



RP 24-2

FIRE PROTECTION - OFFSHORE

February 1995

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SCOPE AND PURPOSE This Recommended Practice gives advice for development of an appropriate philosophy for life saving and limitation of Business Losses arising from fires in offshore plant. It discusses methods for identification, characterisation and quantification of hazards. It also gives technical requirements for active and passive fire protection systems.											
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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory Volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory Volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Recommended Practice

An approach for accurate determination of active fire protection systems at an early project development stage has been developed. Areas requiring passive fire protection can be readily determined using the recommended methods.

Application

Text in *italics* is Commentary. Commentary provides background information which supports the requirements of the Recommended Practice, and may discuss alternative options. It also gives guidance on the implementation of any 'Specification' or 'Approval' actions; specific actions are indicated by an asterisk (*) preceding a paragraph number.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Principal Changes from Previous Edition

Fire protection requirements were previously split between two documents covering active (BP CP 15) and passive (BP CP 16) fire protection, for both onshore and offshore facilities.

Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSE's, to assist in the process of their continuous improvement.

For feedback and further information, please contact Standards Group, BP International or the Custodian. See Quarterly Status List for contacts.



1. SCOPE

- 1.1 This Recommended Practice shall be applied to the design of all new offshore installations and used for assessment and modification of existing facilities. It specifies BP requirements for the design of active and passive fire protection systems for offshore facilities, utilising fire hazard assessments whereby credible risks to life, investment and production can be addressed. It matches fire protection to the potential fire hazard it protects, based on BP's operating experience.
- 1.2 Part 1 addresses hazard identification, minimisation and assessment. It addresses the appropriate choice of active and passive fire protection measures to contain and, where practicable, extinguish potential fires.
- 1.3 Part 2 addresses additional considerations specific to areas and gives guidance on the choice of exposure protection, taking into account fire type and equipment or structure to be protected
- 1.4 Part 3 addresses the technical requirements for selection of active and passive fire protection systems. This part of the document is intended for use with appropriate design guides and codes, e.g. BS, NFPA.
- 1.5 This Recommended Practice does not cover explosion hazards.
- The Steel Construction Institute interim guidance notes provide some useful information.*
- 1.6 Recommendations for onshore facilities are given in BP Group [RP 24-1](#).
- 1.7 The design philosophy for fire and gas detection and control systems is set out in BP Group [RP 30-7](#). Design of these systems should proceed in parallel with the development of fire protection requirements.
- 1.8 *The approach taken in this Recommended Practice is analogous to hazard management as outlined in [ISO/WD 13702](#) and the UK00A guidance on fire and explosion hazard management, emergency response and evacuation. Note that at the time of preparation of this Recommended Practice, those documents were in draft form only.*
- 1.9 This document is aimed at the following persons:-
- *Design Managers. To promote the integration of all design disciplines in order to ensure full and optimum management of all hazards.*
 - *Process, control and layout disciplines. To optimise their designs to minimise the frequency and scale of fire hazards.*
 - *Hazard Analysts. To identify and quantify fire hazards in a form that can be used by discipline engineers and operators.*
 - *Loss Control/Fire Protection Engineers. To design operable fire protection systems to match the identified fire hazards and consequences.*



- *The Operator. To provide input to the design to ensure that the hazard management strategies and systems are acceptable and comply with the operations and maintenance philosophy.*

2. FIRE HAZARD MANAGEMENT PHILOSOPHY

2.1 General

- 2.1.1 Fire hazards shall be managed to minimise personnel exposure, preserve life, minimise injury and limit business losses arising from fires which could reasonably be anticipated.

This Recommended Practice should be used in conjunction with BP Group RPSEs for fire and gas detection, formal safety assessments and other guidelines.

- 2.1.2 Each installation shall have a fire hazard management philosophy which shall be developed at the design concept stage.

The philosophy will require the:-

- (a) Identification of fire hazards at an early stage in design.
- (b) Selection of a strategy to deal with the hazards.
- (c) Optimisation of the design to minimise frequency, scale and consequence.
- (d) Provision of systems to control the hazards.
- (e) Implementation of the strategy and maintenance of the systems.
- (f) Updating of the strategy throughout the life of the installation.

This should be developed as a Fire and Explosion Hazard Management Plan (FEHMP) which is agreed with the operator of the installation, fully documented and included in the operating procedures.

The recommended fire hazard management process is shown, in a simplified form in Figure 1 and in detail in Figure 2. It requires that all major fire hazards are identified and quantified, and that a strategy is chosen for each hazard.

Since hydrocarbon releases are hazardous as potential fuels for both fires and explosions, it is sensible to embrace both aspects in the FEHMP. However this Recommended Practice does not advise on the specific design requirements for explosion hazards (see 1.5).

2.1.3 The choice of a particular strategy should be made at an early stage when it is still possible to optimise the design, to minimise the hazards and take due credit for these features before committing expenditure on extensive protection. This approach will achieve full integration of prevention, protection and mitigation of all fire hazards.

The possible strategies are:-

- (a) Fire Prevention.
- (b) Fire containment and prevention of escalation. (i.e. minimisation)
- (c) Acceptance of consequential damage.
- (d) Evacuation.

Each of these chosen strategies requires the provision of measures to manage the hazard, and at each stage, cost effectiveness must be considered. These measures will be a combination of prevention and control to minimise the frequency, scale, intensity and duration of the hazard and mitigation to protect personnel and critical equipment. These measures will be identified and specified by the designer to suit the type, scale and frequency of the perceived hazard. They will be included in the plan as it develops during the project and ultimately handed over to the Operator as part of the operating procedures.

2.1.4 The chosen strategies shall aim to reduce the risks to personnel on the installation to as low as reasonably practicable (ALARP). They should also address the need to prevent escalation to a major environmental incident. They shall, as a minimum, meet the client/operator and national targets for individual risk and major accident frequency.

Considerable asset protection will result from any personnel protection provisions. Further specific asset protection should only be provided following a request from the client/operator and may be subjected to a cost benefit analysis (CBA).

2.1.5 A fire risk analysis shall examine the chosen strategies to independently verify that the measures are adequate. It should also be a formal review of the strategy to ensure that all hazards have been identified and that the quality of the FEHMP is acceptable.

2.1.6 The plan should be handed over to, and subject to acceptance by, the client/operator who will modify and update it as necessary throughout the installation life.

2.2 *Benefits*

2.2.1 *General*



This approach provides protection which is matched to the fire hazards and consequences and identifies the 'design case'. This places obligations on the Operator to ensure that the chosen strategy and associated facilities are maintained in an operative condition.

2.2.2 *Implications for Capital Investment*

This approach should ensure that the optimum combination of prevention control and mitigation measures is chosen, eliminating unnecessary systems and selecting the most cost effective way of managing each hazard.

2.2.3 *Implications for Operators*

A clear strategy is put in place for each hazard and all the thinking behind it. The systems required to implement it and performance standards for each prevention, control and mitigation measure, are documented and handed over from a project. This allows effective hazard management to be documented.

The requirements for procedural controls, maintenance, inspection and test as developed during design and construction would therefore be transmitted to the Operator.

2.2.4 *Implications for Passive Fire Protection*

Areas requiring passive protection are more easily identified and unnecessary protection can be avoided.

2.2.5 *Implications for Active Fire Protection*

The approach described in this Recommended Practice has the benefit of determining more accurately the information upon which fire water requirements are based. This occurs at an early design stage and requires assessment of potential fires, which are chosen as the design case in individual risk areas, and matching the protection to them. It is more realistic than the traditional Reference Area method and does not require arbitrary correction factors.

2.3 Caution on the use of this Procedure

Since the hazard management approach is based on different assumptions from the Reference Area method, the two techniques should not be used in combination.

The Reference Area method of determining active protection for hydrocarbon areas uses prescriptive water application rates which are pre-defined regardless of the hazard addressed. One result of this type of approach may be the over or under design of water systems. The Hazard Management approach, which matches fire protection closely to the fire risk, leads to more effective protection and a more effective design.

PART 1 - HAZARD IDENTIFICATION AND ASSESSMENT/SELECTION OF DESIGN CASE

3. HAZARD IDENTIFICATION AND LISTING

3.1 Identification

Identification of hazards shall be approached on a formalised basis. Any attempt to assess hazards unsystematically may cause concentration on certain risks to the exclusion of others.

The installation shall be divided into areas and if necessary sub areas. External areas, e.g. lay down areas, where there could be a significant permanent or transient hazard e.g. ATK transit tank shall be included. For each area a Fire Risk Analysis (FRA) Report shall be prepared.

The Fire Risk Analysis (FRA) shall establish all hydrocarbon inventories and the valving arrangements in order to identify the major isolatable inventories, source, fire type, combustible material, pressures etc. This information can be presented in tabular form as shown in Table 1. If an identified hazard can impact upon other equipment or areas then it shall also be listed as shown in the example entry in Table 2.

Special note shall be made of instances where fires may be preceded by an explosion (the initiating event) which may cause larger/multiple releases and fires or structural damage. Fires and explosions in other fire areas which can affect the area in question shall also be considered.

3.2 Information Sources

An assessment of this type requires installation design information which may be available from:-

- (a) Hazardous area drawings.
- (b) Plot plans, including equipment lists.
- (c) P&ID's, e.g. main process area, separation area, wellhead etc.
- (d) Process data sheets.
- (e) Plot plans of escape routes.
- (f) Process flow diagrams.

- (g) Key operating procedure details.
- (h) HVAC philosophy.
- (i) Well fluid characteristics, e.g. composition, pressure.
- (j) Drilling Programme.
- (k) Anticipated production profile and variations.

In the early stages of design, some of the information may only be available in provisional form.

3.3 Fire Types

Different types of fire should be considered:-

- (a) Flash from gaseous hydrocarbons
- (b) Jet from gaseous hydrocarbons
- (c) Jet/Spray from high pressure liquid hydrocarbons
- (d) Pool from low pressure liquid hydrocarbons
- (e) Boiling liquid expanding vapour explosion (BLEVE)
- (f) Electrical
- (g) Cellulose
- (h) Fire resulting from an explosion.

Fires may be described in a number of ways. Within this document the following definitions have been assumed:-

3.3.1 Flash Fire

A flash fire occurs when the combustion of a flammable liquid and vapour results in a flame which passes through the mixture at less than sonic velocity such that damaging overpressures are negligible.

3.3.2 Jet Fire

A jet fire is a stable jet of flame produced when a high velocity discharge catches fire. The flame gives off little smoke as a considerable amount of air entrainment takes place during discharge.

3.3.3 Jet/Spray Fire.



The understanding of the fire characteristics of pressurised liquid releases is limited. It is known that the proportion of the release which will burn as a jet or spray increases with the pressure and the volatility of the liquid. In the absence of more accurate data, the following may be taken as default pressures above which all the liquid burns as a spray. Below these pressures some or all of the release may burn as a pool.

(a) Condensate: 2 bar g

(b) Light Oil: 4 bar g

(c) Heavy Oil: 7 bar g

Note that under some circumstances a pool fire may be preceded by a jet/spray fire as the plant or process sections depressurise. Under these circumstances jet fire protection should be specified if the pressure quoted above can last longer than 10 minutes. Gas/oil jet fires produce more smoke than either gas or gas/condensate fires and can feed pool fires.

3.3.4

Pool Fire

A pool fire involves the combustion of hydrocarbons evaporating from a layer of liquid. It may occur within a clearly defined boundary, e.g. the bunding below a vessel. It may also be unconfined and the spread then depends on numerous factors such as the nature of the surface, the presence of drains and the presence of water surfaces. The flames are often accompanied by large quantities of smoke with both flames and smoke orientated downwind.

3.3.5

Boiling Liquid Expanding Vapour Explosion (BLEVE).

In some cases where hydrocarbon containing vessels become very hot in a fire situation and then fail with a resulting loss of containment, the expanding burning vapour results in a BLEVE.

4. SELECTION OF FIRE HAZARD MANAGEMENT STRATEGY/ DESIGN FIRE CASES

4.1 General

A strategy is required for every major fire hazard on an installation. The options are detailed in section 2.1.3.

The client must decide at the beginning of a project if the strategy should only address the preservation of life and the environment or include investment protection.

The selection of the strategy will depend on two considerations; the scale of any incident and the practicality of implementing it. It may also be necessary to review the selected strategy at various points in the design (such as the concept safety evaluation) to verify it is viable. It is preferable and more cost effective to specify prevention measures than mitigating.

4.2 Fire Prevention

There are some potential events, such as uncontrolled riser failure, which would overwhelm an installation. These would be classified as extreme accidental events (EAE). Whilst it may be theoretically possible to design a temporary refuge (TR), to withstand these events the selected approach should utilise cost benefit analysis (CBA). The aim should be to reduce the frequency of these events to within acceptable limits and as low as reasonably practical. (ALARP)

It may also be possible, after close examination of all the causes of failure, to prevent incidents which, hitherto, have been considered as design cases. Such an example is a wellhead or wire lining blowout within a wellbay where all the possible causes could be identified and addressed. The acceptability of a prevention strategy is not only dependent upon the provision of adequately engineered systems, but equally on the Operator to maintain the systems and follow necessary procedures.

4.3 Fire Containment and Prevention of Escalation

This strategy can be used where there is a safe place for personnel to shelter on the installation while the fire is allowed to burn out or is extinguished. Normally, this would be the temporary refuge. It must be recognised that in the event the platform manager has the option to evacuate and that personnel may take matters into their own hands.

This should be the most common strategy for all process, fuel and non hydrocarbon fires. It is based on preventing escalation to a scale of incident which would overwhelm the TR and evacuation routes. Critical equipment should be protected by location or systems which match the type and duration of the initial hazard. It also depends on the

operation of control equipment such as drains and ESD. The Operator must be aware of his obligations for maintenance and testing to ensure that these systems work when needed.

Where the size, location and character of a fire is predictable, proven extinguishing methods can be employed to put it out or control it before there is critical escalation or loss of life. Such effective extinguishing/control methods may be used to protect the accommodation (sprinklers, CO₂, dry powder), helideck (foam monitors) and engine enclosures (CO₂ or water mist). Extinguishment may be an alternative to passive protection for stored fuel or very low pressure oil processing.

Post extinguishment reignition hazards, such as residual flammable gas pockets or liquid pools, need to be considered in selecting an appropriate measure. Extinguishment of gas releases and flashing liquids should not be considered if there may be a subsequent gas ingress and/or explosion hazard to the accommodation or utilities.

4.4 Acceptance of Consequential Damage

This category applies in circumstances where a fire would not cause a significant risk to life and the consequential damage can be limited to an acceptable level; fixed protection is not needed.

If containment or control requires the provision of passive protection (e.g. fire walls) or manual fire fighting facilities, the hazard shall be classified under 4.3.

4.5 Evacuation

This strategy would be selected where the frequency of an incident, which could ultimately overwhelm the TR, is above acceptable limits and cannot be reduced by any other practicable design or procedural means. Such events may include drilling blowout when extensive development drilling is carried out from the production facility.

It could also apply to certain major process fires but only if it has not been possible to optimise the design so that the scale and duration of the fires do not overwhelm the TR. The fire prevention approach outlined in 4.2 should be adopted as far as possible and thereafter, the design and layout must also be optimised to minimise the levels of radiation and smoke around the TR and evacuation routes

5. HAZARD QUANTIFICATION

5.1 General

Hazard quantification is the means of formally identifying the size, duration, release rate and intensity of all of the major fire hazards which would be chosen as design cases for either active or passive fire protection. A detailed analysis of the low frequency overwhelming events is not needed but a coarse assessment will be required to assist in the selection of the appropriate management strategy. Where the fire hazards are well understood and do not vary significantly on different installations, these may be classed as generic hazards. Examples are cabins, offices, etc. These do not need to be quantified in the rigorous detail described below.

Where the hazard is variable, but standard methods of protection have proved to be fully effective, it may be classified as standard, e.g. fuel storage and helidecks. Rigorous quantification is not required but a general listing of the variables which would affect the fire, such as the primary flammable inventories or the containment, would be needed. Information is required at the following stages of a project:-

- (a) Concept Selection.
- (b) Fire Hazard Management Strategy Selection.
- (c) Concept Safety Evaluation/Assessment.
- (d) Process Design Optimisation to minimise fire hazards.
- (e) Detail Design of Protection Systems.
- (f) Formal Safety Assessment.
- (g) Operator Handover.
- (h) Platform Modification.

The level of detail will depend on the level of process and layout detail available at the time.

Fire hazard quantification is an ongoing process which should simply be updated as more detailed information becomes available or the design is modified. The project safety plan will identify any requirement to carry out an independent check of the fire hazard quantification at either the concept or formal safety assessment stage.

5.2 Method

5.2.1 The quantification should be carried out using methods approved by the client/operator. Different methods may be applied to different fire hazards. The BP computer programs HARP and CIRRUS are considered acceptable for release calculation and fire characterisation respectively. Other techniques will be needed for compartment or obstructed fires. The fires will need to be quantified in a form which can be used as the basis of the fire protection design. It may also provide input data to a quantified risk assessment (QRA) to ensure that the platform meets the client/operator criteria for impairment of the temporary refuge and for individual risk. The project safety co-ordinator will advise on the need for and quality of the QRA. The following cases will be needed for specifying fire protection:-

- (a) The largest design fire case lasting long enough to cause failure.

The duration will need to be specified in order to carry out this analysis. Under intense hydrocarbon fires, items may theoretically fail in a few minutes. In practice, the time to failure may be slightly longer than the theoretical minimum. Items which are particularly weak, such as plate heat exchangers, should be identified.

- (b) The largest design fire cases at specified times.

These may be the times at which proprietary passive protection fails (e.g. 60 minutes), the maximum time to evacuate the platform, the required temporary refuge survival times, the time when evacuation by lifeboat or helicopter commences or other times specified by the project safety co-ordinator.

- (c) The duration of the smallest significant fires.

Normally this would only be needed if investment protection was required and the durations were likely to significantly exceed any of the other cases already analysed.

5.2.2 The following variables should be taken into account when carrying out the analysis for various hydrocarbon processing parts of the platform:-

- (a) Each inventory and the proportion which can be released.
- (b) Type of hydrocarbon fluids.
- (c) Burn characteristics for these fluids, including transition pressures from spray to pool for liquid release.
- (d) Management strategy for each inventory.

- (e) Maximum hole size or release rate in the case of continuous well or riser incidents. It should be recognised that the largest hole does not necessarily give the worst fire from an isolated inventory for a particular duration. Some analysis methods may require the selection of a number of hole sizes to represent typical incidents. Advice on this should be sought from the project safety co-ordinator.
- (f) Location of all potential releases.
- (g) ESD operability and time to operate.
- (h) Depressurisation operability and time to operate.
- (i) Release pressure profile taking into account depressurisation and reheat due to the fire.
- (j) Pool size and drainage.
- (k) Ventilation rate.

5.3

Smoke and Gas Ingress Assessment

Where the TR could be affected by the products of combustion from a major external fire, a smoke and gas ingress assessment (SGI) should be undertaken. This would normally apply to installations where the TR is on the same jacket as processing or well/reservoir hazards. Where it is on a separate jacket, but fire on the other jacket could affect it, a SGI is also required.

In carrying out the assessment a number of representative fire cases should be examined. Those most likely to impair the TR are fires originating from large oil inventories, which will cause prolonged large fires with copious amounts of smoke and toxic products.

The assessment should examine the likely concentration of toxic products (such as carbon monoxide) outside the TR and assess the rate at which these build up inside the TR. This should take into account the likely air movement through the TR caused by forced and natural ventilation, e.g. through doors which may be opened in an incident, leakage, poor seals, etc. The results from the assessment of the internal conditions should be compared against the client's impairment criteria for a TR to verify if the required duration is achieved or to find out how long it will remain habitable.

A detailed guide to carrying out a SGI is given in [BPX HSQ 01.03.01](#).

5.4

Results

The following outputs are needed from the analysis, and may be presented in tabular form (See Table 3), with a summary in the FEHMP.

- (a) Fire type: pool, jet, spray or solid combustibles.
- (b) Fire size, location and flame geometry. (These should be superimposed on platform layouts and take reasonable account of obstructions and wind effects).
- (c) Burn or release rates.
- (d) Heat intensities (fluxes) inside and outside the flame.
- (e) Lists of critical equipment subjected to radiated heat or direct flame impingement.
- (f) Smoke densities near the refuge and escape routes.

Smoke densities may be quantified as part of a smoke and gas ingress (SGI) study which will require details of the release rate, fuel type, location and burn conditions.

When the design has been finalised, the fire quantification should form part of the fire hazard management plan and should be included in the handover documentation. It should be in a form which readily communicates the characteristics of the major hazards to the platform operating personnel.

It is also a valuable way of conveying the fire hazards associated with the design to process and layout engineers who can contribute to reducing the fire cases.

6. PREVENTION

Prevention is the primary defence against fire and applies to all fire hazards. It is implemented through the selection of appropriate design and construction codes and standards and operational controls. These are considered to be adequate where the potential fire is protectable, i.e. it can be controlled without the need to evacuate the platform.

In cases where the platform may be overwhelmed, the temporary refuge impaired or evacuation required to preserve life, then an even more rigorous approach to prevention is needed over and above that normally in place. This is specifically tailored to the particular hazard and is inferred when the selected strategy for the hazard is either prevention on its own, or prevention combined with evacuation.

All the potential causes of failure must be identified and a combination of design features and operational procedures put together to address each one. The causes of failure can, during conceptual design, be identified by a hazard identification (HAZID) study. This should be verified by a hazard and operability (HAZOP) study during detail design. The studies should include the following:-

- (a) Fire (the effects of all other major fire hazards on this particular case).
- (b) Impact (this should include ship impact and dropped objects).
- (c) Corrosion (internal and external).
- (d) Environmental (severe weather).
- (e) Breaches of Containment (maintenance and operation).
- (f) Overpressure (process control failure or overheating).
- (g) Explosion.
- (h) Isolation Failure (failure to isolate the hazard from another part of the plant).

In each case, the contributing elements to the failure should be identified, e.g. the lockout of a fire and gas detection system may prevent closure of the shutdown valves. The HAZOP and HAZID studies may be augmented by a fault tree and a failure modes and effects analysis (FMEA). Once identified, the adequacy of the preventive measures embodied in the normal codes and standards and operational procedures should be examined. This judgement is based on the contribution of the particular hazard to the overall risk to the platform. Where the overall risk is acceptable, ALARP and the hazard is not a primary contributor to that overall risk, then no further action is required other than to ensure that the design codes and procedures are applied. These should, however, be documented as a critical prevention measure in the FEHMP.

