in the stand-by mode, with either the jockey pump(s) or other pressure source (e.g., static height, cooling water system) maintaining a minimum pressure of 2 barg (29 psig) in the fire water distribution system. In this condition, the pump discharge control valve 100 PCV-101A or 100 PCV-101B (air failure open) is at the minimal stop, while the dump valve 100 PCV-101C (air failure open) is in the closed position.

The Principal may decide that other normal (stand-by) operating conditions are required.

(b) Fire Operating Condition

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When the main firewater pump or the “first main fire water pump” (if more than one main fire water pump is required according to section 4.1.2 (a)) is manually started, 100 PCV-101C shall fully open. To prevent a pressure surge in the main fire water system, the main firewater pump shall only be allowed to start when 100 PCV-101C has reached its fully open position.

If the distribution system pressure does not reach 5.5 barg (80 psig) within twenty seconds after starting of the first main fire water pump, another pulse shall be sent to start the fire water pump designated as the spare or back-up. Thirty seconds (i.e., the time necessary for the valve to open) after the main firewater pump was manually started, controller 100 PIC-101 shall throttle control valves 100 PCV-101A or 100 PVC-101B, and 100 PCV-101C as required maintaining the firewater distribution system pressure at 6 barg (90 psig) to 7 barg (100 psig) This initial set pressure of 6 barg to 7 barg (100 psig) is chosen for personal safety reasons (i.e. for hose handlers and/or other firewater users at the time of pressure increase).

In the central control room, a facility (100 HIC-101) shall be provided to adjust the firewater distribution system pressure. While normally set at 6 barg (90 psig) to 7 barg (100 psig) as noted above, the pressure control system shall be designed allow a manual increase of the fire water distribution system pressure to a maximum of 10 barg unless a higher maximum set pressure is required from a fire fighting point of view to be able to supply firewater at sufficient pressure to specific locations. This higher set pressure shall only to be allowed up to a maximum of 12 barg (175 psig), and only after validation of all components of the fire main system, and only with the approval of the Principal.

The Principal may decide that other fire operating conditions are required.

4.1.4 Pipe and Valves

(a) Pipe or “Ring Mains”

The distribution system shall consist of “ring mains” as detailed in Appendix 3, installed to reach (surround) all processing units, storage facilities for flammable liquids, loading/unloading facilities for road vehicles and rail cars, gas bottle-filling plants, warehouses, workshops, utilities, training grounds, laboratories and offices. The system shall be installed at close proximity to access facilities where fire-fighting equipment can be hooked up. A single firewater line is acceptable for jetties and fire-fighting training ground.

The distribution system design shall provide for a maximum allowable velocity in the firewater piping of 3.5 m/s (11.5 ft/s) to prevent surging at these conditions. The pipe sizes shall be calculated based on design flow rates at a pressure of 10 barg (150 psig) at the take-off points of each appropriate section even if one of the supply sides has been blocked or is out of operation. A check calculation shall be made to prove that pressure drop is acceptable with a blocked section of piping in the system. A surge analysis of the firewater distribution system shall be performed and, where required, surge protection devices SHALL [PS] be provided.

A full bore flushing connection shall be provided in the fire water distribution system if the fire-water quality could result in settlement of silt in the piping, if marine growth is likely, or in cases where corrosion (rust flakes) or erosion (cement particles) products may be formed. The full bore valved flushing connections shall be located so that all sections and dead ends can be properly flushed out. The flushing connections shall be sized for a fluid velocity in the relevant piping of not less than 80% of the velocity under normal design conditions, with a minimum of 2 m/s (6.5 ft/s).

The firewater distribution system components SHALL [PS] be installed underground if located within the 0.15 bar (2.18 psi) over-pressure contour corresponding with an exceedance frequency of 1E-4/yr in plant areas where explosions cannot be excluded unless materials are used that will survive the maximum design explosion overpressure loads. The firewater distribution system components SHALL [PS] be installed underground or alternative winterisation measures are to be installed where

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the ambient temperature can drop below 0ºC (32ºF) for prolonged periods. When installed underground, placement shall be in accordance with DEP 31.38.01.11-Gen and materials of construction should be glass-fibre reinforced plastic (GRP) in accordance with DEP 31.40.10.19-Gen for underground piping. Other materials such as HDPE, lined steel may be used if approved by the Principal

When the firewater distribution system is installed above ground, it shall not be laid in pipe tracks at risk from potential spill fires. In addition, appropriate protection from potential physical damage shall be provided in areas where impact is likely. The material selection for aboveground piping shall be based on the predominant firewater quality.

