

DEP SPECIFICATION

ACTIVE FIRE PROTECTION SYSTEMS AND EQUIPMENT FOR ONSHORE FACILITIES

DEP 80.47.10.31-Gen.

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DESIGN AND ENGINEERING PRACTICE

DEM1



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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) as defined and documented by the fire safety assessment, refer to DEP 80.47.10.30-Gen.
- the hardware requirements (how each fire protection system is to be designed and engineered) that is the scope of this DEP.

Although primarily intended for new construction, this DEP may also be applied for existing facilities 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 February 2015; 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 shall 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.

The word **shall** indicates a requirement.

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

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.



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.
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.
Fire Area	A plant (surface) area where a sustained and intense fire is considered credible.
Fire Safety Assessment	Process of analysing and evaluating fire hazards. It involves both causal and consequence analysis and requires determination of likelihood and risk. This can be both a quantitative as well as a qualitative assessment based upon experienced based rule setting.
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.
Freeze Areas	Locations where the design ambient temperature ranges to below 0 °C (32 °F) for prolonged periods.
Hazard Consequence Modelling (HCM)	Use of mathematical models to estimate the effect of explosions, fires and dispersion.
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.

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 Topsides 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 is 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	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 <u>specific</u> 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
AC	Accidentally Contaminated
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
EDP	Emergency De-pressuring
ESD	Emergency Shutdown
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, now known as SIF (Safety Instrumented 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

Term	Definition
TSO	Tight Shut-Off
UL	Underwriters Laboratories

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause 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 full revision of the DEP of the same number dated February 2015. The change in this revision are extensive and too numerous to list here however the primary work has been to restructure and clarify requirements, enforced use of shall/should /may for normative statements.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
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DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

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.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. ENGINEERING, SPECIFICATION, AND INSTALLATION

2.1 GENERAL

1. NFPA 25 should be consulted for guidance on selected details.
2. If performance criteria templates are required by the project specifications, refer to DEP 80.47.10.12-Gen.

2.2 DESIGN AND ENGINEERING SCOPE

1. The design and engineering scope shall include the following:
 - a. Preparation of layouts of the system.
 - b. Determination of the total firefighting 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 should be designed to avoid welding at site.
 - k. Design of Pipe supports
 - l. Detailed design of the heat/fire detection and alarm system:
 - m. Layouts.
 - n. Single line diagrams.
 - o. Cause and effect diagram (logic diagrams, matrix and write-up).
 - p. Panel layout.
2. Engineered information shall include:
 - a. Plot plan(s).
 - b. Piping general arrangement drawings.
 - c. Equipment layout drawing(s).
 - d. Utility engineering flow diagram - fire water system.
 - e. Firewater distribution system general arrangement drawing.
 - f. Equipment list.
 - g. Local codes.

2.3 ACCEPTANCE TESTING

1. After the system has been mechanically completed, the Manufacturer/Supplier shall arrange a performance test to confirm that the system performs in accordance with the design requirements.
2. For integrated fire protection systems (single system consisting of equipment from several proprietary manufacturers), the Contractor shall be responsible for the overall integrity and functionality of the integrated system.

3. DETECTION

1. For design of Fire and Gas Detection systems (FGS), refer to DEP 32.30.20.11-Gen.

4. WATER-BASED SYSTEMS

4.1 FIRE WATER DISTRIBUTION

4.1.1 General

1. Firewater distribution shall be designed to provide firewater at the designed flow rate and pressure in all plant sections under all credible circumstances as defined by the fire safety assessment.
2. Non-availability of a section of the firewater distribution main shall not affect the firewater availability elsewhere in the plant where a ring main system is required.
3. Distribution systems shall be provided with block valves such that sections may be isolated for maintenance.

4.1.2 Storage

4.1.2.1 General

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

1. 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 be provided.
 - a. 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).
2. Dedicated fire water storage facilities shall be located outside the main processing areas in an area within the property fence.
 - a. The fire water storage shall be located at least 50 m away from fire areas or in a safe area away from fire hazard area according to results of a HCM.

4.1.2.2 Design

1. Firewater storage facilities may be of the following types:
 - a. membrane-lined earthen bund wall basin (refer to Appendix A);
 - b. concrete basin;
 - c. metallic tank.

The choice is determined by economic and local conditions (e.g., available land area and sub-soil conditions).
2. A level instrument shall be installed to give a low level alarm in the main control room at 80% of the maximum filling level.
3. An overflow shall be provided at the maximum filling level.
4. Provisions should be made for injecting water treatment chemicals to control the growth of algae or bacteria such as legionella.
5. The design, particularly of open type storage facilities, shall cater for evaporation losses.
6. The outlet connection(s) on the storage facilities (e.g., suction to fire pumps, replenishment system) shall include strainers.
7. In freeze areas, provisions shall be made to prevent the water becoming frozen.
 - a. Such provisions should include a combination of circulation, heating and increased storage capacity to compensate for an anticipated maximum ice layer.
8. Refer to DEP 34.51.01.31-Gen. or DEP 34.51.01.33-Gen for metallic storage facilities:

Metallic fixed roof tanks are normally more cost-effective than closed non-metallic or concrete tanks.
9. Refer to DEP 34.11.00.11-Gen. for basins.
10. Basins shall be impermeable.