If, however, the hazard dominates the overall risk or the platform design cannot meet the client/operator criteria for major accidents, loss of the temporary refuge or individual risk, then each cause of failure shall be individually addressed and reasonably practicable design and operational measures shall be put in place. Expenditure on these measures should be ALARP. The project safety co-ordinator should provide advice in this area.

Once these additional specific preventive measures have been identified and design features included, then they must be documented together with the general prevention measures such as the design codes, in the fire hazard management plan so that the Operator knows what they are and his obligations for operation and maintenance.

7. HAZARD MINIMISATION AND CONTROL MEASURES

7.1 General

The first stage in hazard minimisation is the use of appropriate codes and standards in the design. However, the use of hazard analysis techniques identifies the largest hazards and allows further examination of them to reduce their scale, duration, intensity and consequence. This is normally only required for the hydrocarbon processing events and possibly the main fuel inventories and helicopter hazards. The aim is to reduce the scale of the hazards to that which would not overwhelm the installation and would be of a size which could be controlled by the fire fighting and protection systems, i.e. to reduce the hazards to a protectable level.

This section concentrates on the techniques to minimise the largest events. The process of design requires the interaction of all engineering disciplines and sufficient time to allow it to take place. The areas which can be optimised are given in the sub-sections that follow.

Control measures are those systems which will limit the size of fires to that which can be counteracted or extinguished by the passive or active protection systems. These are critical elements in the fire hazard management process as, without them, the fire could spread to areas with inadequate protection.

7.2 Inventory Minimisation

The major fire hazards are dominated by a small number of events. These will probably be the risers, blowouts and a few of the individual isolated process inventories such as the separators or slug catchers.

Isolation valves should be located as close to the vessel as possible, with protection or positioning to withstand any anticipated explosions or fires. They should close automatically on signals from the fire and gas and emergency shut down systems and have local/remote manual operation.

The fire hazard quantification may also show that the degree of isolation provided between some inventories is disproportionate to others, i.e. that there are a number of small inventories which, if combined, do not constitute as severe a hazard as other individual ones. If this is the case, it may be appropriate to rationalise the

isolation philosophy by reducing the valve numbers and concentrate the resources on other, more severe hazards.

The riser and blowout events can be minimised by the fitting of remote isolation valves. But it should not be automatically assumed that these valves are necessary since there are hazards in servicing this equipment, which would offset their benefits. They may also not be cost effective. The frequency of the initial event and its consequence should determine the requirement. The project safety co-ordinator should advise on the requirement. The selected location for a remote isolation valve should give a balance between the residual isolated inventory (and its consequent fires) and the requirement to locate the valve as far as possible from any hazards such as fire or dropped objects.

In the case of isolated process inventories the design will be restricted by the minimum size of vessel required to carry out the processing. Where the fire quantification shows that the inventory is so large that it can still overwhelm the installation, then it will be necessary to introduce specific design features and procedures to control the rate of release. It may be appropriate to question the design specification that determined size and discuss the vessel with the Operator. It may also be appropriate to consider the dumping of liquid inventories, although the hazards associated with this should not be overlooked. These measures should only be undertaken where the frequency of the overwhelming event is such that it makes an excessive contribution to the overall risk on the platform.

7.3 Optimisation of Release Location

Two benefits can be achieved by optimising the location of potential releases.

- (i) The number of fire areas into which the inventory can be released is reduced.
- (ii) The thermal loading of critical plant and structure can be minimised.

The first benefit requires that the major inventories are isolated within the fire area so that they cannot cascade into others via the process pipework and systems. The second requires that the major isolated inventories, well hazards and risers are positioned so that the fires resulting from potential release points have the minimum potential for impact on critical plant, structure and particularly the temporary refuge, escape and evacuation routes.

It may be possible to optimise the location of potential sources of release; pig launcher and receiver doors, instrument tappings and flanges so that a pressurised liquid or gas release does not impinge directly onto critical plant or processing equipment with a high escalation potential.

7.4

Control of the Rate of Release

The rate of release can be controlled in two ways:-

- (i) Minimisation of the pressure profile with respect to time.

The pressure profile will be a function of the initial pressure and the effects on the inventory of the fire and control actions. The fire itself will cause the liquid inventory to boil off, increasing the pressure. This can be minimised by fire resistant insulation but this should withstand the effects of the fire if credit is to be taken for it.

Depressurisation will reduce the pressure and dispose of a proportion of the gas inventory. It will also help to reduce the pressures generated by the boiling liquids. Where the major inventories dominate the fire cases, particularly those of long duration, there may be scope to optimise the allocation of the flare capacity to minimise their post ESD pressure profiles at the expense of other smaller inventories.

Relief valves will only keep the pressure to the relief pressure setting if they are realistically sized for the boil-off rates which will be generated by the particular fire types and size.

- (ii) Minimisation of the maximum hole size on which the design fire cases are based.

Minimisation of the hole size through which a release can occur can be achieved by a combination of design specifications and procedures. However, these must be thoroughly documented in the FEHMP and implemented if credit is to be taken for it in any safety assessment. The design considerations are the minimisation of fittings above the critical size, the use of particular jointing systems (e.g. ring type joints) above the critical size, design of the process plant to withstand the maximum anticipated explosion conditions, particularly fittings, and the specific identification and minimisation of any cause of large bore failure (e.g. corrosion or erosion). The operational procedures include the control of any breaches of containment above the critical size and the control of any operations likely to cause these larger failures (e.g. heavy lifts). This may not be practical on all process equipment but it can be applied to individual inventories, risers and well operations.

7.5

Control of Liquid Releases

Where there is a possibility of a pool fire, both the location and size of the fire can be optimised by controlling the spread of the flammable liquids. This may be achieved by either bunding or gulleys but, in either case there should be provision to dispose of any fire water and to safely dispose of any unburnt hydrocarbons. Flammable liquid should be prevented from spreading towards any critical structure or plant if possible. Particular attention should be paid to the location of the fire with respect to the refuge and the consequent smoke effects. The total pool fire area will determine the burn rate and the overall fire size. This

is a particularly powerful tool in the control of fire hazards but it is only effective if the liquid release pressure is low enough to prevent the majority of the liquid burning as a spray.

A conscious decision should be taken on the firewater drainage philosophy. There are three options:-

- (i) To hold the liquid inventory in the pool area and only drain the excess fire water into the sea. This will cause all the released inventory to burn under controlled conditions until it is exhausted or extinguished, but it will require bunding of adequate volume.*
- (ii) To drain all the firewater and hydrocarbons into a drains caisson or drum where the water is separated and dumped to sea. This offers the greatest contribution to minimising the fire as most of the hydrocarbons will be recovered and prevented from burning.*
- (iii) To drain all the water and hydrocarbons direct to the sea. This may cause a sea pool fire which should be quantified and its effects on the platform assessed. The probability of re-ignition of the draining oil can be minimised by maximising the distance between the fire and the drainage outlets, which should also be as far from the TR as practicable.*

Investment in a drainage caisson or drum should only be considered if the consequences of allowing the fire to burn on the platform or the sea are unacceptable and cannot be controlled at reasonable cost.

7.6 Control of Fire Spread

The effects of a fire may be controlled by firewalls around the fire area. These may also limit the ventilation causing reduced combustion and possible extinguishment. This should only be considered if there is not a significant gaseous explosion hazard in the area or the firewalls are arranged so that the explosion overpressures are unlikely to cause escalation. Water curtains may be considered for controlling the spread of smoke and billowing flames from pool or low pressure spray fires.

8. PROTECTION AND MITIGATION METHODS

*** 8.1 General**

The protection of an area may be achieved by active means, passive means or a combination of both. The choice will vary from one area to another and from one platform to another. Each area should therefore be treated on its own merits.

As part of the review of each area, the fire hazards should be examined to determine whether it is practical to extinguish the fire. Extinguishment shall only be chosen as the sole means of fire protection



if all consequent explosion or fire hazards can be eliminated until disposal or dispersion of all inventory has been achieved, or arrangements made to extinguish re-ignited fires. It may be used in addition to exposure protection as a means of damage limitation. This shall be at the discretion of client/operator.

8.2 Protection Measures

8.2.1 Exposure Protection without Extinguishment

The choices of exposure protection are:-

(a) Active:-

- Deluge systems.
- Monitors.
- Manual fire fighting.

(b) Passive:-

- Coatings (Intumescent and Cementitious).
- Firewalls.
- Enclosures.
- Insulation or panel systems.

Passive protection may also have dual functions such as blast walls, insulation, platform segregation and paint systems.

Protection systems should be provided if the anticipated design fire conditions could lead to any of the following failures:-

- Catastrophic failure.
- Significant escalation leading to a combined fire size in excess of the protection possible.
- Penetration, overheat or excessive smoke levels within the TR.
- Loss of sufficient emergency equipment needed to counteract the initial event.
- Loss of sufficient emergency equipment needed to preserve life from the initial event (including escape and evacuation systems).
- Loss of sufficient emergency equipment needed to control the event before the equipment has operated. (e.g. ESD valves).

- Progressive structural collapse.
- Structural failure or the collapse of heavy loads leading to escalation as above.

The duration rating of the passive protection shall be based on the expected fire duration or, if the fire is of extended duration, the time required for platform shutdown and evacuation. In all cases the protection should prevent the structure/equipment reaching its failure temperature, within the specified time.

8.2.2 Extinguishment without Exposure Protection

When adopting this approach the protection should guarantee the extinguishment of the fire and any consequential fires (e.g. cable fires, running fires, etc.) before critical failure can take place. In addition the protection should guarantee the prevention of re-ignition or have sufficient residual capacity to extinguish any recurring fire.

8.2.3 Choice of Method of Exposure Protection

Where jet fires are predicted, the point of impingement will receive high levels of heat input. Water spray alone may not be effective in protecting structures and equipment, although some cooling may be achieved. As a result, passive fire protection or limitation of jet fire duration may be the only effective options.

The choice of active and/or passive fire protection and their allocation to equipment, structures and walls will depend on:-

- (a) Suitability of the chosen system to the type of fire.
- (b) Weight and cost constraints.
- (c) Overall platform water capacity and infrastructure.
- (d) Corrosion as a result of water deluge.
- (e) The need to insulate vessels for process reasons where passive protection may have a dual role.
- (f) Reliability and availability of active systems.
- (g) Survivability of passive systems in normal operational conditions. (e.g. mechanical damage on drill floor).

- (h) Survivability of active and passive systems following an explosion.
- (i) The required duration of protection.
- (j) Preventing failure of instrumentation and electrical equipment.
- (k) Access for inspection and reinstatement.
- (l) Disruption to operations during active system testing.
- (m) Predicted life and maintenance refurbishment requirements of active and passive systems.
- (n) The heat intensity of the design event.
- (o) Corrosion under passive fire protection.
- (p) Practicality and complexity of application to exposed plant or structures.
- (q) Environmental conditions in application and use.
- (r) Performance verification.
- (s) Secondary effects, burn rate control.
- (t) Operator exposure.

The reasons behind the choice of protection method shall be documented and handed over to the Operator to support the fire and explosion (FEHMP) hazard management plan.

8.2.4 Choice of Method of Extinguishment.

The choices of extinguishing method are:-

- (a) Oxygen starvation
- (b) Foam
- (c) Inert Gas
- (d) Water Systems
- (e) Dilution

(f) Dry Powder

The considerations for the choice of method are:-

- Suitability for the fire hazard
- Post extinguishment security
- Personnel safety
- Practicality of application
- Consequential damage
- Speed of response

Reactive gas systems may be considered if a proven halon replacement becomes available

9. IMPLEMENTATION AND DOCUMENTATION

9.1 General

There must be adequate communication and documentation from each stage of a project to the next, and to the Operator, so that the hazard management decisions are understood and recorded. This is, preferably, done in the form of a Fire and Explosion Hazard Management Plan, (FEHMP). It may also be encompassed within an overall plan for the management of all hazards on the installation. The plan should contain the following information:-

- (a) A specific listing of each major fire hazard (e.g. separator fire).
- (b) A listing of groups of generic hazards (e.g. cabin fires).

9.2 Information Required

For each of the major hazards and groups of generic hazards, the following information is required:-

- (a) The strategy to manage the hazard.
- (b) The list of engineered prevention, control and mitigation measures.
- (c) The list of software systems/procedural controls.

- (d) A description and quantification of the design accidental events (the fire hazard quantification).
- (e) A description of the extreme accidental events and consequences.
- (f) Nominated responsible persons for each of the prevention, control and mitigation measures.

9.3

Support Documents

The following support documentation should be provided for the prevention, control and mitigation (PCM) measures (as appropriate).

- (a) Performance and design standards, e.g.:-
 - (i) corrosion thickness (prevention).
 - (ii) impact deck strength (prevention).
 - (iii) ESD closure time (control).
 - (iv) drainage flowrate (control).
 - (v) passive protection rating (mitigation).
 - (vi) deluge application rate (mitigation).
 - (vii) availability and reliability (all).
 - (viii) Criticality.
- (b) Controls and operating restrictions during maintenance or non availability of the PCM measures e.g.:-
 - (i) control of heavy lifts during impact deck panel removal.
 - (ii) deployment of portable deck monitors during deluge system maintenance.
- (c) Documentation for procedural PCM measures e.g.:-
 - (i) corrosion inspection procedures.
 - (ii) wireline BOP assembly, connection and test procedures.

- (d) Maintenance procedures and frequencies.
- (e) Inspection procedures, test frequencies and performance acceptability limits e.g.
 - (i) maximum valve closure time.
 - (ii) minimum wall thickness.
- (f) Emergency response procedures, both onshore and offshore.
- (g) Demonstration, using QRA, that the design meets company and legislative criteria for individual risk.

The FEHMP should be a living document which conveys information to all those who are responsible for safe operation, in a form which is concise and easily read. It should not be an over detailed, cumbersome, mammoth work. This particularly applies to the description of the fire hazards which should be in pictorial form with a short descriptive text.

9.4 FEHMP Preparation

The preparation of the FEHMP should commence at the conceptual design stage when the major hazards are identified. It should be prepared by a responsible person with input from all disciplines and the Operator. As the project progresses, other hazards may be identified, strategies selected and PCM measures specified. The plan should develop as each item of information becomes available. The fire quantification and engineering sections should be substantially complete before construction. Prior to commissioning, the operational and procedural sections should be completed and handed over to the commissioning/operating team. The FEHMP supporting documentation should form the basis of the check lists and acceptance procedures for the PCM systems during inspection, test and commissioning.

9.5 FEHMP Review

The FEHMP will also be a support document to any safety case requirements and must be completed in time for submission if required. Particular care must be taken to make the drilling and well completion sections available in good time if these operations commence prior to production.

It must be regularly reviewed and updated whenever there is either an engineering modification affecting the hazards or the PCM measures, or a management reorganisation affecting responsible persons.

9.6 Inspection, Maintenance and Test

9.6.1 The documentation shall include an inspection and maintenance programme covering all aspects of prevention, control and mitigation systems. Only the requirements for fire protection systems will be outlined in this Recommended Practice but the principles should be applied to the other prevention and control elements of the FEHMP.

The aim of the inspection, maintenance and test programme is to ensure that the fire protection systems function correctly with an acceptable probability of success. This will be reflected in its criticality rating and estimated availability. The time when a system is not available can be caused by:-

- (a) undetected failure of components;
- (b) inadequate performance of components;
- (c) failure of components before the system has completed its function;
- (d) isolation for maintenance, inspection or test;
- (e) downtime while awaiting repair.

The availability philosophy for critical systems should be developed as appropriate for the project. For example it may be based on the maximum downtime prior to shutdown or the maximum allowable downtime during a specified period of operation.

Target availability levels should be developed excluding (d) and (e).

9.6.2 The required inspection, maintenance and test programme should be developed to match the assumed levels of availability. This may involve some further loss of availability due to system downtime. If this availability is inadequate for the level of risks then the following options can be used:-

- increase the inspection and test frequencies;
- duplicate critical components so that at least two failures are required before the system fails;
- provide secondary systems or components so that the system remains operational during test, maintenance and repair;

- develop contingency measures to reduce the hazard during test, maintenance and repair;
- eliminate the hazard when the system is not available (process shutdown);
- substitute an alternative when the system is not available (e.g. deploy portable monitors in place of a deluge).

Options used to improve the availability should be practical and operable in an emergency. Access for manual operation, exposure of personnel to smoke and heat, and the need for operability in the minutes following an explosion or the start of a fire are important criteria to be met.

9.6.3 Discussions on the required system availability and which, if any, of the enhancements listed above are needed should be held between the designer and Operator. Decisions should be documented as described in 9.2 and implemented through the platform safety management system.

PART 2 - ADDITIONAL CONSIDERATIONS SPECIFIC TO AREAS

10. PROCESS AREA

10.1 Aims of Fire Protection

Fire protection measures in the hydrocarbon processing areas of offshore installations are primarily aimed at protecting personnel (saving life). This is achieved by containing the fire by cooling or extinguishment (if possible or advisable), preventing escalation (reducing the possibility of further hydrocarbon releases) and avoiding structural failure.

Fire and gas detection systems will assist in limiting fire spread by early detection and intervention. See BP Group [RP 30-7](#).

A fire protection system that is well matched to the risk it protects will minimise damage to the TR, equipment and structure and maintain escape route availability for evacuation.

10.2 Types of Fire Hazard

The types of fire hazard likely to occur in process areas are: liquid pool fires, pressurised liquid spray fires from MOL pumps, etc., and running fires from leaking vessels/pipework. There is also the possibility of gas jet fires from fractured mains or leaking flanges on gas manifolds. Where gas can accumulate, there is the possibility of a flash fire of high intensity but short duration. In a confined or congested space the accumulation of gas could lead to an explosion.

10.3 Protectability

All engineering disciplines should work together to encourage the development of designs that are more protectable. If extinguishment of a particular fire is not practicable then it must be contained by active and/or passive means until the available hydrocarbon inventory is exhausted. Protectability is improved and the level of hazard is reduced by minimising inventories.

The maximum fire size and duration which would be acceptable on a platform should be considered. Although it may be practicable to design protection systems to withstand total fire engulfment of the installation for several hours, such exposure is clearly unacceptable to the personnel and evacuation would be impossible. Codes of practice do not set limits of acceptability for fire size but there are scales of incident that must be handled primarily by prevention, e.g. riser failure. If the TR or a large proportion of the process or wellbay areas suffers

excessive exposure on calculating the fire impacts then the hazards should be reduced as discussed in 10.4.

10.4 Reduction of Fire Hazards

A number of measures can be taken at the conceptual and front end design stage:-

- (a) Avoid placing process plant which has a high explosion potential (high pressure gas compressors and NGL knock out drums) in the same area as major inventories.
- (b) Concentrate on reducing the largest isolated inventories in items such as oil/gas separators and slug catchers.
- (c) Minimise number of potential leak points, flanges and instruments.
- (d) Minimise the vulnerability of tappings.
- (e) Minimise the diameter and length of interconnecting liquid piping.
- (f) Minimise or specifically protect hydrocarbon equipment which would be particularly vulnerable to fire e.g. sight glasses, valves between flanges (duo check) and plate type heat exchangers.
- (g) Install ESD valves as close as possible to vessels.
- (h) Reduce the possibility of release or the rate of release, for example by preventing releases from orifices greater than a particular size.
- (i) Optimise the flare system to minimise the long term release rates from the major inventories.
- (j) Minimise the number of areas into which the major inventories can be released by careful location of ESD valves.
- (k) Minimise the vulnerability of major inventories to explosion damage by providing adequate structural strength.
- (l) Position likely points of release, such as instrument tappings and flanges, to avoid critical items, structures or major inventories.

- (m) Design events should normally be based on isolated inventories with blowdown, if provided. The release rate should be governed by a maximum hole size.
- (n) High pressure oil release would completely burn as a spray with limited oil drop out. At lower pressures, pool fires would be created allowing limitation of burn rate by pool area. (See 3.3.3).

10.5 Need for Protection

Only the critical items in the area which are subject to fires of sufficient intensity and duration to cause failure shall be protected. These would normally only be structural and process plant which could lead to the failures listed in 8.2.1. Note that gas plant would not constitute a significant escalation if it is automatically depressurised, as the quantity of gas available at the time of failure should be relatively small compared with the initiating event. Particular attention should be paid to thermally weak items e.g. stud bolts.

All critical items outside the process area which would be subject to external flaming should be identified and protected if they may receive sufficient fire exposure.

Other hazards can affect fire protection measures and have a profound effect on protectability. The explosion hazard from escaping hydrocarbon gases, or flashing liquids may damage the control and mitigation systems and cause single or multiple releases, leading to fires which exceed the protection system capability.

10.6 Choice of Protection

The choice of exposure protection shall be guided by Table 4. This addresses the fire type and the equipment or structure to be protected, assuming that the fires are likely to cause failure and the consequences justify protection, and alternative protection methods are indicated where appropriate. The considerations in 8.2.3 shall be used to determine the choice of protection method.

Guidance on the preferred form of extinguishment is given in Table 5.

11. DRILLING AND WELLBAY AREAS

11.1 Aims of Fire Protection

Fire protection measures in drilling and wellhead areas also aim to protect personnel (saving life). Fire protection systems in wellhead



areas may have to be designed for an ignited blowout, with hydrocarbon inventories which can be almost unlimited. Protection needs to be closely matched to the wellhead risk it protects in order that radiated heat to other areas of the platform is kept to a minimum during evacuation of personnel.

Unlike fire hazards elsewhere in an offshore installation, drilling area hazards may not be of finite duration. It is probable that evacuation will be required under fire conditions.

The primary aim should be to prevent critical failure before evacuation and protect personnel during evacuation. Critical failure may include the catastrophic collapse of the drilling substructure or derrick, the failure of the wellbay firewall or the release of further significant hydrocarbon inventories such as those from adjacent wells.

Drilling and wellbay areas may also be subjected to fires from isolated inventories such as production manifolds.

Wellhead fire protection systems may also have to protect the wellheads from the effects of radiated heat from process area fires where firewalls have been breached following a hazardous incident.

Drilling utilities, such as shale shakers, may need protection if there is risk of mud returns being contaminated with hydrocarbons, or if the drilling muds could be ignited by other fires. (They would not normally be considered as a fire hazard because of the difficulty of direct ignition.)

11.2 Types of Fire Hazard

The fire hazards will depend on the well fluids and pressure. These could give rise to fires from gas jets, liquid pools or intense sprays. Such releases may result from isolated inventories, e.g. manifolds, or continuous well releases and blowouts. Other hazards may be present with drilling and well service facilities.

The following points should be considered when quantifying the hazards.

- (a) Blowouts should be quantified according to the release pressure, location, release rate and fluid type.
- (b) The only design cases in the wellbay are likely to be releases from production, test or gas lift manifolds or the release of lift gas from an annulus. Wellhead blowouts would normally be prevented through careful examination of the cause of release and appropriate measures/procedures.