(b) Valves

Standard (Full) bore isolation valves shall be incorporated in the firewater distribution system so that sections can be isolated for maintenance, etc. These sections shall be selected so that the required quantity of water can still be supplied from other hydrants with fire hoses having a maximum length of 100 m. For fire fighting systems, piping classes 11201 (carbon steel), 17101 and 17120 (GRE), 18011 and 18101 (galvanized carbon steel) are available (see DEP 31.38.01.12-Gen.). The block valves, included in these R&C piping classes, shall be gate valves or butterfly valves and selected as defined in the applicable MESC buying descriptions. Valves should be approved, where practicable, to UL 262 and UL 1091 or in compliance with MESC specifications related to the piping classes for firewater service. When valves are installed in an underground system, it shall be possible to observe whether the valves are in the open or closed position. This shall be indicated by the rising spindles of the valves, or by valves fitted with position indicators.

At the foot of a jetty, manually operated isolation valves shall be provided between the firewater distribution system and the firewater piping on the jetty. The objective is to save the integrity of the firewater distribution system in the event of serious damage to the jetty.

4.1.5 Hydrants

In order to be able to take water from the firewater distribution system at the required location, permanent hydrants shall be installed.

(a) Location

Permanent hydrants shall be located in strategic positions. For this purpose, the spacing shall not exceed:

- Around process units and LPG bottle-filling plants — 60 m (200 ft)
- Loading/unloading facilities and off-site pump stations — 60 m (200 ft)
- Around storage facilities — 80 m (260 ft)
- Alongside pipe tracks — 80 m (260 ft)
- Around storage and pumping facilities for LPG — 60 m (200 ft)
- Around utility areas, offices, workshops, laboratories, jetty approaches, flares, and other areas. — 80 m (260 ft)

Hydrants shall be readily accessible from roads and be located in such a way that possible damage by road traffic will be minimised. They shall be provided with a guard post. The location should not be less than 1.5 m (5 ft) from the curb of the road, and at least 10 m (33 ft) from road crossings, sharp road curves, and buildings or other structures. For processing units/areas, the distance to the nearest hydrant shall not

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exceed 50 metres (165 ft). Each hydrant should be provided with a hard-paved grade (e.g., concrete, asphalt, packed dirt).

Hydrants shall be compatible, wherever practicable, with equipment specified for use by site first intervention team and fire brigade or in use amongst local authority/municipal fire response groups and mutual aid organisations.

(b) Selection

Hydrants each with four outlets shall be provided for in:

- Processing units/areas;
- Loading/unloading facilities;
- LPG bottle filling plants;
- Storage facilities for flammable liquids and LPG;
- Off-site pump stations;
- Jetty heads/berths.

Hydrants with minimum two outlets shall be installed around all other areas, such as:

- Jetty approaches; (if needed)
- Warehouses;
- Workshops;
- Laboratories;
- Offices;
- Utilities.

All hydrants in and around a process plant shall be of the type suitable to mount stationary monitors (see section 4.1.6). This shall also be considered for other specific locations as directed by the fire safety assessment.

The fire safety assessment shall identify if hydrants are to be equipped with a large bore firewater truck connection above the number of outlets specified above.

(c) Design

Each outlet branch shall have a DN 80 (NPS 3), ASME class 150, flat-faced flange, for accommodating a 65 mm (2½ in) hydrant valve. The valve shall be of the angle type, with an angle of 45° between inlet and discharge, suitable for a working pressure of 16 barg (230 psig). The valve outlet shall be provided with a 65 mm (2½ in) coupling in accordance with local standards. The coupling shall point downwards and be fitted with a chained cap. Valves and the valve components shall be as specified in MESC 96.25.10. Recommended coupling types are Storz (which is preferred) and instantaneous - female connection. Alternative types subject to approval by the Principal could be used to give locations flexibility of using similar connections to hydrants that they already have.