4.1.3 Pumps and Drivers

4.1.3.1 General

The fire safety assessment will determine the pump sparing requirements, including the backup philosophy (applying the $n + 1$ principle) for:

- *for the main pump(s)*
 - *the selection of drivers for the pumps,*
 - *the maximum flow rate.*
 - *Sparing philosophy*
 - *Common failure modes.*
1. The pump driver selection shall be based on the specified overall system reliability.
This is directly related to the reliability of the associated utility system (power, steam and fuel supply) and the instrumentation system.
 2. Refer to DEP 31.29.02.11-Gen. for the selection of pumps, drivers, and auxiliaries (e.g. battery back-ups, instrumentation).
 3. Mobile, modular or containerised pump sets, driven by diesel, electric or hydraulic means may be used where fixed pumps are not justified or practicable from fire assessment.
 - a. The considerations regarding reliability and availability shall still apply to these type installations.
 - b. Refer to DEP 80.47.10.32-Gen.

4.1.3.2 Pump Design

1. 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.
2. Individual pump design capacity should not exceed 1000 m³/h (4400 gpm) unless handling and maintenance facilities are available.
 - a. If the required pump capacity exceeds 1000 m³/h (4400 gpm), subject to the n + 1 principle two or more smaller pumps shall be installed.
3. Firewater pumps shall be:
 - a. of the submerged vertical type if taking suction from open water, and
 - b. of the horizontal, between bearings, type if taking suction from a storage tank.

This requirement does not apply to mobile, modular or containerised pump sets, driven by diesel, electric or hydraulic means (4.1.3.1, Item 3).
4. If a jockey pump is used to keep the distribution system pressurised, it shall be backed up by a spare (installed) jockey pump, unless the required pressure and capacity can be made available via other means within 48 hours (e.g. spares from warehouse, mobile unit, or alternative water stream).
 - a. The minimum capacity of each jockey pump shall be 15m³/hr (66 gpm) to compensate for leakage.
 - b. If the jockey pumps are also to be used for providing plant service water and/or they are also used for testing the active fire protection systems, then they should have a larger capacity, subject to approval by the Principal.
 - c. If there are significant (e.g., excess of 10 m [33 ft.]) differences in elevation of sections of the distribution system, the jockey pump and control system shall ensure sections are:
 - i. not left dry;
 - ii. subject to over pressures.

4.1.3.3 Pump Suction and Discharge Piping

1. Refer to NFPA 20 for pump suction and discharge piping design.
2. Each pump shall be connected separately to a common manifold (see Appendix B).
 - a. 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.
3. For piping refer to DEP 31.38.01.11-Gen.

4.1.3.4 Driver

1. 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).
2. 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.).
3. For Diesel drivers installation refer to DEP 31.29.00.10-Gen. and DEP 61.10.08.11-Gen.
4. A clutch shall not be installed between a diesel driver and a firewater pump.
5. For Diesel storage vessels (fuel tank) construction, refer to DEP 30.10.02.11-Gen and NFPA 20.

4.1.3.5 Housing

1. Refer to DEP 31.25.00.10-Gen for pump hoisting requirements.
2. In freeze areas, the fire water pumps shall be installed in a heated housing for protection.
 - a. For other locations, only a rain/sun cover should be provided.

4.1.4 Pressure Control

4.1.4.1 General

1. For manned installations, the firewater pumps should always be started manually.
2. Manual starting of each firewater pump shall be possible:
 - a. at the pump;
 - b. from the control centre;
 - c. and, if necessary, from the emergency centre.
3. Manual stopping of each pump unit shall only be possible at the pump.
4. The control scheme shall be designed in accordance with Appendix B,
Application of the requirements in Appendix B will ensure that if 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 will automatically start.

4.1.4.2 Normal (Stand-by) Operating Condition

1. 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 (fail open) is at the minimal stop; while the dump valve (fail open) is in the closed position.
2. Other normal (stand-by) operating conditions required are subject to approval by the Principal

4.1.4.3 Fire Operating Condition

1. When the main firewater pump or the “first main fire water pump” (if more than one main fire water pump is required according to (4.1.3.1)) is manually started, dump valve shall be fully open.

To prevent a pressure surge in the main fire water system, the main firewater pump will only be allowed to start when dump valve has reached its fully open position.