- (c) The only design cases on the impact/BOP decks are likely to be wirelining blowouts which may be beneath or to one side of the derrick. These may impinge on the drill rig support structure and well bay firewall, which should be protected for sufficient time to allow evacuation, if these releases cannot be prevented.
- (d) The drill floor design cases are likely to be either production drilling or wirelining blowouts.
- (e) Shallow gas blowouts should be managed by the use of a diverter, but the possibility of its failure due to erosion should be examined. Radiant heat protection from a diverted release may also be needed.
- (f) The effects of a blowout on other parts of the platform can be minimised by optimising the location and elevation of the possible release points, e.g. bell nipple and wirelining lubricator.
- (g) Other cases which should be examined are ethanol/methanol fires (well service) and drilling mud fires. The hazards associated with flammable drilling muds and recycled well fluids and the flammability of any oil or diesel based muds should be assessed.

11.3 Protectability

Wellbay design is often determined by drilling locations and programmes and is not readily made more protectable. However, certain measures can be taken to reduce the severity of potential incidents, such as locating significant hydrocarbon inventories outside the wellbay area.

Although beyond the scope of this Recommended Practice the provision of a blast/fire wall between wellhead and process areas often needs consideration.

The protectability of the platform from controlled or uncontrolled wellbay releases can be significantly affected by the location of the point of release. Major points of release and the consequent fire exposure should be discussed with the appropriate discipline engineers. Layout options for the drilling facilities should be considered where the exposure of critical equipment, and personnel involved in well control operations, may be minimised. Every effort should be made to ensure that the conditions under which an ignited release can take place are fully understood in, for example, draw-casing or wirelining operations.

Drilling utilities modules are often located directly above wellhead areas and can suffer severe damage in an ignited blowout. Protection of these facilities from very high heat levels is essential if personnel are to evacuate with minimum risk to life.

11.4 Reduction of Fire Hazards

A number of measures can be taken at the conceptual and front end design stage:-

- (a) Wellhead areas should normally be separated from process areas by an H rated firewall matched to the duration of predicted fires, or evacuation time.
- (b) Releases from isolatable inventories should be minimised as described in section 10.
- (c) Fire protection systems should be designed or protected to withstand the initial event.
- (d) Wellhead blowouts should not normally be design cases, providing:-
 - (i) Wellhead and DHSV's are reliable.
 - (ii) Wellheads are protected from impact e.g. casing and BOP stacks.
 - (iii) Drilling derrick collapse is prevented or delayed until evacuation is complete.
 - (iv) Swab valve releases are prevented by appropriate design of the wireline BOP connection and good operational practice.
 - (v) Wellhead completions are only carried out on plugged or killed wells.

11.5 Need for Protection

General recommendations and concerns are as follows:-

- (a) Primary failures to be considered are the loss of the drilling derrick, the loss of drilling facilities and sub-structure, the loss of the wellbay/impact deck fire wall and the failure of an adjacent wellhead. Consideration should be given to protection of any other structure or plant which may fail on exposure to

more than 35 kW/m² for longer than one hour. Particular attention should be paid to the direction of collapse of the flare and derrick/support structure.

- (b) The impact deck firewall should normally be protected so that it does not fail before the prescribed evacuation time.
- (c) The wellbay firewall should normally be protected in accordance with (b) unless it can be shown that all credible releases are from finite inventories and these fires would have a shorter duration.
- (d) Protection would normally be required in the wellbay to match the fire characteristics of releases from isolated inventories in the production manifolds. The need for specific wellhead deluge would be determined by the size and duration of a manifold release and the fire resistance of the xmas tree.

11.6 Choice of Protection

General recommendations and concerns are as follows:-

- (a) Passive fire protection or specific deluge of derricks or flare towers is not normally practical.
- (b) The preferred method of derrick protection is by large top deck monitors mounted on the accommodation side of the platform. This would encourage any collapse of the derrick in a direction away from the accommodation. The structural design should also encourage collapse in this direction.
- (c) Drill floor water spray protection is not normally considered necessary unless personnel require protection during emergency well kill operations. It is difficult to provide a secure supply of fire water since the flexible connections would be exposed to wireline blowouts and failure could put the whole water supply system at risk.
- (d) Where the support structure of the wellbay fire wall may be affected by a release from another area protection should be provided to match that release.
- (e) The drill rig support structure may be protected either by passive protection or fixed/oscillating monitors on the impact or top deck.

- (f) Protection should be designed to prevent escalation or structural failure before evacuation takes place.

Guidance on the preferred form of protection and extinguishment method is given in Tables 4 and 5.

12. SUBSTRUCTURE

12.1 Aims of Fire Protection

Fire protection goals for the substructure (jacket, bottom of integrated deck etc.) of an offshore installation should be defined clearly as part of an overall approach to fire risk assessment.

The primary aim should be to eliminate major substructure fire hazards, or where this is not possible, to provide equipment and systems which reduce the frequency of damaging fires below that which requires protection.

The aim of substructure protection is to avoid structural failure affecting the jacket and preventing the loss of escape routes during predicted fire incidents. This reduces risks to personnel and prevents escalation.

12.2 Types of Fire Hazard

The most likely fire hazards would come from fractured or damaged risers, which could give rise to jet fires of oil or gas.

There would always be the possibility of a sea slick fire emanating from oil falling down into the sea.

12.3 Protectability

All major fire hazards such as risers and conductors should be rigorously examined for likely causes of failure and prevention measures provided as described in section 6. Only when it has been shown that fires or releases under the substructure cannot be prevented, should protection be considered.

Substructure can be made more protectable by routing of risers clear of the accommodation module and control room. In the case of a riser failure, the further it is from the TR, the easier it is to protect this safe haven. Risers may be fitted with ESD valves so that a fire above the valve level can be reduced to a fairly short duration. In the absence of SSIVs an ignited riser failure is not an event against which one can

realistically protect, other than to ensure that structural failure is delayed long enough for escape and evacuation to take place.

12.4 Reduction of Fire Hazards

A number of measures can be taken at the conceptual and front end design stage:-

- (a) Any riser release would normally be considered as an EAE or prevention case. All potential causes of failure should be identified and addressed. These include:-
 - (i) Internal and external erosion/corrosion.
 - (ii) Top deck fire or explosion.
 - (iii) Impact (ship and dropped object).
 - (iv) Topsides release and ESD valve failure.
 - (v) Overpressure.
 - (vi) Support Failure.
- (b) Connections to risers should be avoided and adequate corrosion/erosion allowances specified.
- (c) Risers should be positioned within the jacket framework to avoid impact damage. Adequate control measures should be applied to visiting/approaching ships.
- (d) All risers should be equipped with ESD valves integrated with the installation ESD system.
- (e) Riser ESD valves and riser top sections should be shielded or protected as defined in BP Group [RP 43-3](#).
- (f) Where considered necessary to limit the inventory available to a fire incident, the fitting of SSIVs to riser pipework, clear of the installation, should be evaluated.
- (g) Risks from dropped loads should be minimised by control procedures during heavy lifts, optimum riser location or provision of impact decks.
- (h) Riser supports should match the environmental loadings, e.g. earthquake zone.

- (i) Top deck liquid spills should be controlled by means of bunding or gulleys and directed to a caisson or effectively dispersed in the sea to prevent pool fires.
- (j) In the case of riser failure where ignition has occurred, removal of inventory at source by operation of an ESD valve or SSIV is the only realistic option. All critical equipment and structure should be protected for the duration of a significant fire following closure of the valve. Passive protection is the only practical means.
- (k) Consideration should be given to the difficulty of monitoring corrosion under a passive fire protection coating on a riser, which may in itself introduce a new risk of corrosion induced riser failure.
- (l) Fire protection should initially concentrate on reducing risks to risers from fires in modules or on decks.

Guidance on the choice of the preferred form of protection and extinguishing methods is given in Tables 4 and 5.

13. HELICOPTER/HELIDECK

13.1 Aims of Fire Protection

Fire protection measures for helidecks and helicopter operations have primary aims as follows:-

- (a) Protection of personnel within and escaping from, the helicopter
- (b) Protection of the helideck crew
- (c) Evacuation of the helicopter personnel
- (d) Prevention of fire spread, damage and escalation to adjacent areas

Rapid fire extinguishment is essential if personnel are to be protected and escalation avoided.

Fire protection systems need to be well matched to helicopter operational risks in order to minimise equipment and structural damage, maintain escape route availability, and maximise the chances of crew and passenger survival.

13.2 Types of Fire Hazard

The main hazard to a helideck is likely to be from ignition of fuel spilled from a crashed helicopter and ignition of the helicopter itself. Of a secondary nature would be fires resulting from a split refuelling hose or, if the refuelling facilities are situated on the deck below the helideck, then there is an additional risk of fire from a fractured storage tank or damaged refuelling pump.

It should be recognised that a helicopter is likely to crash on its side and fires cascading from fuel tanks on the upper side of the crashed aircraft are possible. Crash debris (e.g. rotor blades) is likely to injure personnel and damage equipment.

13.3 Protectability

Development of the helideck design and the location of ATK storage should facilitate cost effective fire protection.

The exposure of aviation fuel storage to risks of rupture should be minimised and the performance of helideck drains subjected to burning aviation fuel should be assessed. Division of the deck into separate pool areas should be considered. The deck should be sloped so that all the fuel drains to one side.

13.4 Reduction of Fire Hazards

A number of measures can be taken at the conceptual and front end design stage:-

- (a) The ability of the TR to withstand helicopter impact should be assessed and the TR passive fire protection rating amended if necessary.
- (b) Rapid drainage of fuel inventories should be examined as a method of reducing the fire size and duration.
- (c) Hydrocarbon plant that is vulnerable to a helicopter crash fire should be suitably protected from impact and, if necessary, fire. Consideration should be given to missile damage from disintegrating rotor blades.
- (d) Refuelling operations, earthing arrangements, and ATK pipework routing should be examined.
- (e) Consideration should be given to preventing a pool fire spreading around the helideck or the area of impact.

There are two primary fuel sources: the aircraft fuel tanks and the refuelling system. In both cases the fuel is high flash point and would normally be difficult to ignite in circumstances other than a crash.

- (f) Incidents such as ship collision, blowout radiation and hydrocarbon jet and pool fires, etc. should be considered when producing a comprehensive list of fire hazards.

13.5 Need for Protection

Personnel should be able to get safely away from helicopter incidents involving fires occurring from spilt fuel or an engine. This would also apply to fires caused by refuelling facilities if they are situated under or near the helideck.

13.6 Choice of Protection

When choosing protection the prime consideration is to maximise the chances of survivors leaving the crashed helicopter either on their own or with the help of a rescue team.

Guidance on the choice of the preferred form of exposure protection and extinguishing method is given in Table 4 and 5.

Normally the helideck would not require protection from process or drilling incidents other than the shielding of evacuating personnel from radiation or smoke.

14. ESCAPE AND EVACUATION

14.1 Aims of Fire Protection

Sufficient escape routes to the TR and muster points, evacuation routes and systems must remain usable to allow the full complement of people on board to escape and evacuate from credible fires.

The protection of escape and evacuation routes should be such that the goals for evacuation, escape and rescue, as laid down in BP Group [RP 44-9](#) and client safety system requirements, are achieved.

To achieve this aim, fire protection may be required to reduce the fire exposure to routes and systems for as long as required to perform their function.

Where enclosed or physically shielded escape routes are proposed on the outside of process areas or wellbays, the effect on explosion over pressures will need to be evaluated.



14.2 Types of Fire Hazard

Escape and evacuation routes should not normally be exposed to fire hazards. However, hazards could come from external sources such as radiated heat, smoke and toxic gas.

14.3 Reduction of Fire Exposure

A number of measures can be taken at the conceptual and front end design stage:-

- (a) Two alternative escape routes should be provided so that in theory one will remain available in all foreseeable fire and weather conditions. Prevailing winds will direct smoke and radiant heat downwind, although large fires may force smoke and flames out of more than one side of a module. This should be the primary and in most cases the only necessary case for protection of escape routes.

Generally evacuation routes should be shielded from process or production fires by the accommodation and alternative routes minimise the possibility of concurrent exposure of both routes.

Protection would normally only be needed if all the alternative routes are likely to be simultaneously exposed to excessive heat or smoke.

- (b) Escape and evacuation routes are susceptible to radiant heat and would not be available at levels much over 5 kW/m². Protection of the primary escape routes from radiant heat should be by their remote location from particular hazards.

Information available from the hazard identification and evaluation will identify escape routes likely to be vulnerable to high radiant heat levels.

- (c) Escape and evacuation routes and muster areas outside the TR will need smoke effects to be considered. Escape routes which can be smoke filled must generally be regarded as not available. Routes that must be available under all but catastrophic conditions should be protected.
- (d) Consideration should be given to the effects of an explosion on escape routes and their fire protection measures.

14.4 Choice of Protection

General recommendations and concerns are as follows:-

- (a) Where high radiant heat levels are predicted, escape routes will be at risk and water or mesh shields should be considered for protection of evacuating personnel .
- (b) Cooling may be achieved by use of water curtains or monitors linked to operation of water spray systems in process or drilling areas where the extinguishing/cooling water systems may have been actuated by an incident.

These may either directly protect the route or be used to divert or limit the spread of smoke and flame from the fires.

- (c) Passive protection can prevent failure of structural members supporting escape routes and bridges for a given period under hydrocarbon fire conditions. Intumescent coatings are less acceptable close to escape routes than other passive types because of their contribution to smoke levels.
- (d) Consideration should be given to punched plate material for escape route construction to assist cooling and prevent flame penetration encountered with grated construction.
- (e) Routes from the TR to muster areas for lifeboat launching, including bridges to adjacent platforms, may require a suitably rated fire enclosure.

15. UTILITIES AREA

15.1 Aims of Fire Protection

It may be necessary to keep essential utilities such as electrical generation and fire pumps available during an incident and appropriate fire protection systems would be required. Other protection to minimise equipment loss or production down time should be specified by the client/operator.

15.2 Types of Fire Hazard

Within the utilities area, the type of fire hazard should be limited to a small number of sources. Gas jet fires could occur from leaking gas mains to the power generation units. There is also a risk of pool fires and running fires from diesel oil, both at the power generation units and the diesel storage areas, from pipework or pumps should adverse conditions prevail. Other hazards include switchgear and cables which could give off toxic fumes and smoke, if they support combustion.

Consideration should be given to potential incidents in other areas which could affect the utilities area, such as blowout radiation and fuel fires.

15.3

Protectability

Utilities design should actively consider external fire exposure and the fire hazards of the utilities systems themselves. Utility location can influence the risks to which they may be exposed during a fire incident. Essential utilities such as fire pumps and electrical generation equipment should be protected or situated remotely from hydrocarbon inventories with high potential radiant heat output.

The layout and design should be discussed with electrical, piping and instrument engineers to encourage the development of designs that are more protectable. This means that specifications for utilities equipment and systems should include as technical requirements the following:-

- (a) Minimum risk of fire initiation, e.g. intrinsically safe.
- (b) Maximum resistance to fire propagation, i.e. maximum use of non combustible materials, built in thermal protection, etc.

Where plant design can incorporate the above characteristics and optimise the siting of essential utilities then, from the point of view of potential fires, 'protectability' is improved and the level of risk reduced.

15.4

Reduction of Fire Hazards

A number of measures can be taken at the conceptual and front end design stage:-

- (a) As much utilities plant as possible should be located in a dedicated non hazardous area that separates drilling and process areas of the installation from the accommodation module/TR .
- (b) Utilities that are important to maintaining control of the platform during an incident should be located in a non hazardous area.
- (c) Equipment items should be suitably separated or protected from each other so, for example, a diesel engine fire cannot disable other adjacent items such as fire pumps.
- (d) Appropriate remote and/or automatic isolation should be provided for hydrocarbon supplies to utilities. In the case of gas supplies, automatic isolation should be initiated on gas detection.

- (e) Switchgear and transformers should preferably not be oil filled. Where these are chosen, the oil should be non-flammable.

In cases where flammable oil is used, the particular fire and smoke hazards should be examined and appropriate shutdown and containment or protection should be provided.

- (f) Where utilities are intrinsically hazardous, such as closed drains, they should be routed well clear of open drains and potential ignition sources.

15.5

Need for Protection

The following utilities should be considered for protection:-

- (a) Plant containing flammable fluids which could give rise to a radiant heat risk to adjacent equipment and structural members, e.g. closed drains, seal and lube oil systems, methanol storage.
- (b) Utilities essential for inventory and/or incident control, e.g. main and emergency electrical power generation, switchgear rooms, fire water pumps.
- (c) Wellbay utilities should be separated from the wellbay area with an H rated fire barrier.
- (d) Plant that can ignite and present a threat to the wellbay/process area should be considered for protection.
- (e) Process and drilling area separation from the utilities area should normally be by a fire/blast wall of H rating based on the predicted duration of hydrocarbon fires in adjacent areas.
- (f) Where utilities are situated in a process area and are deemed essential, they should be enclosed in an H rated enclosure able to withstand a potential fire incident. Where possible, utilities essential to inventory control and mitigation of major fires, should not be sited in process areas.
- (g) Switchrooms should utilise zero spread of flame materials wherever practicable, in which case detection techniques will be adequate to allow manual intervention in case of a fire.
- (h) Main power generation should be protected, normally by the use of inert gas or fine water spray within its own fire rated acoustic hood. Emergency generators are normally situated within their own fire rated enclosure/room with total flood inert gas facilities provided.

- (i) Where electrical equipment is likely to be exposed to water as the extinguishing agent, specifications should allow for the necessary degree of water resistance if rapid recommissioning is required.

15.6 Choice of Protection

Guidance on the type of exposure protection to be used and the suggested method for fire extinguishment is given in Tables 4 and 5.

16. ACCOMMODATION

16.1 External Protection

16.1.1 Aims of Fire Protection

The primary aim of external accommodation protection is to prevent ingress of radiant heat and smoke into the living quarters, and protect the temporary refuge (TR) for personnel during predicted fire incidents. The TR itself must provide a protected enclosure with a breathable atmosphere that allows muster of personnel prior to decisions on evacuation.

16.1.2 Reduction of Fire Hazards

Consideration should be given to all fire types that could effect the accommodation. These could arise from any pressurised hydrocarbon systems, including helicopter fuel and other fuel systems as well as the produced fluids.

A number of measures can be taken at the conceptual and front end design stage:-

- (a) Consideration should be given to whether the whole of the accommodation module is designed as the TR or whether the TR will be a secure area within the larger structure.
- (b) The whole TR should be designed and maintained so that it does not exceed a passive air change rate in specified weather conditions.

This will be determined by the smoke and gas ingress (SGI) analysis (see 5.3). Doors and HVAC dampers should be as tightly sealing as possible. Rapid response smoke detection and HVAC shut down should be considered.

- (c) Risers should be routed well clear of the accommodation module and TR.
- (d) Wherever possible, the accommodation module should be separated from process and drilling areas by a non hazardous utility area.
- (e) The accommodation and TR should be as low as possible to minimise exposure to radiation from a blowout and the possibility of smoke or flame engulfment.
- (f) HVAC inlets, main access doors and evacuation doors should be positioned to minimise the possibility of smoke or flame engulfment.
- (g) Primary access and evacuation route doors should be fitted with air locks or corridors capable of holding at least 10 people.

This will minimise the possibility of both doors being opened simultaneously. Doors fitted to allow escape from fires within the accommodation, do not require air locks.

- (h) Fire wall and blast wall design in other areas should aim to prevent high overpressures or radiant heat from reaching the accommodation module and its supporting steelwork.
- (i) The use of fully socked external wall systems specifically rated to match the external fire hazards and/or the required survival and evacuation times. Materials should have a minimum rating of class A-60 in accordance with [IMO, SOLAS 1974](#).

Where external hydrocarbon fire hazards have been identified and quantified, then materials should be rated for the appropriate duration to class H in accordance with HSE Guidance Notes.

- (j) Structures directly and indirectly supporting the TR shall be protected. Passive protection of accommodation supports should be rated as necessary to permit platform evacuation.
- (k) All surrounding areas shall be critically examined to identify all faces of the accommodation module that could be exposed to the predicted fire loadings and wellhead incidents, such as blowouts, together with the smoke concentration and duration. Both the roof and base of the accommodation module should be considered for protection.

16.2 Internal Protection

16.2.1 Aims of Fire Protection

The primary aim of internal protection is to minimise the risk to life of the occupants by controlling the spread of fire and, where practicable, providing rapid extinguishing systems.

16.2.2 Reduction of Fire Hazards

General recommendations and concerns are as follows:-

- (a) Fire retardant construction materials and fittings, fire resistant foams, partitioning and escape route protection should be considered to improve the protectability of the total structure.
- (b) Protection should be provided for potential fire sources such as galleys, laundry and switchrooms. Specific protection should be given to deep fat fryers.
- (c) Passive fire protection should aim to prevent the spread of smoke and flames through the accommodation and TR.
- (d) The risks of fire and fire spread should be minimised and suitable detection systems specified before considering water based (sprinkler) systems. In many cases the residual risks to life will not be significant and sprinklers will add minimal further benefit.
- (e) Protection should be provided within the module and TR to support life for the period necessary to effect evacuation or, preferably, until the fire burns out.
- (f) Internal passive protection should be of the inert (not intumescent) type to avoid smoke generation. Surfaces that are likely to receive direct hydrocarbon flame impingement should be considered for rating to class H.
- (g) As a default for internal fire walls in the accommodation or TR, the ratings shown in SOLAS may be chosen in the absence of a detailed analysis. In the presence of particular fire hazards or high fire loadings, these ratings may need to be increased to suit. In particular, walls around laundries should be rated at least class A-0 in accordance with [IMO, SOLAS 1974](#).
- (h) Where utilities are situated within the accommodation module, reference should be made to all relevant points in section 15.

Particular care should be taken to prevent fire spread into the occupied and sleeping areas and in the specification of suitable fire walls and damper systems.

- (i) All escape routes should be considered for passive protection from fires originating in the accommodation module itself. These should be of B-15 rating internally and A-60 rating externally in accordance with [IMO, SOLAS 1974](#).

16.2.3 Guidance on the type of exposure protection to be used and the suggested method for fire extinguishment is given in Tables 4 and 5.

17. CONTROL ROOMS

17.1 External Protection

All necessary external protection should be determined as for the accommodation/TR as given in section 16.1.

17.2 Internal Protection

17.2.1 Aims of Fire Protection

For the purposes of this document, control room(s) are those areas which would become the emergency control centre. For remote control stations, e.g. local process control rooms, protection should be provided according to the need for them to remain operable and/or habitable during an incident. The need for them to be manned and their emergency functions, e.g. ESD, should be considered in this criticality.