Hydrants may need a large bore outlet branch for feeding fire trucks. In areas where large volume fire fighting scenarios may exist, such as storage tank areas, hydrants may need large bore outlet branch(es) allowing high volume water transport. The size and number of high volume outlet branches shall be specified by the Principal.

For expansion of existing installations, or for new construction projects in the neighbourhood of existing installations, couplings shall be of the same type as already applied in these installations. Couplings should also be compatible with the type used by the local fire brigades.

Where freezing can occur, hydrants shall have an automatic bottom drain valve unless local circumstances and or local authorities require other arrangements. The drain

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valves shall have drain holes of minimum size 8 mm (0.31 in) and total free area of at least 200 mm^2 (0.31 in^2). The drains shall be located so that checking for blockage and maintenance is facilitated. The drain openings shall automatically close when the hydrant isolation valve is being opened.

Hydrants shall be in accordance with one of the following Standard Drawings unless otherwise specified by the principal. The minimum alternative design requirements shall use UL listed hydrants.

GRE underground mains	Freezing area	S 88.012
	Non-freezing area	S 88.013

Hydrant header construction shall be in accordance with one of the following Standard Drawings unless otherwise specified by the principal. The minimum alternative design for hydrants shall be UL listed:

Four-way hydrant header	S 88.017
Four-way hydrant header, with monitor connection	S 88.018
Two-way hydrant header	S 88.016

(d) Material specification

Hydrants shall be made from carbon steel; for salt/brackish water internally coated carbon steel pipe shall be used in accordance with DEP 31.38.01.12-Gen.

4.1.6 Stationary monitors

(a) General

The fire safety assessment shall determine the location, the capacity, the area to be covered, the method of operation (i.e., manual or remote-control powered) and the type (i.e., ground level or elevated) of stationary firewater monitors. For general protection purposes, the preferred arrangement is fixed manually operated monitors with adjustable nozzles installed at strategic points around and inside plant areas where fire hazards have been identified. Generally, self-oscillating monitors are not recommended due to their unreliability. The spacing (for a standard 2000 L/min [530 gpm] monitor) should be based on a 50 m (165 ft), 360° water projection with no blockage from adjacent equipment to the fire hazard area.

Where practical, stationary monitors may be installed on firewater hydrants (see 4.1.5). This reduces the number of tie-inn connections to the fire main.

Elevated stationary firewater monitors may be needed to protect congested areas and where obstructions (e.g., at table tops and at jetty heads) prevent the effective use of ground level monitors. Locally controlled elevated monitors can be provided with cable, chain or gear mechanisms to adjust elevation, rotation and nozzle setting. Remotely controlled elevated monitors, when installed, should have a rotation and elevation speed of approximately six degrees/second.

In salt/brackish firewater service or in freeze areas, monitors shall be provided with a connection to drain and flush the normally dry parts of the monitor after testing or use.

(b) Design

Upstream of the mounting flange each monitor shall be provided with a butterfly valve or another type of valve specified by the Principal accessible from grade. For elevated monitors the valve shall be operable from grade and in case an additional valve is installed at the elevated monitor this valve shall be locked or car-sealed open.

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The inlet mounting flange connection shall be ANSI/ASME B 16.5, 150 lbs., Raised Face (RF), DN 100 (NPS 4) for a standard 2000L/min [530 gal/min] monitor. Higher capacity monitors might require larger diameter inlet flanges. .

The typical monitor should have a 65 mm (2 ½ in) threaded connection and be equipped with a constant flow, adjustable stream (i.e., fog to jet) nozzle.

Unless determined differently from the fire safety assessment, the monitors shall be 2000 L/min [530 gal/min] capacity at a working pressure of 10 barg (150 psig). The maximum operating pressure shall be 16 barg (230 psig). At 7 barg (100 psig) inlet pressure, the fire water **jet stream** at 30° elevation should reach 50 m (165 ft) and have a footprint of 4 m x 6 m (13 ft x 20 ft) with 80 % of the total water flow reaching the footprint. At the same inlet pressure [7 barg] (100 psig) water **fog stream** at 30° elevation and 30° nozzle position shall reach 18 m and have a footprint of 7 m x 8 m (23 ft x 26 ft) with 80 % of the total water flow reaching the footprint.