2. 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, the fire water pump designated as the spare or back-up shall be started.
 - a. Thirty seconds (i.e., the time necessary for the valve to open) after the main firewater pump was manually started, controller shall throttle control valves, as required, maintaining the firewater distribution system pressure between 6 barg (90 psig) and 7 barg (100 psig).

This initial set pressure of 6 barg to 7 barg (100 psig) is chosen for safety of personnel (i.e. for hose handlers and/or other firewater users at the time of pressure increase).

3. In the central control room, a facility shall be provided to adjust the firewater distribution system pressure.
 - a. While normally set at 6 barg (90 psig) – 7 barg (100 psig), the pressure control system shall be designed to allow a manual increase of the fire water distribution system pressure to a maximum of 10 barg (145 psig).
 - i. If all components of the fire main system is designed and approved by the Principal, this set pressure may be increased to a maximum of 12 barg (175 psig).
4. Other pump fire operating conditions required are subject to approval by the Principal.

4.1.5 Pipe and Valves

4.1.5.1 Pipe or Ring Mains

1. The distribution system shall consist of ring mains as detailed in Appendix C, installed to cover:
 - a. all processing units,
 - b. storage facilities for flammable liquids,
 - c. loading/unloading facilities for road vehicles and rail cars,
 - d. gas bottle-filling plants,
 - e. warehouses,
 - f. workshops,
 - g. utilities,
 - h. training grounds,
 - i. laboratories
 - j. offices.
2. Refer to (Appendix C) for typical system.
3. The distribution system shall be installed within the specified distance to access facilities where fire-fighting equipment can be hooked up.

The specified distance can be found within the NFPA requirements.
4. A single firewater line should be acceptable for jetties, fire-fighting training ground and low fire risk areas.
5. The distribution system design shall provide for a maximum allowable velocity in the firewater piping of 3 m/s (10 ft./s), to prevent surging conditions.
 - a. The pipe sizes shall be calculated based on design flow rates at a pressure of 10 barg (145 psig) at the take-off points of each section even if one of the supply sides has been blocked or is out of operation.
 - b. A check calculation shall be made to prove that pressure drop is acceptable with a blocked section of piping in the system.
6. A surge analysis of the firewater distribution system shall be performed.
 - a. Surge protection devices shall be provided as per the requirement of surge analysis.
7. A full bore flushing connection should 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.
 - a. The full bore valve flushing connections should be located so that all sections and dead ends can be properly flushed out.
 - b. The flushing connections should 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).
8. 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.

Firewater distribution system may be installed above ground where piping and its will survive the design accidental loads (Explosion overpressure).

9. In freeze areas, the firewater distribution system components shall be installed underground below the frost zone or provided with alternative winterisation measures.
10. Refer to DEP 31.38.01.11-Gen for underground and installation of the distribution piping.
11. Refer DEP 31.40.10.19-Gen for the materials of construction of the distribution piping.
 - a. Other materials such as HDPE lined steel may be used subject to approval by the Principal.
12. When the firewater distribution system is installed above ground, it shall not be laid in pipe tracks at risk from potential pool fires.
13. Necessary protection from potential physical damage shall be provided in areas where impact is likely (e.g. impact by vehicles).
14. The material selection for above ground piping shall be based on the predominant firewater quality.

4.1.5.2 Valves

1. Standard (full) bore isolation valves shall be incorporated in the firewater distribution system so that sections can be isolated for maintenance.
2. Isolatable 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 (330 ft.).
3. Refer DEP 31.38.01.12-Gen for piping class related to various materials used for firefighting system.
4. The block valves shall be gate valves or butterfly valves and selected as defined in the applicable MESC buying descriptions.
5. Valves should be either:
 - a. listed in accordance with UL 262 and UL 1091;
 - b. approved in accordance with ISO 7259 and ISO 10631;
 - c. in compliance with MESC specifications related to the piping classes for firewater service.
6. The position of the valves shall be indicated by the rising spindles of the valves, or by valves fitted with position indicators.
7. 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.

4.1.6 Hydrants

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

4.1.6.1 Location

1. Permanent hydrants shall be located as defined by the fire safety assessment.
 - a. The spacing should not exceed as listed in Table1

Table 1: Hydrant Spacing Requirements

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.)

2. Hydrants shall be accessible from roads and protected from damage by impact from the road traffic.
 - a. Hydrants shall be provided with a guard post.
 - b. The location of the hydrant 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.
 - c. For processing units/areas, the distance to the nearest hydrant shall not exceed 50 metres (165 ft.).
 - d. Each hydrant should be provided with a hard-paved grade (e.g., concrete, asphalt, packed dirt).
3. Hydrants shall be compatible with:
 - a. equipment specified for use by site first intervention team and fire brigade or
 - b. equipment specified for use by in use amongst the local authority/municipal fire response groups and mutual aid organisations.