Fire protection goals for control rooms and control stations should be defined clearly as part of an overall approach to fire risk assessment.

The primary aim of control room passive protection is to keep it operational during a fire incident, maximising control of hydrocarbon inventory until evacuation of non essential personnel has taken place.

17.2.2 Reduction of Fire Hazards

General recommendations and concerns are as follows:-

- (a) The central control room (CCR), which is normally manned at all times, can be made more protectable by locating it low down within the accommodation module/TR complex.

Provision of an emergency control room within the TR will give it additional protection from measures used to protect the TR. Extending the

period for which a control room remains operational effectively raises the evacuation threshold of the platform.

- (b) The floor and supporting structure of the control room should be protected.
- (c) Flame retardant materials (especially cables) should be used where possible. Consideration should be given to emergency and safety type systems where fire resistant cables may be used.
- (d) Important control stations located in open areas should be provided with heat shields to allow the maximum chance of operation during an early fire situation.
- (e) Separation of the accommodation/control room complex from process and drilling areas by a non hazardous utilities area.
- (f) Due consideration should be given to incidents in other areas that could affect the control room(s) such as blowout radiation, hydrocarbon jet and pool fires.
- (g) Control rooms should be critically examined to identify areas that could be exposed to fire loadings likely to require protection measures.
- (h) Protection should be given to structures within the accommodation module directly and indirectly supporting the control room.
- (i) Internal fire hazards should be examined to determine whether it is practical to extinguish the fire and keep the control room in a manned condition.

Normally, the fire loads and consequences of fires inside the control room would not justify fixed protection. High quality detection and manual intervention would normally be sufficient, especially as any main control room is normally manned at all times.

17.2.3 Choice of Protection Method

- (a) The discharge of fixed fire systems will seriously disrupt operations and cause damage. Fire detection equipment designed to give the earliest practicable alarm and attack with hand held extinguishers is preferred. However, where necessary, fixed extinguishing systems should be designed for rapid extinguishment and minimum potential damage.

- (b) Passive fire protection materials should not release toxic or other fumes into the control room when exposed to predicted fire conditions.
- (c) Control room protection shall meet or exceed the minimum standards set for the accommodation/TR complex design.



PART 3 - TECHNICAL REQUIREMENTS FOR ACTIVE AND PASSIVE FIRE PROTECTION SYSTEMS

18. INTRODUCTION

The designer should have developed a full understanding of the fire hazards on the installation and know where protection is required, the type of protection (active or passive) and the type of systems, e.g. deluge, intumescent coatings, prior to applying Part 3 of this Recommended Practice.

The following sections identify the need to set performance standards for each system, the factors which should be considered when setting these standards, minimum default standards and cost effective systems. The infrastructure to support these systems, e.g. fire pumps and ring mains, is also described.

Definitions of active and passive fire protection are given in Appendix A.

19. PERFORMANCE STANDARDS

Performance standards are the overall measures of suitability and efficiency of the systems to carry out their designated role.

Performance standards should ensure that the system:-

- (a) Is suitable and fully effective for the type of fire.
- (b) Has sufficient capacity for the duration of the fire or the required duration of operation/survival of the system.

For example, a system may be required to keep functioning until evacuation has been completed.

- (c) Has sufficient availability to match the frequency of the initiating event and the acceptability criteria for escalation to a major accident or critical failure. This should determine whether or not backup systems or contingency measures are needed to cover for maintenance and breakdown.
- (d) Has adequate resistance to any preceding explosion.
- (e) Has adequate response time to fulfil its role.

- (f) Is suitable for the environmental conditions within the maintenance and repair constraints of the operation and maintenance philosophy.
- (g) Is suitable for typical operating conditions (impact, abuse etc.).
- (h) Is operable by the quality of the personnel available on the platform under realistic incident conditions. This could include initiation and/or isolation and reinstatement of damaged systems, e.g. ring mains.
- (i) Can be maintained under actual environmental and manning limitations and thus ensure the availability requirements are met.

Sections 20 and 21 address performance standards for active and passive fire protection respectively.

20. ACTIVE FIRE PROTECTION

20.1 General

Active fire protection can be achieved in many ways, using a range of different systems and equipment. However, the basic media and typical applications are discussed below.

All active systems require some form of initiation before they can be used. This initiation can be either automatic, manual or a combination of the two and should be determined from the manning philosophy, accessibility and the required speed of response. Supplies of commodities such as diesel fuel and foam concentrate will determine the effective duration of the protection provision.

20.1.1 Water

Water is the most widely used medium, being applied to deluge systems for wellbay, process areas and utilities. The primary purpose of deluge is to cool areas and equipment which may be effected by radiated heat from a fire, and prevent escalation.

Water is also used inside the accommodation in the form of sprinkler systems. Here the purpose is to extinguish a domestic type of fire and to limit spread to other areas. Other developments in producing very fine 'fog' sprays are being considered and may be used more widely in place of gaseous systems.

20.1.2 Foam

Foam is used extensively, but only where there is a pool fire or other fire that can be extinguished (e.g. a helicopter fire).



Foam can be introduced to deluge systems or foam sprinkler systems, distributed by high velocity jet through monitors, or through hand lines. This has the benefit of reducing the burn rate and possibly achieving extinguishment once an oil system has depressurised.

* 20.1.3 Gas

Halogen compounds (i.e. Halon 1211, 1301 or other products identified within the Montreal Protocol) shall not be used. However, in some jurisdictions their use may be considered if it is defined as an “essential” requirement (see definition in Appendix A): BP must be consulted and give approval of any such case.

CO₂ shall only be used in areas where systems are in place to ensure that personnel are not present in the event of a discharge.

20.2 Water Based Systems

The basic elements of a fire water system shall be a supply sufficient to meet the demands and a piping distribution between the pump(s), hydrants and systems. Additional reserve pumps and duplicate water feeds such as ring mains shall only be provided if a single system cannot meet the designated availability performance standards. The fire main and fire pumps shall be sized to provide water sufficient for the worst single potential fire incident identified as a design case for the installation.

This may include the combined supply to large fixed water spray systems, and fixed monitors, as well as mobile attack, as required for the scenario.

Sea water will normally be used as fire water although some areas (e.g. accommodation) will have a fresh water based system.

20.2.1 Performance Standards

The following performance standards should be set for water supply, or for fixed systems themselves, including deluge systems, foam systems, sprinkler systems and monitors.

20.2.1.1 Availability (and Reliability)

The availability of systems and equipment should be such that the chance of the systems failing to fulfill their function during a major design incident does not constitute an unacceptable risk to life. This applies to all components and support equipment needed to provide the minimum performance including: sufficient water at adequate pressure, valving, foam supply and metering (as appropriate) and the application system. As a default minimum, a normally manned platform should not be operational for more than 12 hours if the capacity of the on-line fire

pumps is not sufficient to counteract the largest design event that could occur, given the hazards associated with the operations in progress. Where other individual components are not available, operational limits including shutdown and contingency measures should be agreed at the design stage. If necessary, backup or by-pass systems may be considered to meet the standard. These should only be specified with the agreement of the client.

20.2.1.2 Speed of Response

The required speed of response of each system will depend on the time to failure of equipment or structure which will increase the risk to personnel. The response time is the cumulative start up time of all the components and support systems, including run up to full flow or, in the case of foam systems, for control (80% extinguishment) of the fire. The response time should not be greater than the following as appropriate:-

- (a) time to critical structure or plant failure (default 5 minutes in jet fire and 10 minutes in pool fire).
- (b) survival time of occupants in a helicopter crash and fire (default 1 minute).
- (c) survival time of a dry system in the fire including steam choking of deluge system (no default - to be specifically addressed).
- (d) survival time of personnel in occupied areas.

20.2.1.3 Duration

Systems should be capable of operating until:-

- (a) the fire is extinguished and area secured (default 10 minutes for production hazards and 30 minutes for pressurised oil hazards),
- or (b) the smallest significant fire duration has elapsed (from the fire hazard analysis)
- or (c) the maximum evacuation time has been achieved (default minimum 1 hour).

It may be desirable to provide longer durations for protection of the investment from events such as blowouts.

20.2.1.4 Survivability



Sufficient capacity and a means of distribution shall remain intact following an explosion, or during a fire, if the water systems are needed to counteract the incidents. Depending on exposure, individual performance standards for resistance to blast overpressure, missile impact, drag loading and fire may be needed for specific system components or for their protective systems/shielding. These performance standards should match the hazard type and required survival time.

20.2.1.5 Application Rates

Application rates for foam, deluge or sprinkler systems will be determined from the fire type. These would normally be applied to the whole equipment surface area, the pool area, or the floor area. Default values are given in Tables 4 and 5. The performance standard requires the following as appropriate:-

- (a) sufficient cooling to prevent failure in the identified fire type (taking into account the ability of water droplets to penetrate the fire).
- (b) proven extinguishing capability with the chosen foam type and application method for the identified liquid fuel (foam systems).
- (c) proven extinguishing capability with water and the selected application method (sprinklers and water spray systems) for the identified fire type.
- (d) extinguishment by dilution (alcohol based fuels).

20.2.1.6 Foam Quality

Performance standards for foam quality should be set to ensure extinguishment of the identified fuel type and prevention of reignition by effective foam coverage. This applies to the combined performance of concentrate, induction and, where appropriate, aspiration systems. The following should be set:-

- (a) Foam concentrate quality (default [MIL-F-24385](#) and ICAO(B) as given in [CAA CAP 437](#) for helideck).
- (b) Induction rate tolerance (default -10% to +33% over the required flow range. This would mean 2.7% to 4% for a nominal 3% foam).
- (c) Aspiration quality where appropriate (default 25% drain time greater than 2 minutes).

20.2.1.7 Coverage

Coverage is generally referred to as that part of the target area for cooling which is actually wetted. Dry areas in this context refer to the unwetted remainder of the target area.

It is not practical to specify 100% coverage for all fixed systems. Coverage should be designed such that lack of cooling in any area would not lead to a significant probability of failure. With foam systems, either the foam flow should extinguish a fire in dry areas (which do not receive direct application), or the remaining fire should be neither life threatening nor have the potential for escalation. Default values are:-

(a) Deluge

- (i) 95% - vessels
- (ii) 75% - piping
- (iii) 100% - *wafer type heat exchangers and sandwich/ wafer type valves.*
- (iv) 100% - ESD valves.
- (v) 75% - pumps, compressors and other plant.
- (vi) 90% - firewalls.
- (vii) 90% - structures.

In all cases, discrete dry areas greater than 2m^2 or 2m in length are not acceptable.

(b) Foam

- (i) 75% direct application and no point on the target area further than 5 metres from a point of application (aspirated).
- (ii) 90% direct application and no point on the target area further than 1 metre from a point of application (non aspirated).

20.2.2 Fire Water Demands



The minimum fire water capacity shall be calculated using approved fire assessment methods as described in Part 1.

The fire water demands will require simultaneous pressure and flow conditions to be met at the appropriate piping nodes, based on the largest design scenarios, as typically shown below.

SCENARIO	PIPING NODE					
	10	11	12	13	14	15
Separator Fire	2000 l/min @ 7 bar		5000 l/min @ 8 bar		400 l/min	
Helideck		1800 l/min @ 14 bar		900 l/min @ 9 bar		
Drill Blowout	2000 l/min @ 7 bar		5000 l/min @ 8 bar			5000 l/min @ 7 bar

After accounting for static and friction pressure losses, the system should be able to supply the simultaneous requirements of all system nodes for any scenario.

The largest design fire cases should be examined, typically blowouts and major vessel fires. In each case, the size of fire which lasts long enough to cause failure should be examined to see which critical items would be engulfed under various wind conditions. The water demand should be based on the simultaneous operation of all fixed systems (protecting identified critical items for the worst case) plus a provision for manual equipment to shield personnel or divert smoke and flame, if considered necessary and practicable. It is clear that a number of smaller systems would be more flexible than one or two very large systems.

Additional water demands for foam manufacture, pump cooling and personnel escape, using fixed and portable equipment, shall be included according to the scenario.

In calculating the actual water demand, it is likely that more systems than the minimum identified for the worst scenario will be actuated, either automatically or manually. Normally the pump run out characteristic should be adequate to supply these additional systems without serious detriment to the performance of the primary systems. However, this should be checked during the hydraulic analysis and, if unacceptable, a water management system (either local or remote manual in the control room) may be needed.

Where fire water management systems are employed to conserve water (e.g. split water spray systems), this shall be acknowledged when calculating the total firewater demand in that area. For any area of plant the total calculated firewater demand shall include adequate provision for manual equipment.

20.2.3 Fire Water Pumps

20.2.3.1 The number of duty pumps (N) should be determined by the capacity of each pump (based on commercially available units) and the maximum fire water demand for the worst case scenario. The number of standby units should be determined in accordance with legislation, required availability and operational philosophy or design codes. It is likely that the minimum total number of pumps will be N+1. For a platform which cannot tolerate extended shutdowns, N+2 may be required.

There are several options:-

- (i) *One or more spare pumps may be provided to allow the platform to continue to operate during pump maintenance or breakdown.*
- (ii) *If no spare pump is provided, the platform production should shut down when there is a pump breakdown or major maintenance is required. (This may be accompanied by a high reliability pump specification and generous spares provision). On a multiple jacket installation production shutdown would not be required, provided safe evacuation to the other jacket can be assured.*
- (iii) *Pump ratings can be utilised more flexibly with spare pumps being available as in (i) for the lower demands of high frequency incidents, such as process fires, but all the installed capacity would be needed to meet the maximum design scenario, e.g. development drilling blowout.*

Main cooling water/sea water winning pumps may be regarded as spare fire water pumps if they are designed to meet all the performance criteria of the primary fire water pumps including power supply availability.

There are several options including the use of fast response electric pumps, direct or indirect diesel pumps or the provision of additional water supplies for smaller demands, e.g. helidecks, from live sea water systems. The demand for fast response of diesel engines may have an adverse effect on reliability and this should be considered when setting a realistic performance standard and specifying the pump.

20.2.3.2 When considering multi platform installations with pipe bridges between platforms, the installation may be considered as one providing:-

- (a) All the individual platform's fire mains are interconnected.
- (b) The inter platform connections are sized to allow all envisaged demands to be satisfied by any combination of pumps.

20.2.3.3 All fire pumps should be installed in a safe area, segregated by space or firewalls and suitably protected from external hazards.

The pumps shall comply with BP Group [GS 124-2](#), [GS 124-3](#) or [GS 124-4](#) depending on the selected type of pump and driver.

The pump performance curve shall be selected to match the flows and pressures needed for each of the major fire scenarios. Both high pressure/low flow incidents, such as helideck fires, and high flow/low pressure incidents, such as process fires using deluge systems, shall be considered.

A flat curve such as that advocated in NFPA is preferred, so that any additional demands do not drastically reduce overall performance. The specification shall provide at least 80% of the design pressure for the largest fire scenario at a flow 20% in excess of the design flow.

The pump power, fuel supplies and other utilities shall be designed such that all installed pumps can be run simultaneously. Pumps shall be positioned within stilling tubes which should incorporate permanent screening equipment.

The NPSHA should be determined for the minimum tidal condition excluding wave effects. This will correspond to the maximum water temperature in combination with the following as appropriate:-

- (i) Lowest astronomical tide.
- (ii) Maximum drawdown in stilling tubes.

Additionally, allowance shall be made for wave effect when the minimum trough exceeds 10% of the NPSHA under continuous conditions as determined above. If the risk of fouling is high it shall be assumed that 50% of the strainers are blocked when determining the NPSHA. Additionally, a 10% margin should be provided on the calculated NPSHA to cover inaccuracies in estimates of the suction conditions. It will also cover temporary losses due to modest fouling of the strainers.

The pump's discharge line should be fitted with a pressure controlled dump valve for testing purposes and to ensure a minimum flow for cooling. The dump line shall be fitted with a flow element capable of measuring the rated pump capacity, at the limit of run out, so that pump performance as described by [NFPA 20](#) can be monitored.

20.2.4 Fire Pump Drivers



Electric motor and diesel engine driven pumps may be provided but gasoline engine driven pumps shall not be permitted. Any combination of electric motor or diesel engine may be used on an installation subject to the following:-

- The selected driver types and support systems should not permit a common mode failure between pumps, thereby ensuring that an incident or fault affecting one pump does not affect another.

With diesel engine driven pumps it is normally practicable to provide a local 24 hour diesel fuel tank but special arrangements may be needed where power is derived from a gas turbine.

Depending on the climate and fuel quality, fuel tanks and lines may require insulation and heating to ensure availability of power supplies.

20.2.5 Fire Pump Control

Pump control panels shall be located adjacent to the pump driver. Fire water pressure adjacent to the pump discharge manifold and at extremes of the ring main should be indicated and repeated in the main control room. For electric motor driven pumps, the control arrangements shall comply with BP Group [RP 12-4](#).

Fire pumps shall be provided with automatic start from the fire and gas detection system. An additional facility shall be provided for manual start from the CCR and from the local pump control panel. The duty pump shall be selected from the main control room. Start of the standby pump shall be initiated if the duty pump fails to start or in the event that the duty fire pump, when running, cannot maintain the required fire water pressure.

* 20.2.6 Fire Mains

The fire main system shall be routed away from, or otherwise protected from, the effects of potential fires and explosions, using any form of protective shielding afforded by structural members. Where this is not practicable, and damage is anticipated, a secondary supply through a ring main may be considered. But this is only acceptable if it is feasible to locate a failure and to isolate it, given the disrupted conditions of a major accident.

As far as possible, the fire main should not extend into or around the main hydrocarbon areas in order to minimise exposure to, and damage from fires and explosions. Supplies to deluge systems and monitors should be located in secure, safe areas. This should eliminate the need for double feeds to systems. It also eliminates the need for ring mains in the hydrocarbon areas.



At extremities of the fire main system suitable valved and blanked flushing points shall be provided.

When specifically identified as feasible and desirable, block valves shall be provided to enhance the functionality of the fire water system during construction, commissioning, operation and maintenance.

If it is reasonably practical to do so, provision should be made for future connections such that there is minimal outage of the fire water system. e.g. headers may terminate in bolted flanges rather than welded ends.

All new systems and major extensions to existing systems should be subject to a full hydraulic analysis to ensure that the required water quantities can be delivered for all major fire scenarios.

The hydraulic analysis may be by computer program subject to client agreement being obtained in advance. A summary report of the computer analysis, including input and output data, shall be a project deliverable.

Fire mains may be constructed in cupro nickel, super duplex stainless steel or titanium. Glass reinforced plastic (GRP), or other plastic alternatives may be acceptable subject to client approval. The choice should be a balance of weight and cost considerations, against technical constraints.

The design pressure of the system and its components should be equal to or greater than the shut-in pressure of the fire pumps plus any allowances to be made for differences in elevation between the fire pump discharges and the lowest point. This philosophy eliminates the need for over pressure protection (e.g. relief valves) within the fire water system.

When the above philosophy results in high design pressures, advantage should be taken of the intermittent use of a fire main and pressure level excursions allowed by the design code [ANSI B31.3](#).

The fire mains shall be kept full of water and pressurised by a cross connection from a suitable water supply such as cooling water, or pressurising (jockey) pump. The cross connection shall be provided with a non-return valve to prevent backflow of water when the fire pumps are started. No cross connection shall be taken from a system supplying domestic or drinking water.

* 20.2.7 Fire Hydrants



Hydrants do not need to be spaced at regular intervals around process areas. It is preferable to provide multiple banks of hydrants at safe approaches to those areas, allowing a planned attack with a combination of branch pipes and monitors from secure positions.

All hydrants outlets shall be compatible with the national design code applicable to the country of operation.

Where there is a danger of hydrants being damaged by explosive overpressure the design of the hydrant shall be agreed with the client.

Where the normal system operating pressure is in excess of 7 barg, consideration shall be given to making hydrant outlets of the dual pressure type. High pressure supplies shall be able to deliver water at full system pressure for monitors. Reduced pressure shall be for hand held hoses. Dual pressure outlets should be normally set to the low pressure mode; changeover to high pressure shall be by a simple local operation, e.g. by the movement of a lever on the hydrant outlet assembly.

Hydrant stations shall be provided with an appropriate number of small (1 3/4") and large (2 1/2") hose, branch pipe and ground monitors to deal with the anticipated fires and substitute for damaged fixed systems if appropriate.

20.2.8 Monitors

Four types of monitors shall be considered:-

- (i) Fixed water foam monitor.
- (ii) Wheeled water monitor (portable).
- (iii) Oscillating fixed water monitor and/or foam monitor.
- (iv) Foam Monitors - would normally be non aspirated and also suitable for water.

Fixed monitors shall be used when they can be located so as to protect more than one item of process equipment or where their use is more effective than a fixed water spray system for fire fighting. They should normally be accessible for manual control under fire conditions or dedicated to one target or have an oscillating spray pattern. Manual control handwheels/levers shall be of such design that they can easily be activated under fire conditions and shall be fixed permanently to the monitor.

Oscillating monitors should be fitted with simple manual override/oscillation disengagement.

The following factors shall be considered when locating fire water monitors:-

- (a) Physical obstructions to water streams between the monitor and protected equipment.
- (b) Local wind conditions where shifting wind patterns may block use of monitors or reduce effectiveness of protection, especially for helidecks.
- (c) Prevailing wind direction.
- (d) Monitors on the periphery of protected areas should be located in positions that will be easily accessible with minimum risk to operating personnel during a fire.
- (e) The maximum distance from protected equipment should be 30 m.

Monitors would normally be supplied through a manual valve. In some cases, a remotely operated valve may be supplied for dedicated or oscillating monitors.

Remote release from the main control room would not normally be provided, unless specified for a particular hazard and local or local/remote operation is not practical.

Monitors may be fixed or automatic traverse (water powered type) dependent upon the risk and role.

20.2.8.1 Fixed Water Monitors

Fixed water monitors shall be of the hand lever operation type, with locking devices, and should allow full rotational movement of 360 degrees and elevation movement from 15 degrees below horizontal to 60 degrees above horizontal. The monitor nozzle shall be of the variable type with a water discharge pattern ranging from straight stream to wide spray. Each monitor shall be provided with a quarter turn valve at the inlet. These should be operated by gear mechanisms to prevent water hammer on shutoff.

Fixed water monitors shall have a straight stream range of at least 36 m in still air conditions at the normal system water operating pressure.

Whilst monitors should normally be located at least 15 m away from the equipment to be protected, it is permissible to reduce this distance if the monitor is located inside a process area, is preset, or oscillating, and fitted with remote valve operation.