The monitor shall have a horizontal traverse of 360° and a vertical elevation of 15° below to 85° above horizontal. For elevated monitors these figures may be replaced by respectively 75° and 45°. Monitors shall be provided with the ability to lock the traverse and elevation in any chosen position.

All moving parts shall be fully protected / enclosed against ice and dirt.

(c) Material specification

The monitor and nozzle shall have adequate corrosion resistance for the environmental conditions and firewater quality used. Acceptable materials are: (Other materials may be specified by the Principal)

Part	Material (typical)
Monitor (stationary part)	Carbon steel (with minimum 400 μm (1300 μft) internal epoxy coating for protection against seawater)
Turret	Nodular cast iron, bronze
Gears	Aluminium bronze
Lever	Austenitic stainless steel (e.g., type 304)
Water nozzle	Brass
Foam nozzle	Austenitic stainless steel (e.g., type 316L)

With the exception of stainless steel, all outside surfaces shall be painted with two coats of amine cured epoxy paint with a red topcoat (RAL 3000). (Refer to DEP 30.48.00.31-Gen.).

(d) Remote control

Remote-control power-operated monitors shall be electrically powered from the essential electrical supply (e.g., typical max. power consumption 1 kW) (refer to DEP 33.64.10.10-Gen.). As a minimum, the equipment and operating panel shall be suitably rated to operate in a hazardous zone 2 environment.

The operating panel shall be located upwind of the prevailing wind direction and at least 50 m (165 ft) away from the fire hazard / consequence area. The operator shall have a good sight of the area. A secondary panel may be installed in the control room when there is a CCTV system provided.

The panel shall be provided with:

a) Power on/off switch (incl. status lights), and for foam/water monitors:

b) Joystick for integrated rotation and elevation, incl. position indicator(s);

c) Push buttons for "jet"/"fog" or deflector control, incl. position indicator;

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d) Switch for opening water supply valve, incl. "open/closed" position indicator;

e) Switch for opening the foam solution inlet valve, incl. "open/closed" position indicator;

f) Reset (stop) button;

g) Individual failure alarm indication for rotation, elevation and jet/fog control motors;

h) Maintenance override.

Where electrical and instrumentation cables run through the fire area they shall be protected against the effect of such a fire. This can be achieved by running them underground, by using fire resistant cables, or by enclosing them in fire resistant cable ducting.

4.1.7 Dry Risers

The fire safety assessment shall determine the need and location of dry riser installations. When specified, the riser shall be installed in or adjacent to the stairway (e.g., main, alternate, and emergency access routes). At the ground floor level of the riser(s), a two-way flapper valve ("collecting breeching") shall be permanently installed. On each floor above (and below) the ground floor, two connections should be provided, each having a hydrant valve and hose connections as detailed in (4.1.7) located 0.7 m (2 ft) above the floor. An automatic vent shall be installed at the riser(s) highest point.

Dry risers should be made from flanged carbon steel pipe to be hot-dip galvanised after fabrication or another non-corrosive material specified by the Principal.

4.2 FIRE WATER SPRAY SYSTEMS

4.2.1 General

The fire safety assessment shall determine which equipment is to be protected by a water spray system, the method of protection, and the amount of protection. All spray system shall be provided with local operation. Depending on the fire risks, spray systems may also be provided with remote (e.g., control room) operation.

(a) Hydraulics

The design of a water spray system shall be based on hydraulic calculations to determine the required pressures and corresponding water quantities of the spray nozzles. The calculations shall be submitted to the Principal for approval.

The normal working pressure shall be established at the point of off-take under conditions of maximum water consumption, i.e. for the fire case. The pressure should be at least 10 barg (150 psig). Pressure spikes/surges may occur during initial admission of water into a "dry" section of water spray systems. The magnitude of such pressure spikes/surges shall be investigated and, if critical, special measures shall be taken (e.g. excess flow control, etc.).