20.2.8.2 Oscillating Fixed Water Monitor

The nozzle shall be oscillated automatically in the horizontal plane by the fire water when flowing. The nozzle shall be variable to discharge a pattern ranging from straight stream to fog and/or foam.

20.2.8.3 Helideck Monitors

These should normally be oscillating type fitted with self inducing spray/jet non aspirated nozzles.

20.2.8.4 Accommodation/TR Monitors

Monitors may be considered for use on the outer walkways between the hazards and the safe ends of the platform. They can be used to deflect smoke and flame billowing out from process/wellbay areas, to provide radiation protection during evacuation, to directly cool the TR and to provide a means of flexible response in the event of a major incident causing damage to the other "forward" fixed systems. Such monitors would normally be fixed with, possibly, remote actuation and fitted with jet/spray nozzles capable of at least 120 degrees spray. They should be rated 1800-3600 l/min depending on the number and pump capacity.

20.2.9 Fixed Water Spray Systems

20.2.9.1 System Philosophy

Fixed water spray fire protection systems may be used for:-

- Exposure protection of structural steel members, bulkheads, critical valves and vessels.
- Control of burning, lowering of temperature.
- Smoke dissipation.
- To extinguish fires, normally in conjunction with foam.

The fixed water spray systems should prevent the failure of the protected items of plant and equipment when exposed to the identified fire types, and give:-

- Suitable coverage of the items
- Adequate application rate and design to penetrate the fire and limit the heat input.
- Adequate response time.

Systems for exposure protection and control of burning may be designed and installed in accordance with [NFPA 15](#) if suitable for the fire hazards. However more onerous application rates and piping arrangements may be needed for spray or jet fires, and such systems should be developed from appropriate test data.

Systems for personnel exposure protection shall be designed and installed in accordance with [NFPA 15](#) or equivalent. Specialist design advice for water curtains should be sought from the Custodian.

The most effective use of available water requires concentration at critical hydrocarbon handling equipment and structures using large, high velocity nozzles. This gives a high probability of counteracting intense fires which may occur in processing and wellbay areas.

Tables 4 and 5 give typical rates of application for fixed water spray systems.

20.2.9.2 System Design

One large system covering all equipment in an area bounded by fire walls is not preferred. Individual groups of adjacent equipment should be protected by discrete systems, e.g. a bank of MOL pumps, a train of separators or a pair of compressors. Systems should generally be sized between 3000 and 8000 l/min. An exception may be the wellbay system which may consume up to 20,000 l/min.

For sea water systems it is recommended that:-

- (a) All pipework be NPS 2 or greater.
- (b) Nozzle openings shall not be less than 8 mm diameter.
- (c) Stainless steel, cupro-nickel or fire protected GRP pipework shall be used.
- (d) Strainers be installed at strategic points, e.g. upstream of deluge valve assemblies utilising control orifices.
- (e) Strainers shall not be installed in the nozzles.
- (f) Lockable drain valves or drain holes be provided.

Water supplies to multiple dry pipe systems fed from a single deluge valve should be through a normally closed flexible sleeve valve. For single systems clack valves are acceptable where remote shut off would not be needed to isolate damage or manage water use. Operation of the deluge valve may be either automatic or manual, remote or local dependent upon the risk. Valves shall be located to permit safe access during a fire incident.

Normally only a single feed to the deluge valve would be needed. A deluge valve bypass or duplicate feed may be necessary if the basic system failed to give the availability requirements (calculated under section 20.2.1) or these enhancements made a significant contribution to achieving these targets.

It should be recognised that neither a secondary feed or a bypass would, in reality, be activated in an incident. These features would only be needed if either the deluge valve or the primary feed was expected to be isolated for a significant time (e.g. greater than 10%) during the operational life. Without these features, deluge skids cannot normally be justified and simple wall mounted control packages can be used.

When designing any system, all pipework must be self draining, as far as possible to an open nozzle. Piping spurs should be taken off the

bottom of main headers. All deluge systems should be fitted with a drain and test connection. Removable drain plugs should not be used. Weep holes may be used providing that an excessive number are not drilled into the pipework and that adequate precautions are taken to ensure that local corrosion is inhibited. They must also be regularly checked for blockage.

20.2.9.3 Detection/Actuation

The type, location and control function of detection equipment shall be determined by reference to BP Group [RP 30-7](#). Except where provided for radiation protection (e.g. blowout) in most circumstances deluge systems would be automatic. Systems protecting ATK, diesel tanks and top deck gas bottles may be manually operated. Remotely operated valves for these systems are only needed if it is not possible to locate manual valves in a safe accessible location. The system should be automatic when manual release cannot give adequate assurance of an acceptable probability of operation or speed of response.

The need for automatic actuation is defined in [BPX HSQ 30.01.02](#). This requires that areas graded A or B for fire detection should have automatic systems and that systems should be remotely closeable from the CCR for water management.

In areas covered by fixed water spray systems which require continuous monitoring, primary fire detection should utilise optical flame detectors. Infra red flame detectors may be augmented by electrical heat detectors positioned over identified hazards, such as pumps, and by smoke detectors in enclosed areas. It is beneficial, where optical systems may be locked out for frequent or long periods, to consider the use of heat detectors in separate zones so that a degree of automatic action is retained during the lockout.

Electrical signals should be routed via the fire and gas panel. Actuation would normally require a signal from at least two fire detectors in the area. Detectors would normally be arranged so that the area covered by a single water spray system would also correspond to a fire zone. Where more than one system is installed in a module, some adjustment of the fire zones may be required to stop multiple system releases. With very large, open modules having numerous water spray systems, a form of priority control may be required to prevent an excessive number of systems being released.

Pneumatic detectors may be a useful addition to the fire and gas system where conventional detectors could be frequently locked out. They are also worth consideration for use in a retrofit, where it may not be possible to link the system into the existing fire and gas panel. Pneumatic systems totally dump the contents of the air reservoir over a long period and it may not be possible to reclose the valve remotely. This is not a serious drawback as pneumatic detectors will only operate when a fire directly impinges on them. The manual pneumatic release should only

be used by personnel leaving an area where fire has been discovered. There should be no need to reclose the valve until the fire is extinguished. The loss of pneumatic signal caused by failure of a frangible bulb should have priority over the electrical, remote close, signal.

Water spray systems should all be fitted with manual actuation at the deluge valve and it may be advisable to fit manual actuation stations at the primary escape routes from the protected area.

The fire pumps should start automatically whenever a water spray system is actuated (automatically or manually). Primary pump start should not depend solely on detection of low fire main pressure but should be on a direct signal from the Fire and Gas panel. Deluge water flow should also be sensed by a pressure switch (downstream of all valving and by-passes) on the deluge valve set. This should also initiate a fire pump start through the Fire and Gas panel.

20.2.9.4 Drainage

Adequate provisions shall be made to promptly and effectively contain and/or dispose of all liquids from the fire area during operation of all water protective systems. Such provisions shall be designed to accommodate:-

- (a) Hydrocarbon spillages.
- (b) Fire water discharged from fixed systems at maximum flow conditions.
- (c) Fire water discharged by hose streams or monitors.
- (d) Rain water.
- (e) Other water sources.

The following methods of disposal or containment shall be considered:-

- sloping floors
- bunding
- open drains systems
- dumping overboard

The method adopted will be dependent on:-

- extent of the hazard
- clear space available
- protection required



Where the hazard is low, the spacing is adequate, and the degree of protection required is not great, sloping floors alone are acceptable. Where these conditions are not present, consideration should be given to bunding or enclosed drainage.

Drainage is a primary control measure to limit the spread of burning oil and the total burn rate or fire size of a pool fire.

The outflow drain must be sized to accommodate the largest liquid hydrocarbon release rate in the area and the maximum deluge and fire water flow into the area. Note that this may be larger than the design flow if the system is operating above the duty point and branch pipes/monitors are also directed into the area.

The drains must be arranged either (i) to take oil from the top of the liquid surface, in order to reduce the fire as quickly as possible, or (ii) to take the water from the bottom and leave the oil in the area. The latter case (ii) should be used if it is not possible to route the drain to a safe location and the oil may reignite in another area or in the sea.

20.2.10 Sprinkler Systems

20.2.10.1 System Philosophy

Automatic sprinkler systems may be used for:-

- (a) Control of burning, lowering of temperature.
- (b) Exposure protection of bulkheads.
- (c) Smoke dispersion.

Normally sprinkler systems are installed to protect accommodation spaces, stores, workshops and office areas. This may be extended to include other areas such as mud pumps, drill offices and cementer rooms.

Systems for personnel exposure protection shall be sized, designed and installed in accordance with [NFPA 13](#).

The need for sprinkler systems is defined in sections 15 and 16 but the increased usage of inherently safe and non flammable materials of construction and contents has, to some extent, reduced the need for them.

20.2.10.2 System Design

The sprinkler systems should extend to all areas where the main source of hazard is ordinary combustible materials.

Means of isolating sprinkler systems should be clearly marked and accessible during a fire in the area protected by the system.

Accommodation systems should be charged with fresh water and all other systems should be either preaction air charged or fresh water charged if not exposed to freezing temperatures. Back up supplies should be available from the fire water main.

The accommodation system pipework would be normally charged from a service water tank sized to provide water simultaneously to two sprinkler heads at the maximum pressure drop for a period of 10 minutes. When the contents of the service water tank are exhausted the Fire and Gas system should automatically change over to water supplied from the fire water main.

The instrument air system would normally pressurise the service water tank. With the phasing out of halon, dry pipe, preaction or a combined dry pipe and preaction sprinkler system may be specified. These should be sized, designed and installed in accordance with NFPA 13.

Sprinkler heads should normally be of the upright frangible bulb type, rated to operate at 68°C. In areas where high ceiling temperatures are expected to occur sprinkler heads should be rated at a minimum of 30°C above the highest ambient temperature anticipated.

20.2.10.3 For wet pipe sprinkler systems it is recommended that:-

- (a) Pipework be carbon steel, stainless steel, cupro-nickel or fire protected GRP.
- (b) Lockable drain test valves be provided.
- (c) In the accommodation, each run of pipework be provided with a facility to flush out prior to refilling with service water.

Water flow to the sprinkler system should be controlled by means of a sprinkler control valve. This valve should also act as a check valve preventing back-flow from the system into the fire water main. An isolating valve should be provided adjacent to the sprinkler valve, with drain and test valves immediately downstream of the sprinkler control valve.

Where a single system protects more than one fire zone, an isolation valve should be provided for each zone. Flow switches are unreliable and may be deleted if there is separate fire detection in each area. Test

connections should be provided at the remote end of each zone, including a normally closed valve and restriction orifice, sized to simulate the operation of one sprinkler head.

20.2.10.4 For dry pipe/preaction sprinkler systems it is recommended that:-

- (a) Pipework be stainless steel, cupro-nickel or fire protected GRP.
- (b) The end section has a system test connection
- (c) Protection against water accumulation above the dry pipe valve shall be provided.

The dry pipe system would typically comprise automatic sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which will permit the water pressure to open a dry pipe valve.

The preaction system would typically comprise automatic sprinklers attached to a piping system containing air, that may or may not be under pressure, and have a fire detection system installed in the same area as the sprinklers. Actuation of the fire detection system should open a valve that permits water to flow to the sprinklers.

A combined dry pipe and preaction sprinkler system would typically comprise automatic sprinklers attached to a piping system containing air under pressure and have a fire detection system installed in the same area as the sprinklers. On detection of a fire the system should initially open air exhaust valves at extremities of the feed main, to facilitate filling of the system with water. Then the necessary dry pipe valves should simultaneously open, to give a controlled loss of air pressure in the system. The fire detection system should also connect into the Fire and Gas system and alarm automatically.

20.2.10.5 Detection/Actuation

Should the frangible bulb on a sprinkler branch be fractured, the flow of water through the branch should cause the relevant flow switch and sprinkler valve limit switch to operate and open the sprinkler valve.

In the event of sprinkler actuation, an alarm should be enunciated both visibly and audibly at the main Fire and Gas panel and in the CCR. The duty fire pump should start automatically. System actuation should be generally automatic, with no manual starting facility, and detected by either a flow or pressure switch, connected to the alarm check valve assembly and providing an alarm in the CCR. The alarm and annunciation system should allow simultaneous warning at the main

Fire and Gas panel of the activation of flow or pressure switches from different zones.

20.2.11 Fine Water Spray

Fine water spray systems can be designed to give effective extinguishment of compartment fires provided that the hazards are well defined and that acceptable test data and design information is available. These systems have undergone sufficient testing such that they are acceptable for use offshore. The BP/Ginge-Kerr water/air system has been approved for use in gas turbine enclosures. This could be extended to reciprocating engines in enclosures or other applications following successful representative testing.

The systems work by a combination of effects on the fuel and the fire. These are:-

- reduction of the vaporisation/burn rate of liquid spills;
- reduction of the oxygen content by steam generation;
- absorption of heat from the flame limiting heat feedback to the fuel;
- spray or gas jet flame destabilisation.

Of these, reduction of the oxygen level is thought to be the primary mechanism. Clearly this will be most effective where there is a limit to the air supply and the fire and hot surfaces have sufficient energy to create enough steam to be effective. In designing the system, the following should be specified:-

- the application rate (concentration) in relation to the enclosure volume;
- the speed of response
- the duration of application
- the number and interval between sequential discharges.

20.2.12 Fixed Foam Systems

20.2.12.1 General

Fixed foam systems are those comprising permanently installed foam distribution equipment and foam making equipment. These may be initiated automatically or manually with remote or local control.

The selection of fixed systems shall be based on the level of risk with special attention paid to the risk to personnel required to operate the system in an incident.

The main areas where permanently installed foam protection systems may be used are:-

- (a) helidecks.
- (b) diesel engines.
- (c) ATK/diesel tank bunds.

Deluge systems giving exposure protection of oil processing equipment may be enhanced with foam if a pool fire of $>10 \text{ kg/s}$ or 200 m^2 could burn for more than 30 minutes. Consideration may also be given to an alternative separate fixed aspirated system (generally medium expansion foam) which can be used both for blanketing an unignited spill or extinguishing a fire, once the process has depressurised. This may often be cheaper than deluge foam induction, as the systems can be designed with inductors rather than foam pumps, and it requires less foam concentrate.

20.2.12.2 Process Areas

Individual foam systems may be installed to add 3% AFFF or equivalent to selected deluge systems. This would provide fire extinguishing capability (via water/foam solution) through the spray heads, foam sprinklers, foam generators or monitors.

Foam may be added by either inductors or pumped arrangements. Inductors are preferred as they are intrinsically reliable (no moving parts), do not require initiation, and do not need power. However, they are limited in their total flow, cause loss of 35% of the available head, need to be installed downstream of actuation valves and need careful design to ensure accurate induction within the tolerance limits of the concentrate. Such systems should be checked and set up during commissioning to ensure that the correct induction ratio is achieved.

Where pumped systems are needed, pelton wheel drivers are preferred, as they do not need actuation or a separate power source. They should either be sized to meter an accurate quantity to an individual system or be provided with a variable flow proportioner to meter the foam into a supply feeding various demands.

Electrically pumped systems are normally only needed for very large systems. These should meter foam through a variable flow proportioner.

The minimum foam storage requirement should be based on the simultaneous operation of the deluge systems for 15 minutes, or in the case of process protection, 10 minutes more than the time needed to reduce pressure below the spray/pool transition pressure of the fuel.

Foam system selection push buttons and foam pump start/stop push buttons should be adjacent to each of the foam/deluge control valve skids and on the Fire and Gas control panel in the CCR.

Operation of a foam pump start push button should start the pump and pressurise the foam discharge manifold upstream of the foam system control valve. Operation of the selected system foam release button should energise a solenoid operated control valve, allowing foam into the required deluge system via a foam injection control unit. All pumped systems may need a return to the foam tank. This should be subsurface to prevent frothing.

Where oil processing plant is not provided with foam induction in the deluge systems, fixed 1000 litre 3% foam tanks should be located in a safe position on at least one, preferably two, outer walkways. This would be normally alongside the utilities or accommodation areas, preferably near the multiple hydrant station (see 20.2.7). They should not be located directly outside the process area. Tanks should be provided with a 900 l/min inductor, hard piped into the ring main with a 3" valved supply. The outlet should have an instantaneous connection, either on the tank/inductor, or piped to a more convenient location on the same level with 3" piping. A 900 l/min matched aspirated branch pipe should be provided.

Alternatively portable foam units may be provided for fire fighting within liquid hydrocarbon areas, from either hand held branch pipes or portable monitors. These would be trolley mounted, each having a storage tank, variable flow foam inductor, fire hoses and portable foam nozzle branch pipe.

20.2.12.3 Helideck

The helideck should be equipped with at least two fire water monitors, supplied from the fire water ring main and equipped with dedicated self inducing foam nozzles. Three monitors should be provided for helidecks with 'D' greater than 22 m. Oscillating monitors should not be located directly beside escape routes as they could impede escape. Monitors should be positioned away from the lowest point of the slope on the helideck since pool fires will flow in that direction. The

monitors shall be suitably located around the helideck to ensure operation under all weather conditions.

The monitors should be self oscillating horizontally, traversed by an integral fire water driven turbine over an included arc of 40 degrees to 115 degrees at up to 8 cycles per minute. Monitor elevation may be set manually between +60 degrees and -20 degrees from horizontal. Manual monitors will only be permitted if they can be manned during helicopter landing and take off.

Each monitor may be supplied with AFFF/fire water solution via a dedicated foam tank adjacent to each monitor or from a centralised storage facility. Each monitor should be able to discharge 1800 l/min of foam solution with a range of 35 m. There should be sufficient foam liquid for a minimum of 10 minutes use by each monitor.

Oscillating monitor nozzles should be fitted with spring indents or locks to set the spray angle to 10 degrees to prevent injury.

Helideck monitor control should be provided from two manual release stations located in protected areas selected to give a good view of the helideck. The release stations may be at the monitors.

A small 80 - 100 l/min water hose reel should be provided for cabin fires.

A manual aspirated foam branch pipe may be considered for post extinguishment security.

The helideck drains should be capable of taking the combined flow of all the monitors operating simultaneously.

20.2.12.4 Foam Concentrates

The suitability of different types of foam concentrates, the application rates and minimum supply requirements are given in Tables 4 and 5.

20.3 Inert Gas Systems

20.3.1 Performance Standards

Performance standards will need to be set in the following areas:-

20.3.1.1 Concentration

The concentration shall be sufficient to ensure extinguishment for the identified fire type. This concentration shall be achieved in all areas for the required retention time.

Default - CO₂ - NFPA

20.3.1.2 Retention Time

The retention time shall be sufficient to ensure extinguishment and cooling below re-ignition temperature or fuel dispersion

Default - 10 minutes, deep seated
- 5 minutes, others

20.3.1.3 Response Time

This shall be sufficient to prevent escalation, critical failure or where appropriate, loss of life. The response would be defined following detection of a specified fire size.

20.3.1.4 Personnel Safety

Where the agent is applied in concentrations which are toxic or asphyxiating, adequate precautions shall be in place to protect the occupants of any enclosure. Time delays should prevent release until the necessary evacuation time is exceeded or lockouts should be supplied.

* 20.3.2 Halons

Usage of halons is controlled by the Montreal Protocol and/or European Commission Regulations and signatory countries are expected to cease production and usage by the year 2000. In the interim, supplies for existing fixed systems will become difficult to obtain and expensive. Proposals for halon systems at new facilities shall be restricted to “essential” use (see Appendix A for definition) and subject to approval by the Client.

There are no immediate replacements for halons traditionally used for fire extinguishing purposes. While alternatives are coming onto the market, these are being subjected by users, government authorities, licensing approvers and manufacturers to physiological, environmental and fire extinguishing tests. Updated information is available from BP (Custodian).



20.3.3 Carbon Dioxide (CO₂) Systems

20.3.3.1 The primary use of CO₂ is the suppression of Class 0, I and II petroleum liquids (see IP Code) and electrical fires. CO₂ shall be used when there is a need for an extinguishing agent but where the use of water, foam or dry power would be damaging to equipment. CO₂ shall be used in either:-

- (a) Portable and wheeled fire fighting equipment or
- (b) Fixed total flooding systems (Enclosure Protection). These may be initiated automatically or by remote manual action.

The installation of fixed carbon dioxide systems shall be based on a risk analysis founded on the criteria of Section 5 of this document.

20.3.3.2 CO₂ systems should be considered for the following applications:-

- (a) Gas turbines.
- (b) Diesel engines.
- (c) Enclosed machinery.
- (d) Switchrooms containing flammable oil-filled switchgear.

20.3.3.3 Because carbon dioxide is both toxic and an asphyxiant, at the concentrations needed for fire extinguishing purposes, fixed total flood systems shall only be installed when the following conditions exist:-

- (a) The area is not permanently occupied and persons visiting the area can lock-off the system before entry.
- (b) The protection requires an extinguishing agent that possesses low electrical conductivity and does not cause damage to the equipment.

20.3.3.4 The design of the system shall be governed by [BS 5306](#) Part 4 or [NFPA 12](#) or an equivalent standard. The minimum acceptable standards shall be:-

- a design concentration of not less than 34% by volume of CO₂.
- the minimum design concentration should be achieved in a maximum time of 1 minute.

The quantity of carbon dioxide required shall be based on a rate of application necessary to completely cover the area or volume to be protected and the time that is necessary to ensure complete extinction of the fuel. The minimum effective discharge time shall be 30 seconds.

In cases of combustible materials that sustain deep seated fires or equipment needing a significant run down period, the minimum design concentration should be reached in a maximum of 7 minutes, but the discharge flow should ensure that a concentration of 30% is achieved within 2 minutes.

All total flood systems shall have reserve cylinders of a number and capacity equal to those of the main cylinders.

20.3.3.5 Where a total flood system is fitted to an enclosure which can be entered, then personnel should be protected by the following:-

- (a) Local alarms, both audible and visible.
- (b) Positive isolation.
- (c) Warning signs.

In addition, entry to the enclosure should not be possible with the system in automatic mode.

Means to indicate the state of the system shall be provided in accordance with BP Group [RP 30-5](#) Section 4.

Following a CO₂ discharge and/or an extinguished fire, personnel should only be allowed to enter an enclosure if:-

- (i) *They are equipped with self contained breathing apparatus.*
- or (ii) *The ventilation system has been operating for a sufficient period of time to clear the atmosphere. In enclosures without installed ventilation and areas such as voids, portable mechanical air movers should be used to clear the atmosphere. Test equipment should be used to ensure that the oxygen content of the atmosphere has returned to normal.*

20.3.4 Chemical Dry Powder

The use of dry powder shall normally be limited to portable and mobile equipment with a maximum capacity of 250 kg. The installation of fixed chemical powder systems shall be based on a risk analysis founded on the criteria of Section 4. Chemical dry powder systems should be considered for the following:-

- (a) galleys
- (b) storage areas containing hydrocarbon liquids and flammable gasses

The design of local applications systems shall be in accordance with [NFPA 17](#) or equivalent.

20.4 Manual Fire Fighting

20.4.1 The Role of Manual Intervention

Individual operators or fire teams can fulfil the following roles:-

- (i) to extinguish small incipient fires;
- (ii) to investigate alarm/incidents and provide information to the CCR;
- (iii) to extinguish or control fires where no fixed protection has been provided;
- (iv) to augment fixed systems where these are insufficient to control fires or to extinguish fires in areas only provided with fixed exposure protection;
- (v) to extinguish or control fires when some or all of the fixed systems have been disabled;
- (vi) to control the movement of smoke and flames, particularly away from the TR and evacuation facilities;
- (vii) to search for, and rescue, missing, trapped or injured personnel;
- (viii) to operate manual fixed systems and to reinstate damaged ones;
- (ix) to protect personnel during muster and evacuation;
- (x) to apply a foam blanket onto an unignited liquid hydrocarbon spill.

The size and capability of the fire team and other individuals on the platform should be assessed, or agreed with the Operator on a new project, before placing reliance on them to fulfil any of these roles. Suitable and sufficient portable equipment shall only be provided to fulfil the identified roles and personnel shall be trained in its use.

20.4.2 Hydrants and Fixed Monitors

Where the fire team is expected to carry out roles (iii), (iv), (v), (vi), (viii) and (ix), the types and characteristics of these incidents should be studied and representative pre-fire plans should be prepared. These would identify the numbers of personnel required and the type, numbers and location of equipment needed for each incident or groups of incidents. Particular care should be taken in the placing of hydrant stations so that they are accessible during the anticipated fire and that there are sufficient outlets (6-8 per process area) to enable a whole fire team to advance from one point. It is preferable to have a large multi hydrant station located in a shielded position on an escape route or access way, than to locate pairs of outlets closely spaced throughout major hazard areas. This can also eliminate the need to route the fire main through process areas, eliminating its vulnerability to explosions.

Fixed spray/jet monitors should be considered at such hydrant stations where they cover hydrocarbon areas and are located on outer walkways. These can give immediate protection to the fire team (while they prepare to advance), control the movement of smoke and flame and provide cooling of the external structure. Hydrant outlet types should be as described in 20.2.7.

20.4.3 Loose Equipment

The following should be provided at each hydrant:-

- 2 lengths of lay flat hose per hydrant outlet
- 1 spray jet branch pipe for each pair of outlets.

Portable monitors may be provided if required for a particular role. They should be designed for offshore use and be secure on plating or grating. They should be provided with safety chains or other securing systems.

The hose should be 1-3/4" for manual branch pipes up to 500 l/min and 2-1/2" for ground monitors or branch pipes with larger flows. The hose should be of sufficient pressure rating to withstand the fire main duty and any surge predictions. It should be of a fire and wear resistant type such as the Home Office specification [JCDD/1/1/3](#).

Branch pipes should be of the spray/jet type and capable of a wide angle shield, varying through a narrow angle spray, to a straight jet. They should not have excessive jet reaction. This may limit water and non aspirated foam types to 500 l/min at 7 bar. Preferably, they should be of the pistol grip type with a water shut-off valve.

20.4.4 Foam Stations

Where roles (iii), (iv), (v) and (x) are expected from fire teams in oil process and wellbay modules, foam branch pipes and fixed foam tanks should be provided at a minimum of two hydrant stations in different locations outside the modules. They should be of the low expansion aspirated type to provide an effective foam blanket on an unignited spill and to provide extinguishment of pool fires. They should give a foam quality (25% drainage time) in excess of two minutes when used with the chosen concentrate. The total capacity of the branch pipes should be sufficient to maintain an application rate of 4 l/min onto the largest pool area on each level of the module. As a default 900 l/min aspirated branch pipes should be chosen for minimal jet reaction.

Alternatively, non aspirated foam can be applied through the water branch pipes for extinguishment but portable, free standing medium expansion foam generators of 900-1800 l/min capacity should be considered for spill blanketing and post extinguishment security.

20.4.5 Extinguishers

A range of extinguishers should be provided suitable for the types of fire hazards. Where located outside, they should be specified, or protected to withstand the saline and other environmental conditions. The need for extinguishers should be determined by examining the hazards, the consequences and the likelihood of competent personnel being present to use them. In addition, suitable extinguishers may be needed for fire watch duties. Extinguishers should be located so that they are readily accessible for use in the areas where they may be needed. It is not necessary to provide one in every space but they may be grouped in clearly marked fire points.

21. PASSIVE FIRE PROTECTION

21.1 General

21.1.1 Passive measures are intended to give protection from the direct heat of a fire whereas active measures are generally intended to cool, prevent the spread of fire to adjacent areas and under some circumstances extinguish the fire.

Passive protection will therefore be the primary method of protection for:-

- (i) *Accommodation, escape and evacuation routes, and temporary safe refuges where there is a need to protect personnel from radiant heat, fire and smoke (including oxygen depletion).*

- (ii) Structures which, if they were to collapse/distort, would lead to significant hydrocarbon release, catastrophic failure, loss or damage to the CCR or emergency systems and/or put personnel at risk.

It may also be considered as an alternative to water spray for:-

- (iii) Plant or equipment such as hydrocarbon storage or process vessels, that, by failing, could release additional inventory which would need to be countered/controlled during the combating of the incident.
- (iv) Process vessels which could rupture catastrophically (BLEVE).
- (v) Critical safety systems such as ESD valves, actuators and control cables. These would only need protection if their inherent fire resistance is insufficient to maintain their operability before they have completed their function.

In addition passive protection may be applied to critical equipment and/or structures in order to protect investment and platform production.

- 21.1.2 Passive fire protection should provide effective fire protection without introducing additional failure modes, such as corrosion, or inhibiting other safety factors such as inspection. To that end, it is preferable to have either a completely demountable system with corrosion protection coatings underneath or a system which is totally impervious to moisture and is difficult to remove. A system which may permit moisture ingress after damage or has porous inner layers is generally unacceptable if the outer layers cannot easily be removed for inspection. Systems must be suitable for realistic offshore environmental conditions and allow for the effects of wear and tear. They should also be suitable for repair in these conditions.

Providing they are correctly maintained passive systems do not require any actions (either human intervention or automatic intervention) to be initiated in the event of an incident. It should be noted however that passive protection does have a finite life during an incident; this life will depend upon the original specification and the similarity of the actual incident to that assumed for the design case.

- 21.1.3 There may be health hazards when working with substances contained in passive fire protection materials and the selection process should take these factors into account.

Health precautions, for example as detailed in [SI 1657](#) COSHH regulations and data sheets, should always be followed. With some materials this may limit the practicality of repair offshore, e.g. asbestos.

21.2 Performance Standards

The following performance standards should be set for passive fire protection systems.

Systems should match the types of fire to which they are exposed and representative tests should be carried out to verify the performance.

21.2.1 Suitability

Systems may be exposed to different fire types and should be suitable for the anticipated range of heat fluxes and flame velocities. Fires should be categorised as:-

- (a) Jet (gas jet, LPG and high pressure oil spray).
- (b) Pool (hydrocarbon pool fires).
- (c) Cellulose (non hydrocarbon hazards).

21.2.2 Duration

Systems should be specified to prevent failure within a specified duration, where failure is defined as the failure temperature. The duration will either be:-

- (a) The maximum anticipated fire exposure time.
- (b) The operating time of the protected equipment (e.g. ESD valves).
- (c) The evacuation time.

21.2.3 Coverage

Coverage defines the plant, equipment and structure to be protected. It should be sufficient to ensure that areas of localised overheating are not sufficient to constitute failure of the protected item. (Default 100% plus protrusions).

21.2.4 Failure Temperature

This is the temperature above which the protected item would have insufficient strength to carry out its role in :-

- (a) Containing hydrocarbons (piping and vessels).
- (b) Supporting loads (structural steel).
- (c) Insulating (accommodation internal temperatures and firewalls).

(d) Isolating (ESD valve closure).

21.2.5 Smoke Generation

The maximum tolerable generation rate of toxic smoke should be defined where materials are used inside accommodation areas or where they may be ingested through doors, HVAC inlets, etc. These external sources should be addressed by the Smoke and Gas Ingress Study.

21.2.6 Operational Life

The required life in the anticipated environmental conditions should be specified.

Default - field life, or a minimum of 10 years.

21.2.7 Applicability

The range of humidity and temperatures during which the material can be applied and repaired should be defined.

Default - up to 25% relative humidity and 5°C to 25°C.

21.2.8 Explosion Resistance

The overpressures and consequent deformation after which the systems are expected to function to their specified performance should be defined.

21.2.9 Impact Resistance

The required resistance to impact should be defined considering normal operations and missiles in explosions.

It is essential that the manufacturer's specifications are followed during installation, reinstatement and maintenance. Any deviation from the specification must be agreed with and approved by the manufacturer. It is advisable to have the installation witnessed and approved by the manufacturer as complying with the specification and meeting the performance standards.

21.3 Structural Steelwork.

Consideration should be given to the maintainability of the fire resistant material in terms of ease of access and frequency of maintenance.

In some areas, e.g. near wellheads, there is a high probability of structural steelwork being knocked during normal operations. In these areas material with a good resistance to impact damage should be used. In addition, sensible protective measures such as column edge protection should be employed.

21.4 Supports for Vertical Towers and Vessels

If the fire exposure of any supporting structure could lead to the collapse of a tower, or release of a further significant hydrocarbon inventory, then that structure shall be fire proofed.

Exterior surfaces of skirts supporting towers or vertical vessels containing hydrocarbons and located within a fire exposed envelope of sufficient duration and intensity shall be fire proofed. Skirt interior surfaces shall be fire proofed when there are flanges or valves within the skirt or if there are manway openings greater than 600 mm diameter. Skirts of vessels less than 760 mm (30") diameter need not be protected on the inside. Pipe penetrations and other small openings should be plugged where possible. Manholes in skirts shall be left clear, and, where necessary, additional reinforcement should be provided around the periphery of the manhole. Vent holes at or near the top of vessel skirts shall be kept clear.

It is essential that direct and indirect supports of vessels requiring protection should retain the ability of the vessel to move on its supports to accommodate thermal expansion.

Anchor bolts shall be fire protected unless otherwise specified. Particular attention shall be paid to the detailing around bolts anchored in epoxy resin, where there is a danger of conducted heat affecting the anchorage.

Elevated exposed legs supporting towers or vessels shall be fire proofed to their full load bearing height.

21.5 Vessels

Passive fire protection of vessels on process plant may be required. Where fire conditions result in relief capacity requirements in excess of that from any other emergency condition, passive fire protection of selected vessels shall be applied, where economical, to reduce the discharge rate and the size of any closed relief system (see BP Group [RP 44-1](#)) Protection may also be needed to prevent a BLEVE or to reduce fire water demand.

The passive fire protection system shall be specifically designed to resist the drag forces of explosion due to foreseeable blast waves (if any), and to maintain its insulation properties for an extended period, which will be specified by fire analysis. This should not be less than 1 hour.

Where a vessel is to be fire protected, the whole vessel shall be insulated. Pipework leading from the vessel shall be protected up to the first fire safe ESD valve.

The insulation should, if possible, be of the removable type to enable routine vessel inspection. It should also be water resistant or the vessel should have an adequate paint, or corrosion resistance, specification. Particular attention should be paid to external vessels or those protected by deluge/fire water systems to ensure that corrosion does not occur. Points to watch are:-

- (a) Chloride stress corrosion cracking of stainless steels.
- (b) Elevated vessel temperatures.

21.6

Electrical Power and Control Cables

Power and control cables associated with critical operating equipment or loss prevention devices located within an area where they may be exposed to flame shall be fire protected. Primary methods to avoid early cable failure include:-

- (a) Routing around or high above areas of high fire potential.
- (b) Providing water spray protection.

If none of the above methods are available and prolonged cable service is desirable within an area exposed to flame the following options should be considered:-

- (i) Cables rated for high temperature.
- (ii) Fire resistant cable trays.
- (iii) Passively fire protected cable trays.
- (iv) Wrap around, foil-backed insulating systems.
- (v) Direct application of fire proofing material to exposed cable jacketing.
- (vi) Preformed pipe insulation.

The protection system selected should keep the temperature of the cable within acceptable limits for the time period necessary to carry out critical control functions.

However, it should be noted that fire proofing systems for cables can result in cable operating temperatures that are higher than normal and the cable may need to be derated.

21.7 Pneumatic and Hydraulic Control Lines

Pneumatic and hydraulic control lines associated with double actuating, critical operating equipment or loss prevention devices, sited within an area where they may be exposed to flame may need to be protected. The methods described for electrical cable are equally applicable to pneumatic and hydraulic control lines.

Hydraulic systems using type 304, 316 and 321 stainless steel tubing may not require fire protection provided all parts of the system are provided with pressure relief.

Other types of control tubing are liable to rapid failure, and fire proofing with preformed pipe insulation should be considered. The assembly should be weather protected.

21.8 Emergency Valves

21.8.1 Where blast and/or fire protection is required, both the valve and the actuator may be protected. The mass of the valve may be such that only the actuator and associated controls will need protection.

Where continued power is required to operate valves, which are critical for safe shutdown, depressurisation or isolating the feed of a unit, the valve and its associated power supply shall be afforded fire protection if within a significant fire exposed envelope. Protection shall be provided to power and signal lines and the motor or actuator. The valve body, pipework and supports 3 m either side of the valve shall also be protected.

The protection shall be designed such that adequate time is allowed for the valve to travel from the fully open to the fully closed position (or vice versa) when exposed to the fires identified in the analysis. Valves that fail to a safe position need not be fire proofed.

Power and control cables shall be protected as described above. The motor actuator may be protected by fire resistant systems such as preformed or panel systems.

21.8.2 When specifying emergency valves and protective covers the following items require special consideration:-

- (a) The system must be designed to allow access for maintenance, inspection and removal. In the latter cases, full strip down of the system may be needed. The system should be robust enough to withstand regular use. This particularly applies to hinges and catches. Systems with screws/bolts on inspection hatches are unsuitable. Blankets and lace-up/strapped systems are not suitable for regular inspection or dismantling.
- (b) Thermal limit switches built into electric motors that may cause the motor to fail during a fire.
- (c) The valve hand wheel and engaging lever shall not be fire proofed to the extent that the valve is inoperable.
- (d) The valve position indicator shall not be covered.
- (e) The diaphragm housing on diaphragm operated valves should not be fire proofed if the valve is designed to fail to the safe position.

21.8.3

The passive fire protection of valves has in recent years been approached largely by establishing conformity with standard fire tests (unwisely often referred to as 'fire-safe' tests) for soft seated ball valves. This general policy has a number of disadvantages, e.g.:-

- (a) *For many soft seated valves, behaviour during a fire is not a significant factor compared with other issues.*
- (b) *For certain important duties however, the overall performance of a valve during a fire may be very significant, whether it is soft seated or not. For such important duties, it is necessary to distinguish between (i) valves that must remain operable for some period during a fire, and (ii) those that are required to remain closed.*
- (c) *The performance during a fire of the motor, actuator and cabling, etc., is just as important as that of the valve itself.*
- (d) *Fire tests of large valves (say NPS 8 and above) have required unrealistically long fire durations for test completion.*
- (e) *Many valves, sold as fire tested to a published standard, when checked have not conformed to the standard.*

Accordingly the requirements should be based on identifying those valves that must be operable during a fire and selecting protection, type of valve or fire tested design as appropriate. BP Group [RP 62-1](#) provides some general guidance for valves that are on critical duty.

21.9 Risers and Riser ESD Valves

Risers and associated ESD valves should be protected as required by BP Group [RP 43-3](#). The protection specification should match the maximum anticipated explosion overpressure and impact loads where the riser and valves cannot be located remote from these hazards. The fire protection systems must match the type and duration of the anticipated fires and should protect the ESD valve, the actuator, control and support systems (e.g. hydraulic power packs) and the riser down to 5 metres below the bottom deck of the platform.

The need for further protection in the splash zone should be determined by the likelihood and severity of fires in this area. Where practical, such events should be prevented. If the consequences of riser failure will overwhelm manned installations, protection will be required. This should withstand the environmental loading, prevent moisture ingress and the anticipated fire types. It should not increase the probability or rate of corrosion unless suitable allowances and inspection measures are provided.

21.10 Selection of Fire Resistant Materials

Selection of fire resistant materials requires care to obtain the desired degree of protection during the service life. Besides fire resistance, a variety of other characteristics are required to ensure proper performances.

The principal characteristics governing selection of fire proofing materials are outlined below.

21.10.1 Fire Performance

Materials should be tested in equivalent, or worse fire conditions than those anticipated. In general, certified A ratings are acceptable for cellulose fires and H ratings are acceptable for pool fires. These should be certified with appropriate furnace tests meeting recognised national and international standards. Approval for jet fire exposure should be subject to the results of representative tests which simulate the hazard.

At present, the only acceptable test methods are those performed by British Gas at Spadeadam (UK) and Sintef at Trondheim (Norway), known as the "Interim Jet Fire Test". Adequate performance in these tests would denote acceptability for gaseous jet and liquid spray fires.

21.10.2 Weight Limitations

Weights should be considered with respect to the overall platform weight, which will affect the jacket design and lift requirements during installation.

Densities of various products to achieve a two hour hydrocarbon pool/jet fire protection rating for steel structures vary and may influence the choice of system.

21.10.3 Adhesive Strength and Durability

Bonding of the fire proofing material to the protected surface should be strong enough to resist mechanical impact damage, vibration, differential expansion caused by changes in operating temperatures. It should also protect the substrate against corrosion.

When applying the material to structures or vessels, fixing methods shall be in accordance with [BS 476](#), [ASTM E 119](#) or [UL 1709](#), and with the manufacturer's recommendations.

Poor bonding will reduce the service life of the fire resistant material. Poor impact resistance may lead to the degree of fire resistance being impaired due to mechanical damage in normal service conditions or blast. Particular systems will require mesh reinforcement.

21.10.4 Weatherability

Humidity, rain, sunlight and ambient temperatures can influence the insulating quality and life expectancy of the coating. Breakdown of the coating can lead to corrosion of the substrate and the coating reinforcing mesh.

Materials should be selected in accordance with international test standards, e.g. [UL263](#), [UL1709](#), [ASTM G26](#), [BS 476](#) Part 5 or equivalent. Leachable chlorides or sulphides in the material should be negligible.

All fire proofing located outdoors shall be sealed to prevent moisture from reaching the fire proofed surface, unless it is inherently watertight. Seals at junction points between the fire proofing and exposed steel structure should be inspected regularly. In cases of high vibration levels, inspection should be every two years.

Weather protective coatings required to seal lightweight concrete and similar materials should have a life expectancy of 5 to 7 years depending upon the environment.

Existing coatings which are peeling or cracked should be removed and repaired as approved by the coating manufacturer.

21.10.5 Chemical Tolerance

Materials shall be selected with regard to their chemical tolerance to acids, bases, salts and solvents present on the plant.

Vapour permeability and porosity can lead to corrosion of the substrate. A significant amount of free water can cause the fire proofing to spall when subjected to a high temperature hydrocarbon fire.

The selection of fire proofing material and installation techniques should be based on the substrates' normal range of operating temperatures.

21.10.6 Combustibility

Intumescent (organic) fire proofing materials generate smoke when exposed to fire. Their level of combustibility can be assigned values according to [NFPA 255](#) for flame spread and smoke developed.

When fire proofing materials are used in enclosed structures and manned areas, combustibility should be limited as follows:-

- (a) Flame spread 0-25
- (b) Smoke developed 0-450

(Note these limits conform to NFPA 101, Class A interior finish.)

When fire proofing materials are used in the open, combustibility should be limited as follows:-

- (c) Flame spread 26-75
- (d) Smoke developed No limit

21.10.7 Repair of Existing Equipment

No repair work should be undertaken without vendor consultation.

Material selection for the repair of existing installations should be treated with caution. Even when using identical or similar generic materials there will always be differences in the properties of the new and old material due to age and weathering.

21.10.8 Ease of Application



Material selection should be based on the following application requirements, both at the construction sites and on location:-

- (a) Vendor approved techniques which have been proven in the field
- (b) Shelf life of the components
- (c) Quality of surface preparation and any difficulty in working within the area
- (d) Thinner to be used. Some materials are water based; others contain hydrocarbons. Solvents may be toxic and/or flammable and therefore hazardous if used improperly. Saline and brackish water can affect the durability of the final product
- (e) Temperature and humidity. Many materials can be applied only within limited ranges
- (f) Vendor approved priming, adhesion coating, top coat and joint sealing systems must be used
- (g) Steel preparation should be in accordance with BP Group [GS 106-2](#)
- (h) Licensing authority approval and system fire test certification requirements

21.10.9 Identification

All passive fire protection coatings shall carry an indelible means of identification such that, as a minimum, material and fire/blast rating is self evident without reference to drawings, documentation or certificates. Suitable methods shall include nameplates or embossed/painted surfaces.

21.11 Specification of Fire Proofing Materials

For each material and system performance standards shall be set as outlined in 21.2.

Particular attention must be paid to the type of fire as many proprietary systems have not been tested or certified for hydrocarbon pool, spray or jet fires. The ability of systems to withstand the erosive effects of jets requires particular attention.

21.11.1 Spray Applied Intumescent and Subliming Coatings

These are particularly suitable for structural steelwork and firewalls in hydrocarbon areas. They are less suitable in continuously manned areas because of the emission of smoke and toxic fumes. They also can be used for vessels and piping but particular provision must be made for inspection, manholes, tappings and instruments.

Generally, only epoxy based systems are recommended because water based equivalents have failed to provide adequate durability and long term fire performance. Products are continually under development and a full examination of manufacturer's claims and tests is required to ensure that they are suitable for the fire and other conditions that may be expected in service. This particularly applies to jet fire resistance.

The selected system must be specified and applied to achieve and retain adequate bond strength to the underlying steelwork. This should ensure that:-

- (a) the coating remains in place for the required fire duration and any preceding explosion and deformation conditions,
- (b) the specified operational lifetime is achieved in normal service, and
- (c) moisture does not penetrate and induce hidden corrosion to the substrate.

Bond strength is achieved by a combination of the underlying paint specification, the intumescent material specification and the reinforcement. Clearly the higher the bond strength the better, but it must have sufficient elasticity to absorb deformation without cracking. Reinforcing meshes are usually steel retained with welded pins, which is desirable for post explosion performance. It is unlikely that a system would give adequate jet fire resistance without at least a single layer, and in most cases double layer, of mesh. Some new systems are using glass or carbon fibre meshes which do not need retention pins. These are cheaper to install and lighter than previous systems, but to date there is minimal service experience, and very careful examination of suitability is required before selection.