The systems shall be designed in such a way that the required pressure for the best operation of the spray nozzles is achieved by adequate dimensioning of the piping without the use of restriction orifices. The on-off control valve, filter etc. shall be factored into the calculation. If there is still a pressure reduction required, a calculated length (max. 2 m [6.5 ft]) of small-bore piping shall be installed downstream of the on-off control valve and the manually operated block valve. The spool material should be Monel 400, flanged and having a minimum size of DN15 (NPS ½).

In all cases a detailed layout shall be made of the equipment and areas to be protected on which the arrangement of the spray nozzles shall be shown. For this purpose the plant's piping model shall be used. Alternatively, in exceptional cases, the relevant piping general arrangement drawing may be used.

(b) Connection to distribution system

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A water spray system shall have two separate connections to two different sections of the firewater distribution system. In case of remote operation one of the connections shall be equipped with an on-off control valve (see section (e) below); the other connection shall be a standard manually operated valve. Both valves shall, if possible, be installed upwind of the prevailing wind direction. The on-off control valve shall be at least 15 m (50 ft) from the water spray system. The manual valve shall be safely accessible under the prevailing fire scenario, and should typically be located 30 m (100 ft) away from the spray system. At both connections, a filter (see (d) below) shall be provided (i.e., a shared filter or one per connection).

Piping shall be flanged for all sizes. Where salt/brackish water is used, the flanged cross-over piping from underground to above ground and piping to the on-off control valve and manually operated valve, shall be internally coated; preferably by epoxy paint (minimum 400 μm [1300 μft] dry film thickness) or alternatively by cement lining.

In locations susceptible to freezing, electrical trace heating shall be considered. If the fire safety assessment indicates that heat tracing is required, it shall be applied in accordance with DEP 33.68.30.32-Gen.

(c) Spray system piping

Horizontal "dry" piping, downstream of the on-off control valve and the manually operated valve, shall be installed with a slope of 1:200 or steeper. At a minimum, low point drains on the piping, weep-holes on the spray headers, and automatic drain valves at selected locations on the system shall be provided. Where the fire water quality necessitates frequent flushing and cleaning of the spray system, a DN 80 (NPS 3) branch with valve and DN 65 (NPS 2 ½) hose coupling shall be provided at each fire water supply side (downstream of the on-off control valve and the manually operated valve).

All overhead piping should be well supported and fixed to prevent deflection and vibrations. When supported from grade, the supports shall be fireproofed if structural redundancy cannot be incorporated to withstand fire exposure.

Piping shall be galvanised, in accordance with DEP 31.38.01.12-Gen. piping class 18011. In exceptional cases where it is envisaged that the orientation of the water spray nozzles will require adjustment after installation, screwed double elbows may be provided.

(d) Filter

Filters shall be of a bucket-type design, with a retractable insert. Each filter shall have a minimum capacity of 800% of the nominal inlet-piping diameter.

The filter openings shall be at least 50% of the size of the smallest spray nozzle orifice opening to be used, with a maximum of 4 mm (0.16 in) diameter.

The filter housing shall be carbon steel; for use in salt/brackish water it shall be internally epoxy coated (min. 400 μm [1300 μft]). Filter element material to be stainless steel (316L) or Monel 400.

(e) Valves

The on-off control valve or manually operated valve shall be an UL-1091 listed butterfly valve or in compliance with MESC specifications related to piping classes for firewater service. The valve shall be tight shut off (TSO: Class V or VI according to IEC 60534-4) in the forward direction against a maximum pressure of 16 barg (230 psig). The control valve shall fully open within 10 seconds. Refer to DEP 32.36.01.17-Gen. for control valves and DEP 31.37.00.11-Gen. for instrument air requirements.

(f) Spray nozzles

Medium velocity, full cone, open-type spray nozzles with external deflectors shall be fitted. **Internal strainers are not permitted** as they can block the nozzle during operation. Recommended operating range is between 2 barg (30 psig) and 3.5 barg (50 psig). The orifice diameter of the nozzles shall not be smaller than 8 mm (0.31 in).

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