Intumescent coatings can deteriorate when applied to materials which reach elevated temperatures during operation, for example export risers. Manufacturers should advise on the permissible maximum working temperature, and where this may be exceeded, an insulating layer may be specified underneath. This must be of a rigid type, such as glass reinforced epoxy resin, totally bonded to the protected equipment and the coating should be spray applied to the insulation. Porous insulation systems, such as mineral wool, must not be used as they will form a moisture trap.

Intumescent coatings are particularly useful for awkward and complex equipment details. The specification for such duties must include:-

- *Interface with other passive systems such as doors, windows and penetrations.*
- *Corners.*
- *Webs of structural beams.*
- *Edges and extremities of coatings.*
- *Piping joints (GRP systems).*
- *Instrument tapplings.*
- *Pipe hangers.*

21.11.2 Spray or Trowel Applied Cementitious Coating

The same considerations as given in 21.11.1 should be applied. However cementitious coatings do not have the same resistance to wear and tear, are unlikely to have as long a working life, and may need repair and refurbishment during that time. Kick and corner plates should be fitted at exposed locations to extend the working life. As cementitious coatings have a lower bond strength, reinforcement for post blast resistance is even more important. As it is more prone to damage and has poorer water resistance, corrosion underneath the coating can be a serious problem. This can be overcome with an adequate surface coating and suitable plating or plastic coating of the reinforcing mesh.

Cementitious coatings do not generally emit toxic fumes in a fire and may be suitable for passive fire proofing of structures inside accommodation modules and manned areas. They generally also have superior jet fire performance. They are not normally suitable for fire proofing of vessels owing to the difficulties with inspection, the possibility of corrosion and the inability of the coating to absorb thermal expansion without cracking.

21.11.3 Insulation Systems

Such systems include mineral wool and block type insulation, similar to that used for process or environmental insulation. In many cases insulation performance is required in normal service as well as the ability to provide fire protection capability and care must be taken to ensure that the specification covers both duties effectively. There are two groups: those providing insulation on the inside of an impervious structural barrier (usually steel); and those providing insulation between a critical item and the fire. In some cases, such as a double sided A 60 firewall, insulation on one side will fulfil both roles. When insulation is provided on the fire side, it is usually protected by a cladding to resist the erosive effects of the fire. This cladding may be a light mesh and aluminised foil or a stainless steel sheet. The system should be fire

tested and certified, installed (and reinstated after removal) in accordance with approved methods.

Mineral fibre systems are suitable for use in continuously manned areas providing that they do not emit excessive quantities of toxic fumes in a fire. This particularly applies to any bonding agents and surface treatments applied to the fibres.

External vessel and pipe insulation is an effective method of providing fire protection. It would normally be provided with stainless steel cladding and the suppliers must provide full details of all the jointing, supporting arrangements, retaining straps, fittings, fixings, etc. The whole system including joint detail should be certified. Vessel and piping systems should, at least, have a hydrocarbon (H) fire rating.

This would be satisfactory for pool fires but special jointing and bonding systems may be needed to give jet fire resistance. These normally use ceramic fibres which require health precautions (breathing masks) for installers and maintenance personnel.

Where it is likely to be exposed to deluge, rain, and/or elevated temperature, or conditions likely to cause condensation, the insulation system should be specified to resist the ingress of moisture. Even with this precaution it cannot normally be prevented so the underlying material should have an appropriate inherent corrosion resistance or protective coating. Particular attention should also be paid to weak points such as the welded pins used to retain mineral wool in some systems.

Composite systems using mineral wool sealed with another layer, such as rubber or intumescent coatings, are unsatisfactory and should not be used.

Process insulation systems may be removed during their working life and the FEHMP should include procedures to ensure that they are reinstated to the approved specification. Points requiring regular access should have removable panels.

Inspection procedures should require a periodic assessment of the insulating material for deterioration. Manufacturers should specify these inspection intervals and acceptable material characteristics.

21.11.4 Panel Systems

Panel systems may be provided in flat or preformed sections. They are suitable for firewalls, ESD valve enclosures, other enclosures, or process equipment, vessels and pipework. They are available as a proprietary panel, in limited sizes (which need a supporting structure and jointing system) arranged for assembly into an integrated system, or custom made to particular shapes and sizes. Some systems can

withstand up to 1 bar explosion overpressure and have some resistance to impact from missiles, but these generally require a supporting structure to match the load.

Jointing systems need to be specified so that they can accommodate any relative thermal expansion between the panel and the supporting or underlying structure. The joints and panel systems must be either arranged to protect the supporting structure, or else the structure should be protected from fire. Care must be taken with the interface detail between a protected structure, and the panels to ensure that full protection is achieved. Where a double sided firewall has been specified (e.g. between a wellbay and process area) the structure will, almost certainly, require protection unless it is sandwiched between a double panel system. Systems which totally shield the structure, will eliminate the need for protection.

The panel systems must be specified as demountable or permanently installed. Permanently installed systems must be designed to withstand moisture ingress, or the underlying structure/equipment must be internally corrosion resistant, or protected to a specification which has an adequate design life. Particular care must be taken with the panel fixing points as they may be weak points in the corrosion protection system. Where demountable systems are chosen, the fixings must be designed to match the frequency of removal. Hinges, latches, toggles, etc. should be specified to take the compression fixing/retention loads and the weight of the panels.

21.11.4.1 Glass Reinforced Plastic Sandwich

These systems have an outer layer of glass reinforced plastic and an inner rigid insulating core. They are generally available in standard panel sizes which can be cut to shape for a particular application. A supporting steel frame will be required in most cases. Curved sections are available for vessel protection. They are recommended for ESD valve enclosures, other enclosures, firewalls and small modules.

Care must be taken in detailing joints, interfaces and areas where the panels are cut for transits. Curved vessel sections should have adequate support which must match the fire duty. This particularly applies to joints, instrument covers and the banding system. The material is suitable for cellulose, pool, spray and jet fires.

It should be recognised that the system is sacrificial and the transition from an inside surface temperature of 50-100°C to full flame penetration may occur in less than 5 minutes. The time to penetration should be specified as at least 30 minutes more than the insulation time

for firewalls directly protecting manned areas. It is not normally necessary to specify a penetration time of greater than 2 hours.

21.11.4.2 Stainless Steel Sandwich

These are normally custom made, with either ceramic fibre or layered foil mesh insulation, and are normally only specified for valve and emergency systems enclosures. They can be self supporting or mounted on a framework. They are suitable for all fire types and are generally reusable following a fire (subject to inspection by the manufacturer). Demountable systems, doors and inspection hatches must be suitable for long term use and reliability. The thickness of outer skins subject to wear and tear should not be less than 18 SWG.

21.11.4.3 Building Panel Systems

These include standard architectural systems for internal use and hydrocarbon rated sheet materials. They are flexible to use and easily installed on site. They must be fully certified and full details of all the likely joints and interfaces must be provided. As they are site installed, careful quality control must be exercised to ensure that all the installation details comply with the manufacturer's requirements. The recommendations for GRP panels generally apply where they are installed in external or process areas.

21.11.5 Tile Systems

Tiles can be supplied either as bolt on or fully bonded arrangements. They are a convenient method of refitting existing platforms as they minimise the need for surface preparation. However, they are not recommended where there are other practical alternatives.

The bolt on systems are generally not removable and can allow water accumulation and spreading underneath the tiles. This leads to corrosion, particularly at the mounting points.

Bonded systems should achieve a total seal and bond over the whole tile surface to ensure long term and post explosion strength, and to prevent moisture ingress.

Full details of installation procedures, including maximum and minimum internal spacings, and detailing for interfaces with other systems, doors, windows, penetrations, caulking, mastic or other infill systems must be provided and the whole system should be certified.

21.12 Specification of Penetrations

Any penetration (doors, windows, etc.) should at least match the performance standards of the main system.

21.12.1 Doors/Airlocks

Doors should be designed to match the overall fire resistance of the enclosure and, generally, the outer door of the airlock and its external walling should be to that standard. Consideration should be given to fitting self closing mechanisms to ensure that doors remain closed. If it is likely that services, such as airlines or water hoses, will be regularly run through the door, then a separate specific transit should be provided to avoid wedging the door open.

Where door seals are expected to wear out within the life of the platform, an inspection plan should be provided and the seals should be of a replaceable type.

Sliding doors should be designed to avoid trapping the forearm between the handle and the door frame during operation (this has caused a number of fractures).

Doors bounding areas where an explosion risk has been identified should be designed to withstand the blast and, where required, to be operable post explosion.

21.12.2 Windows

These should be the same rating as the wall. While it may be desirable generally to eliminate windows, they are an essential element for personnel in gathering information during an incident, particularly on conditions outside the TR and the possible need to evacuate.

If it is not possible to specify a window to the same rating as the wall, internal and external shutters may be provided, with internal release and fusible links.

21.12.3 HVAC Penetrations

Dampers should be fitted which match the rating of the firewall. This rating may require duct insulation extending 1 m, or 2 x duct width, whichever is greater, from the firewall. In cases where a duct passes through an area and there are no outlets or inlets, the ductwork may be to the firewall standard throughout the area. Where dampers are critical to prevent smoke and gas ingress to or movement within the accommodation module or TR, they should close automatically and limit the maximum leakage at a specified differential pressure. This limit should be derived from its contribution to the overall tolerable leakage for the accommodation or the TR.

21.12.4 Cable and Piping Penetrations

These should be to the same rating as the wall. Where post explosion deformation of the wall may occur, the penetration integrity should be maintained. Sealing materials should not emit excessive quantities of toxic fumes if used in accommodation or manned areas.

FIRE AREA :							
AREA TYPE :							
Fire Type	Source or Item (Note 1)	I.D.	Combustible Material	Capacity/ Inventory (kg)	Pressure (bar g)	Enclosed	Consequential Hazards (Note 2)
Pool	HP Separator	V01	Crude oil	20,000	14	No	External flaming smoke
	LP Separator	V02	Crude oil	1,900	2	No	External flaming smoke
	Pump Lube Oil Tank	T04	Lube oil	1,000	Atmos	Yes (A0)	Smoke
Spray	HP Sep	V01	Crude oil	2,000 oil	14	No	External flaming smoke
Jet	HP Separator	V01	Gas	3,000	14	No	External Jet
	Gas Meter	G03	Gas	1,500	150	No	External Jet
Elect	Compressor Motor	M01	Insulation	100	-	-	Smoke

Note 1: Fires from other areas shall be identified by area only and not by specific source.

Note 2: This is not the consequence of the fire within the area in question but a note of the possible consequences in other areas.

TABLE 1
HAZARD IDENTIFICATION (EXAMPLE DATA)

AREA :			
Source or Item	I.D.	High Probability Hazards	Low Probability Hazards
1st Stage Separator	0000	Escalation to other vessels. Failure of pipework and vessel supports. Partial or total deck collapse under the vessel. Obscuration of adjacent escape routes. External flaming effecting levels above.	Wellhead failure. BLEVE.

TABLE 2
ASSOCIATED HAZARDS (EXAMPLE DATA)



AREA - PROCESS								
Source	Fire Type	Combustible Material	Release Rate (kg/s)	Release Quantity (kg)	Fire Size	Radiant Heat (kW/m ²)	Duration (s)	Other Data
First Stage Separator	Jet	Gas	5 (initial)	100	30m Long	250	50	

TABLE 3
HAZARD QUANTIFICATION (EXAMPLE DATA)

Equipment, Plant or Structure	Fire Type or Exposure	Protection Method (in order of preference)
Hydrocarbon Pressure Vessels	Jet Spray Pool	Passive) 1. Passive) 2. Deluge
Shell and Tube Heat Exchangers	Jet Spray Pool	1. Passive, 2. Deluge) 1. Deluge) 2. Passive
Plate Type Heat Exchangers	Jet Spray Pool	) 1. Passive Enclosure) 2. Deluge)
Pumps and Compressors	Jet Spray Pool	)) Deluge)
Packaged Units (e.g. Metering Skid)	Jet Spray Pool	)) Deluge)
Wellheads	Jet Spray Pool	) 1. Fire safe wellheads) 2. Deluge)
Pig/Sphere Launchers and Receivers	Jet Spray Pool	) 1. Location) 2. Deluge) NOTE J
Piping (welded)	Jet Spray Pool	) 1. Passive) 2. Deluge)
Piping (flanged)	Jet Spray Pool	)) Deluge)
Manifolds	Jet Spray Pool	)) Deluge)
ESD Valves	Jet Spray Pool	) 1. Passive,) 2. Deluge)
Primary Fixed Structure	Jet Spray Pool Radiation	Passive) 1. Passive,) 2. Water Spray)
Mobile Structure (Drill Rigs)	Jet Spray Pool	) 1. Monitors,) 2. Passive,) 3. Water Spray

TABLE 4 (SHEET 1)
EXPOSURE PROTECTION METHOD



Equipment, Plant or Structure	Fire Type or Exposure	Protection Method (in order of preference)
Substructure	Jet Spray Pool	) 1. Passive,) 2. Standby Fire Fighting Vessel)
Jacket	Jet Spray Pool	) 1. Redundancy,) 2. Standby Fire Fighting Vessel,) 3. Passive
Tower Structure (Flare, Derrick)	Jet Spray Pool Radiation	) 1. Passive,) 2. Monitors,) 3. Water Spray)
Utilities Areas	Jet Spray Pool Radiation	Firewalls or Specific Enclosures. This may be augmented by water spray for pool and radiation exposure.
Safety Systems	Jet Spray Pool Radiation	) 1. Location) 2. Inherent Fire Resistance) 3. Fire Rated Enclosures) 4. Passive
Accommodation, Temporary Refuge and Control Room	Jet Spray Pool Radiation Smoke	) 1. Location) 2. Passive, including) effective sealing of) ventilation.) 3. Water Spray
Gas Bottle Storage	Jet Spray Pool Radiation	)) Deluge))
External Evacuation Routes and Muster Stations	Jet Spray Pool Smoke Radiation	) 1. Location, 2. Diversity,) 3. Enclosures) 1. Location, 2. Diversity,) 3. Water Curtain 1. Location, 2. Diversity, 3. Mesh Radiation Shields
Lifeboats	Jet Spray Pool Radiation Smoke	)) 1. Location, 2. Diversity,) 3. Mesh, 4. Water Curtain) 1. Location, 2. Diversity, 3. Water Curtain

TABLE 4 (SHEET 2)
EXPOSURE PROTECTION METHOD

NOTES TO TABLE 4 - EXPOSURE PROTECTION METHOD

Protection Methods are numbered in order of preference for each case.

- (A) Exposure protection should only be applied where the fire could cause failure and it is deemed necessary following an analysis of the risks.
- (B) Exposure protection may also provide some degree of combustion interaction or even extinguishment. General area deluge cover in partially enclosed areas can extinguish pool and spray fires in particular circumstances. Non aspirated foam may be specifically designed to fulfill both roles.
- (C) The 'Jet Fire' type covers gas jets, high pressure LPG releases and high pressure oil releases with a high dissolved gas content. (Generally the latter only applies to light oil/gas and gas/condensate well releases.)
- (D) Where equipment is only subjected to radiation exposure the appropriate pool fire method should be used.
- (E) Passive fire protection should be chosen to suit the fire type and rated for either the duration of the fire, the required survival time of the protected item or the evacuation time of the installation.
- (F) Jet fire passive systems should be tested and certified to a recognised standard which would be approved by BP. These include the British Gas 3 kg/s methane jet fire test and the 0.3 kg/s propane jet fire test developed by Sintef in Norway. (also known as the Interim Fire Test Standard.)
- (G) Water curtains do not have any recognised design codes but can be used for either smoke or radiation suppression. Designs should be based on representation testing for the hazard conditions which are anticipated and the required performance in terms of the required smoke or radiation reduction.
- (H) If the fire may be preceded by an explosion, the chosen system should be able to withstand the explosion characteristics or arranged so that it is not exposed. It may be easier to specify a passive system in these cases but the specific guidance in the practice should be followed.
- (J) It is impractical to passively protect launchers and receivers and still have operable plant. The riser and ESD valves should be passively protected in areas where they may be exposed to a fire.

TABLE 4 (SHEET 3)
EXPOSURE PROTECTION METHOD

NOTES TO TABLE 4 - EXPOSURE PROTECTION METHOD (Continued)

- (K) Deluge application rates for specific application onto identified equipment should be suitable for the fire and application. In the case of jet fires, the only proven effective protection and design standard is that for wellheads at 350 to 400 l/min per wellhead. However this should only be used in consultation with BP as the exact details of the wellhead type and nozzle layout of the original tests are not available. In the case of pool and spray fires, the following application rates may be used as default values in the absence of better research and design information. The higher rates relate to oil spray fires and the lower rates to pool fires and radiation.

Medium or high velocity nozzles may be used for pool fires but high velocity or large droplet nozzles (greater than 1 mm diameter droplets) should be used for spray fires.

Vessels, Pipe Racks & Structure	10 - 20 l/min/m ²
Packaged Units & Pumps/Compressor	15 - 30 l/min/m ² of the nominal area of the sides, ends and top
Shell & Tube Heat Exchangers	10 - 20 l/min/m ² of the hydrocarbon section
Plate Type Heat Exchangers	20 - 40 l/min/m ²
Manifolds/Complex Pipe Arrays	20 - 40 l/min/m ² (general area cover)

- (L) General area deluge may give some exposure protection and simultaneously cool the atmosphere, the fire plume and reduce the rate of combustion.

Where exposure protection and the reduction of a pool fire burn rate are the predominant requirements, the system should be high velocity, mounted within 2 - 4 m of the plant or floor if practical and have a minimum application rate of 20 l/min/m².

Where cooling of the fire plume and atmosphere are predominant, high level medium velocity or open sprinkler systems should be used. Application rates should be 12 - 24 l/min/m² for pool and spray fires respectively.

- M) Where appropriate deluge exposure systems should be designed to [NFPA 15](#).

**TABLE 4 (SHEET 4)
EXPOSURE PROTECTION METHOD**



Fire Type	Extinguishing Method	Notes
Gas Jets and LPG Jets NOTE D	1. Isolate and Depressurise 2. Dry Powder	Provide exposure protection until inventory vented. Extinguishers only.
Process - Oil Spray NOTE D	1. Isolate, Depressurise and Foam Deluge. 2. Fine Water Spray 3. Water suppression 4. Dry Powder	Non aspirated deluge for process oil hazards. NOTES A & B Enclosures only. NOTE C Extinguishers only
Process - Oil Pool NOTE D	1. Non aspirated Foam Deluge 2. Aspirated Foam Deluge 3. Water Spray	NOTES A & B NOTES A & B. Only suitable for atmospheric processing. Bunding must be effective. Low flash point fuels only. High velocity deluge at 20 l/min/m ² . NFPA 15.
Blowouts	1. Well kill 2. Water Monitor	This can only work on a low pressure well with clear access and no flame impingement or obstructions such as the derrick or drilling substructure.
Stored Diesel Oil, Lubricant and Aviation Fuel	1. Manual aspirated foam application 2. Fixed aspirated foam application 3. Non aspirated foam application	Only if adequate access, bunding and suitably trained personnel. Bunding required. Manual initiation. NFPA 11 . Only to be used if exposure protection from other fires is required as well. Application rates as in Table 4. NOTES A & B.

TABLE 5 (SHEET 1)
EXTINGUISHING METHODS



Fire Type	Extinguishing Method	Notes
Transfer and Processing of Pressurised Diesel Oil, Lubricant and Aviation Fuel	1. Shutdown and apply aspirated foam 2. Apply non aspirated foam	Manual application or fixed systems according to the risk. Bunding required. Only to be used where exposure protection is also required or shutdown cannot be assured.
Reciprocating Diesel Engines	1. High velocity water spray 2. Non aspirated foam deluge 3. Fine water spray	Application rate 20 l/min/m² on sides, top, ends and fuel system. NFPA 15. Application rate 10 l/min/m² on sides, top, ends and fuel system. NFPA 16. To be used for enclosed engines only. System design to match layout and enclosure.
Gas Turbines (gas or diesel oil fuel)	1. Carbon dioxide 2. Fine water spray 3. Gaseous systems	NFPA 12. To be designed in accordance with relevant experimental data. Only to be used if environmentally acceptable and proven effectiveness.
Stored Drilling Mud	Aspirated Foam	Only required for open top tanks. Minimum application rate to be used (4 l/min/m ²). Aspiration quality should minimise the rate of liquid drop out. NOTE E.
Pumped Drilling Mud	Non aspirated foam	Application rate as for exposure protection of pump systems with spray fires. NFPA 16.
Helicopter Crash on Helideck	Foam	Non aspirated foam monitors backed up by manual aspirated branch pipes. Application rate 6 l/min/m ² for 10 minutes.
Helicopter Crash on Top Deck	Manual response - aspirated foam	450 l/min branch pipes.
Laydown Hazards on Top Deck	Fixed monitors	Water monitors - general hazards. Non aspirated foam monitors - hydrocarbon areas.

TABLE 5 (SHEET 2)
EXTINGUISHING METHODS

Fire Type	Extinguishing Method	Notes
Chemical Storage	Protection by assessment	To suit chemicals/fires. Aspirated foam sprinklers may be suitable if compatible with the chemicals. NOTE F
Paint Store	1. Manual Foam 2. Aspirated Foam Sprinklers	If suitably trained personnel available. NOTE B
Electrical Hazards - Alternators	1. Inherent design and shut down. 2. Carbon dioxide	NFPA 12.
Electrical Hazards - Switchrooms and Transformers	1. Inherent design and shut down. 2. Carbon dioxide 3. Gaseous agents	Non flammable cables, air or vacuum break switchgear and encased transformers or non flammable oil.) Only needed for confirmed) hazards. Ensure personnel) protection is provided.
Electrical Hazards - Electronic Panels and Control Rooms	1. Inherent design, sensitive smoke detection and manual intervention. 2. Gaseous agents.	NOTES G & H. Not normally justifiable and only required for unmanned areas where loss of the protected system would directly cause a hazard to the hydrocarbon plant, i.e. non fail safe control systems.
Accommodation - Cabins and Corridors	1. Inherent design, sensitive smoke detection and manual intervention. 2. Sprinklers	NOTES G & H. May not be justifiable if the inherent design is optimised.
Accommodation - Galleys	1. Dry powder systems 2. Manual intervention 3. Sprinklers	Deep fat fryers. NOTE H. May not be justified unless there is potential for escalation from cookers. Avoid fat fryers.
Offices, Restaurants and Rest Rooms	Good house keeping, inherent design and manual intervention	NOTE H.

TABLE 5 (SHEET 3)
EXTINGUISHING METHODS



NOTES TO TABLE 5 - EXTINGUISHING METHODS

- (A) 3% foam solutions are preferred with 6% foams for alcohols. Aspirated foam sprinklers should be designed to [NFPA 16](#) with application rates of 10 l/min/m². Non aspirated foam should use the appropriate exposure protection rates for the deluge in Table 4.
- (B) Film forming foams should be used for non aspirated applications. Alcohol risks must use the foam in aspirated form. Aspirated sprinklers may use synthetic, fluoroprotein or alcohol type compounds which are suitable for the hazards and system.
- (C) Intense water application by deluge or monitor can extinguish pressurised oil fires, particularly in partially enclosed modules. There are no approved design codes and system should be based on verifiable experimental research.
- (D) Post extinguishment security and protection from gaseous/vapour explosions should be considered.
- (E) Drilling mud is a critical safety system. It can be seriously impaired by the addition of water. Only aspirated foam systems with 25% drainage times in excess of 3 minutes should be used. The application time should be minimised. Manual application is preferable.
- (F) Seek specialist advice for oxidising agents.
- (G) Inherent design includes the selection of materials, fixings and fittings which are non flammable or have a low surface spread of flame.
- (H) Manual intervention will require suitably trained personnel and a sufficient provision of extinguishers, hose reels, hydrants and portable equipment.

TABLE 5 (SHEET 4)
EXTINGUISHING METHODS

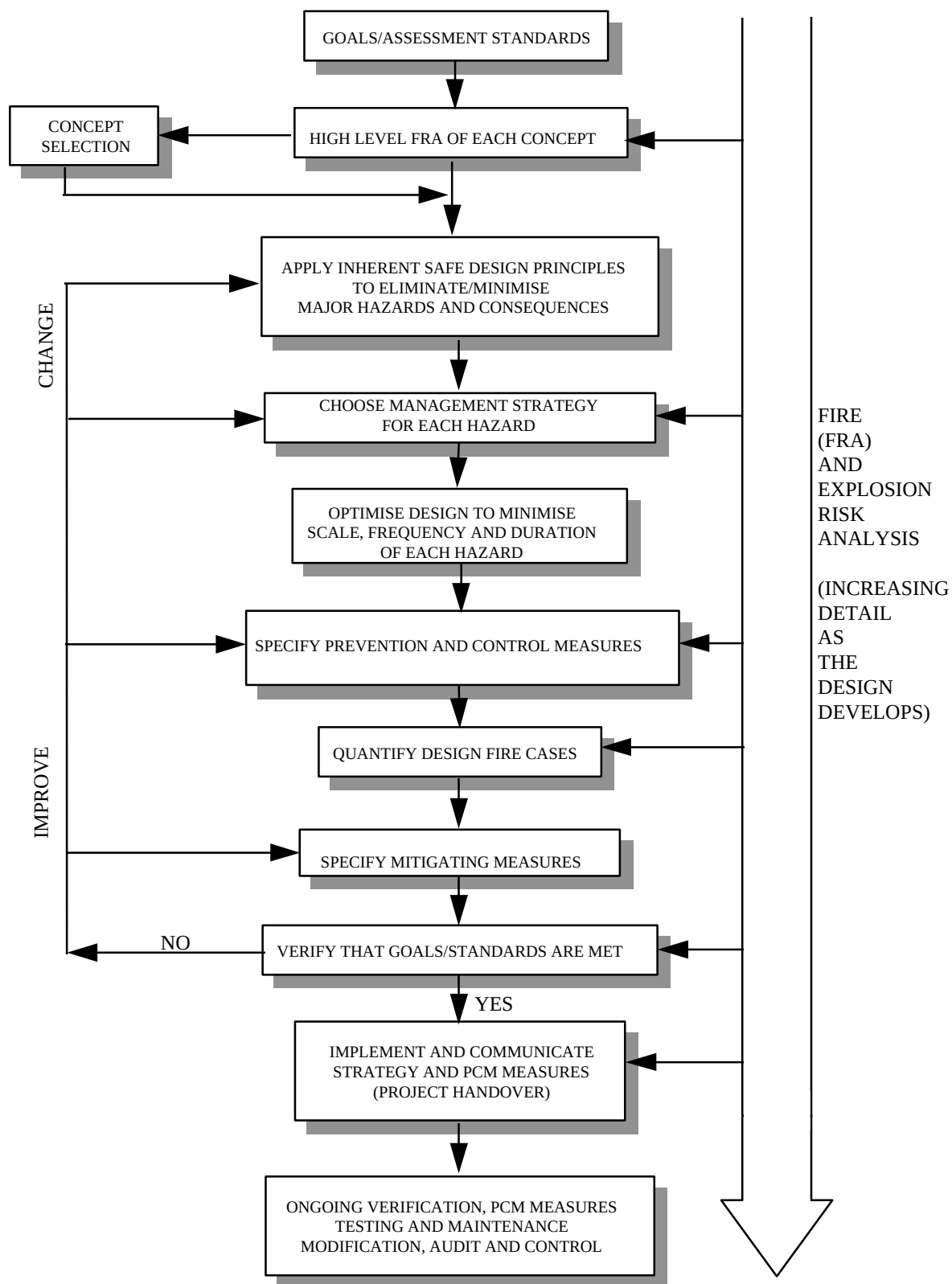


FIGURE 1
HAZARD MANAGEMENT PROCESS OUTLINE

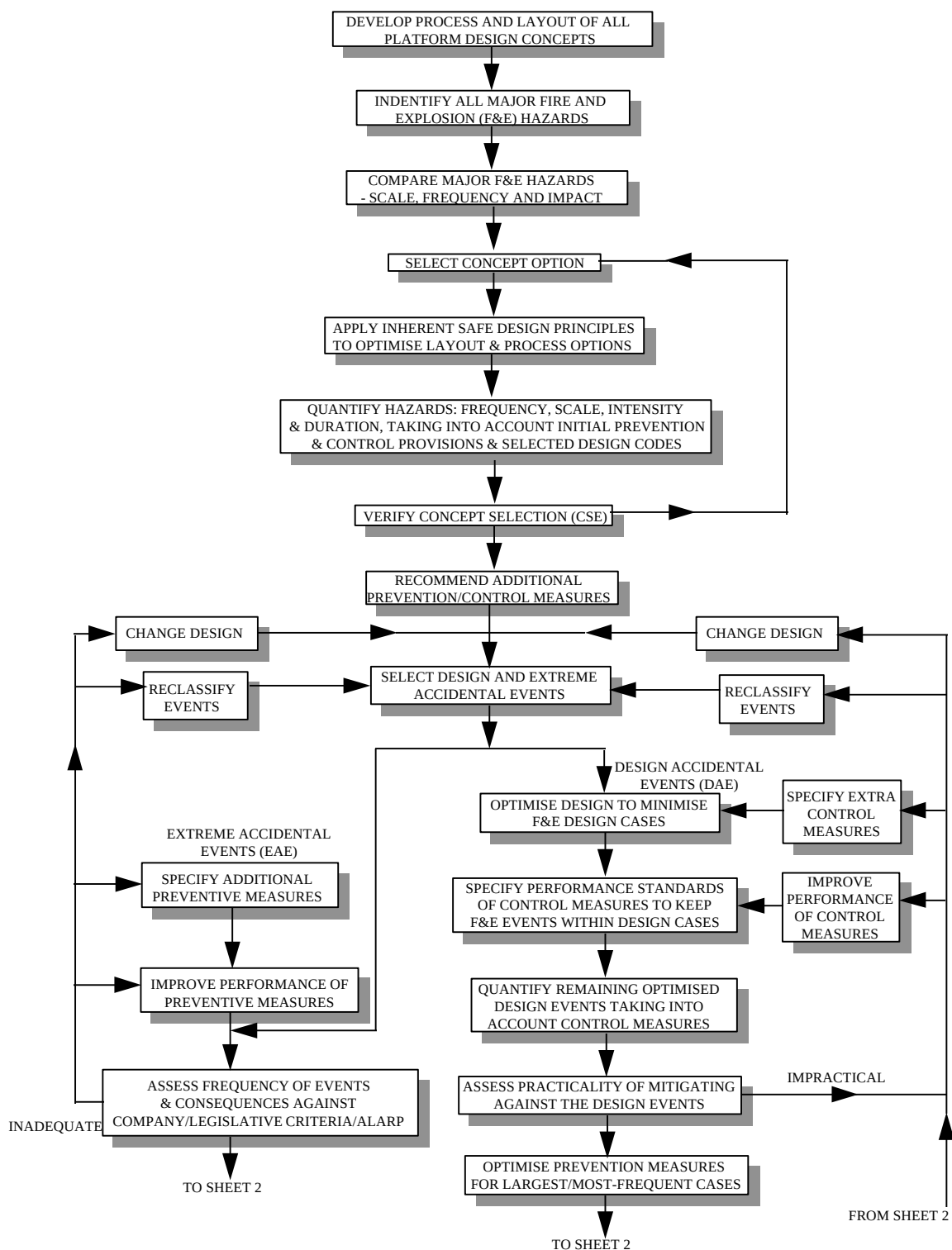


FIGURE 2 (SHEET 1)
HAZARD MANAGEMENT PROCESS DETAIL

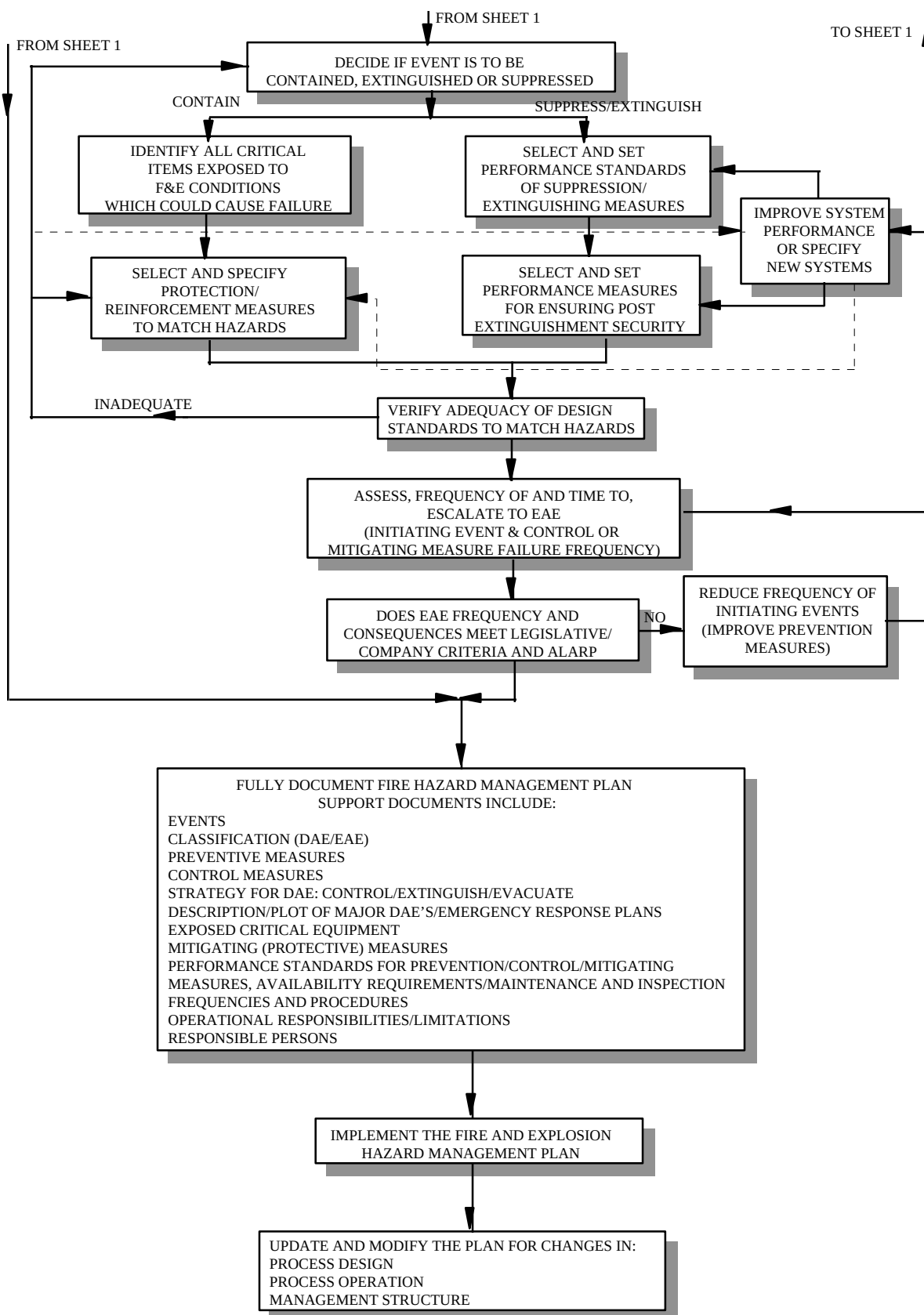


FIGURE 2 (SHEET 2)
HAZARD MANAGEMENT PROCESS DETAIL

DEFINITIONS AND ABBREVIATIONS

Definitions

Standardised definitions may be found in the BP Group RPSEs Introductory Volume.

Active Fire Protection: The equipment, systems and methods required for the detection, alarming, control and extinguishing of fires using water, foam, dry powder or gaseous extinguishants. An example of this would comprise detection equipment for fire, smoke, gas or heat which will activate fixed extinguishing or control systems.

Client The organisation for whom fire protection facilities are provided. Within BP this can be a Business, an Associate or an Operating Unit.

Essential Use (Halons) Halon use shall be defined as essential in existing and future facilities where halons afford genuine protection from a significant risk of:-

- (a) loss of human life
- (b) traumatic injury
- (c) hazard to health e.g., toxicological effects of alternative agents, or
- (d) damage to the environment, e.g. due to a major catastrophe.

and other means of protection (e.g. alternative systems, deleted systems, alternative agents) would increase the above risks or combination of risks to an unacceptable level.

Additionally, international, regional, national or state laws, regulations, etc. may demand that protection systems be installed for other reasons which cannot be fulfilled except through the use of halon systems (e.g. protection of equipment, materials, operations or installations of vital national interest).

Fire Proofing:	Materials or application of materials to provide a degree of fire resistance to protect substrates.
Fire Rating:	The fire resistance performance of the fire protection in terms of fire type, time and temperature. This is usually Hydrocarbon (H) or Cellulosic (A) rating.
Fire Resistance:	The ability to resist fire for a given time when tested under defined conditions.
Hydrocarbon Risk Area:	An area in which there is plant, equipment or storage containing hydrocarbon liquids, vapours or gases which may feasibly be released. These include crude oil, fuels, produced fluids, and utility fluids such as seal and lubrication oils, where their flash point requires that they be protected.
Integrated Safe Design:	The incorporation of design safety features on an inter-disciplinary basis, encouraging a co-ordinated approach to safety in the overall design process.
Operator	The organisation responsible for safe operation of the Client's plant. Within BP this would be an Operating Unit.
Passive Fire Protection:	The provision of non-combustible materials which in a fire will, for a defined period of time, protect equipment, prevent the collapse of structural supports or limit the spread of fire. In addition, passive systems embrace the basic requirements for area separation and classification.
Petroleum Liquids:	Defined in IP Model Codes of Safe Practice Class 0: Ethane, ethylene, propylene, LPG and LNG Class I: Liquids which have a flash point below 21°C. Class II: Liquids which have a flash point from 21 °C to 55°C inclusive. Class III: Liquids which have a flash point above 55°C up to and including 100°C.

Class II or III liquids can be further subdivided. Class II(1) or III(1) liquids are those which are handled below their flash points. Class II(2) or III(2) liquids are those which are handled at or above their flash points.

Portable Systems:	Systems whose components can be transported by hand or by tractor and used without need for mechanical handling equipment.
Protectability:	The extent to which a given system lends itself to efficient protection by active/passive fire protection methods.
Radiant Heat Output:	The heat energy radiated from a fire (kW).
Source of Release:	Any Continuous, Primary or Secondary grade source of release as defined in BP Group RP 44-6 , i.e. a point from which flammable gas, vapour or liquid can be released into the atmosphere.
Unclassified Liquids:	Liquids which have a flash point above 100°C.

Abbreviations

AFFF	Aqueous film forming foam
ALARP	As low as reasonably practical
ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
ATK	Aircraft turbine kerosene
BLEVE	Boiling liquid expanding vapour explosion
BOP	Blowout preventer
BS	British Standard
CAA	Civil Aviation Authority
CBA	Cost benefit analysis
CCR	Central control room
CO ₂	Carbon dioxide
COSHH	Control of substances hazardous to health
CSE	Concept Safety Evaluation
DAE	Design accidental event
DHSV	Down hole safety valve
EAE	Extreme accidental event
ESD	Emergency shutdown
F & E	Fire and Explosion



FEHMP	Fire and explosion hazard management plan
FMEA	Fault tree and failure modes and effects analysis
FRA	Fire Risk Analysis
GRP	Glass reinforced plastic
HAZID	Hazard identification
HAZOP	Hazard and operability
HSE	Health and Safety Executive (UK)
HVAC	Heating, ventilating and air conditioning
ICAO	International Civil Aviation Organisation
IMO	International Maritime Organisation
IP	Institute of Petroleum
ISO	International Organisation for Standardisation
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MIL	Military (US Department of Defense)
MOL	Main oil line
NFPA	National Fire Protection Association
NGL	Natural gas liquids
NPS	Nominal pipe size (inches)
NPSHA	Net positive suction head available
PCM	Prevention, control and mitigation
P&ID	Piping and instrument diagram
QRA	Quantitative risk assessment
SGI	Smoke and gas ingress assessment
SOLAS	Safety of Life at Sea
SSIV	Sub-sea intervention valve
SWG	Standard wire gauge
TR	Temporary refuge
UKOOA	United Kingdom Offshore Operators Association
UL	Underwriter's Laboratory

LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

International

IMO	International Convention for the Safety of Life at Sea (SOLAS) 1974, Chapter II-2, Construction - Fire Protection, Fire Detection and Fire Extinction
ISO WD 13702	<i>Requirements and Guidelines for the Prevention, Control and Mitigation of Fires and Explosions on Offshore Oil and Gas Installations</i>
UL 236 UL 263 UL 1709	Couplings for Fire Hose Fire Tests of Building Construction and Materials Standard for Safety Rapid Rise Fire Tests of Protection Materials for Structural Steel.
Montreal Protocol	Montreal Protocol Assessment II of the Halons Technical Options Committee.
IP	Model Code of Safe Practice in the Petroleum Industry. Part 9

British Standards

BS 476	Fire Tests on Building Materials and Structures Part 5 - Method of Test for Ignitability Part 8 - Test Methods and Criteria for the Fire Resistance of Elements of Building Construction
BS 5306	Fire Extinguishing Installations and Equipment on Premises Part 2 - Specification for Sprinkler Systems Part 4 - Specification for Carbon Dioxide Systems
BS 8110	Structural Use of Concrete Part 1 - Code of Practice for Design and Construction
HSE	Guidance Notes on Design, Construction and Certification
CAA CAP 437	Offshore Helicopter Landing Areas: Guidance on Standards
SI 1657	<i>COSHH Regulations</i>



JCDD/1/1/3

Specification for Fire Hose (UK Home Office Document)

UKOOA

Draft - Guidelines on Fire & Explosion Hazard Management

American

ANSI B31.3

Chemical Plant and Petroleum Refinery Piping.

API 2218

Fire Proofing Practices in Petroleum and Petrochemical Processing Plants

API 2021

Fighting Fires in and around Storage Tanks.

ASTM C150

ASTM E119

ASTM G26

Specification for Portland Cement

Method for Fire Tests of Building Construction and Materials

Recommended Practice for Operating Light-Exposure Apparatus (xenon-arc type) with and without Water for Exposure of Non-Metallic Materials

MIL-F-24385

Fire Extinguishing Agent - Aqueous Film Forming Foam (AFFF) Liquid Concentrate for Fresh and Sea Water

NFPA 11

NFPA 12

NFPA 13

NFPA 15

NFPA 16

NFPA 17

NFPA 20

NFPA 24

NFPA 30

NFPA 86

NFPA 101

NFPA 255

Low-Expansion Foam

Carbon Dioxide Extinguishing Systems

Installation of Sprinkler Systems

Water Spray Fixed Systems for Fire Protection

Deluge Foam-Water Sprinkler and Foam-Water Spray Systems

Dry Chemical Extinguishing Systems

Centrifugal Fire Pumps

Private Fire Service Mains and their Appurtenances

Flammable and Combustible Liquids Code

Ovens and Furnaces

Code for Safety to Life from Fire in Buildings and Structures

Surface Burning Characteristics of Building Materials

BP Group Documents

BP Group [RP 4-1](#)

Drainage Systems
(replaces BP CP 6)

BP Group [RP 12-4](#)

Power system protection and control
(replaces BP CP 17 Pt 4)



BP Group RP 24-1	Fire Protection - Onshore (replaces BP CP 15 & 16)
BP Group RP 30-5	Instrumentation - Part 5 - Protective Systems (replaces BP CP 18 Pt 5.)
BP Group RP 30-7	Design Philosophy for Fire and Gas Detection and Control Systems
BP Group RP 42-1	Piping systems (replaces BP CP 12)
BP Group RP 43-3	Subsea Isolation Systems (replaces BP CP 43 (Appendix C))
BP Group RP 44-1	Overpressure Protection (replaces BP CP 14)
BP Group RP 44-6	Area classification (replaces BP CP 39)
BP Group RP 44-9	Design Guide for Offshore Evacuation and Escape
BP Group RP 52-1	Thermal insulation (replaces BP CP 13)
<i>BP Group RP 62-1</i>	<i>Guide to Valve Selection</i>
BP Group GS 106-1	Cement-mortar lined pipe (replaces BP Std 106)
BP Group GS 106-2	Painting of metal surfaces (replaces BP Std 141)
BP Group GS 124-2	Direct Diesel Engine Driven Fire Water Pumps
BP Group GS 124-3	Electric Motor Driven Fire Water Pumps
BP Group GS 124-4	Hydraulic Motor Driven Fire Water Pumps
BP Group GS 158-2	Vertical Storage Tanks for Non-Refrigerated Liquids - Tanks to BS 2654 (replaces BP Std 163, Part 1)

BPX HSQ 01.03.01

Methodology for Assessing Smoke and Gas Ingress to Accommodation and TR Volumes

BPX HSQ 30.01.02

Deluge actuation policy

