



**RULES FOR THE CLASSIFICATION AND
CONSTRUCTION**

PART 5. OFFSHORE TECHNOLOGY

**VOLUME XII
RULES FOR FACILITIES
ON OFFSHORE INSTALLATIONS
2013 EDITION**

BIRO KLASIFIKASI INDONESIA



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CONSTRUCTION**

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VOLUME XII

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ON OFFSHORE INSTALLATIONS

2013 EDITION

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The following Rules come into force on 1st July 2013

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Foreword

These Rules consist of technical safety requirements and criteria applicable for BKI in the review and survey of hydrocarbon production facilities that are being considered for Classification and for maintenance of Classification. It is applicable to Hydrocarbon Production and Processing Systems include with its associated utility and safety systems located on fixed (bottom-founded) offshore structures of various types and applicable to systems installed on floating installations such as ships shape based FPSOs, tension leg platforms, spars, semisubmersibles, etc.

The differences between floating and fixed offshore installation design are due to physical limitations inherent in the construction of facilities on new or converted floating installations. Due to these differences, the requirements for facilities on fixed and floating installations are specified in separate Sections. Section 3 covers requirements for facilities on floating installations and Section 4 covers requirements for facilities on fixed installations.

Facilities designed, constructed, and installed regarding with the requirements of these Rules on BKI classed fixed or floating offshore structure, under BKI review and survey, will be classed and identified in the BKI Register by an appropriate class notation as defined herein. These Rules have been written for world-wide application, and already comply with international requirements. Any compliances with individual requirement needs the analyses and plans to be submitted to demonstrate the adequacy of the facility as arranged by this Rules.

BKI acknowledges that there is many and wide range of documents that may be required for submittal to satisfy these Rules. It is not the intention of these Rules to impose requirements or practices in addition to those that have previously proven satisfactory in similar situations. Design and installation requirements presented in these Rules are based on existing methodologies and attendant safety factors that are deemed to provide an adequate level of safety. BKI will always looking forward to develop requirements which provide adequate safety and as much as practicable to carried out

Primarily, the use of such methods and limits in these Rules reflects what is considered to be the current state of practice in the design and installation of offshore facilities. The application of these Rules by BKI will not seek to inhibit the use of any technological approach that can be shown to produce an acceptable level of safety. These Rules are applicable to the classification of facilities for which applications, or contracts for classification, are received on or after 1 June 2013.

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Section 1

Scope and Conditions of Classification

A. Classification

The requirements for conditions of classification are contained in the separate, generic BKI Rules for The Classification and Construction of Offshore Technology (Part 5) - Volume 1, Rules for Classification and Survey

Additional requirements specific to facilities on offshore installations are contained in the following Sections.

B. Application, System Classification Boundaries, Symbols, and Notations

A listing of Classification Symbols and Notations available to the Owners of vessels, offshore drilling and production units and other marine structures and systems Rules for The Classification and Construction of Offshore Technology (Part 5) - Volume 1, Rules for Classification and Survey, Section 2.

The following classification boundaries, symbols and notations are specific to facilities on offshore installations.

1. Scope

The requirements in the Rules are applicable to hydrocarbon production and/or processing facilities located on floating or fixed offshore installations, and apply to the following systems and associated equipment:

- Hydrocarbon Production
- Hydrocarbon Processing
- Process Support
- Process Control
- Marine Support
- Electrical
- Instrumentation and Control
- Fire Protection and Personnel Safety

The following BKI Rules and Guide, latest edition, are applicable as referenced therein for systems or services other than for the hydrocarbon production and processing facilities.

- i) *FPI Guidelines* *BKI Guidelines for Floating Production Installations*
- ii) *Offshore Technology Rules* *BKI Rules for Classifications and Constructions of Offshore Technology (Part 5)*
- iii) *Seagoing Ship Rules* *BKI Rules for Classification and Construction of Seagoing Ship (Part 1)*

Appropriate flag state and port state authorities are to be consulted for their specific requirements.

- . Section 2 provides definitions, references, abbreviations and acronyms associated with these Rules.
- . Section 3 covers requirements for hydrocarbon production and processing facilities on floating installations.

- . Section 4 covers requirements for hydrocarbon production and processing facilities on fixed installations.
- . Section 5 covers requirements for survey during and after construction.

2. Classification Boundaries

The boundaries for classification where a hydrocarbon production and/or processing facility is installed on an offshore installation are defined to include the following major items:

- i) For floating installations:
 - a) Vessel, including hull structure, equipment, and marine machinery, subject to the requirements of the FPI Guidelines.
 - b) Position Mooring System, according to the requirements of the FPI Guidelines.
 - c) Hydrocarbon Production and/or Processing Facilities (topside), according to the requirements of this Rule.
- ii) For fixed installations:
 - a) Structure, subject to the requirements of the Part 5, BKI Rules for Classification and Construction of Offshore Technology – Volume 7, Rules for Fixed Offshore Installations
 - b) Hydrocarbon Production and/or Processing Facilities (topside), according to the requirements of this Rule.
- iii) Classification of additional equipment and systems can be provided if requested by the owner.

3. Classification Symbols

3.1 Floating Installations

For floating installations, systems which have been designed, built, installed, and commissioned in accordance with approved plans to the satisfaction of the BKI Surveyors, and which are deemed to meet the full requirements of the applicable BKI Rules and Guides, or their equivalent, where approved by the Head Office, for service in specified design environmental conditions, will be classed and distinguished in the BKI Register by the symbols ✖ **A100** followed by the appropriate notation for the system's intended service.

FLOATING PRODUCTION, STORAGE AND OFFLOADING SYSTEM	(FPSO)
FLOATING PRODUCTION (AND OFFLOADING) SYSTEM	(FPS)
FLOATING STORAGE AND OFFLOADING SYSTEM	(FSO)

3.2 Fixed Installations

For fixed installations, systems which have been designed, built, installed, and commissioned in accordance with approved plans to the satisfaction of the BKI surveyors, and which are deemed to meet the full requirements of the applicable BKI Rules and Guides, or their equivalent, where approved by the Head Office for service in specified design environmental conditions, will be classed and distinguished in the BKI Register by the symbols ✖ **A100** followed by the appropriate notation for the system's intended service:

OFFSHORE INSTALLATION - HYDROCARBON PROCESSING
OFFSHORE INSTALLATION - HYDROCARBON PRODUCTION

Note: The mark ✖ (Maltese Cross) signifies that Hull, machinery, anchoring equipment and/or special equipment (e.g. refrigerating installation) have been constructed: – under the supervision of BKI in accordance with the Rules of BKI at the shipyard and/or at subcontractors supplying construction components / hull sections – and with certification by BKI of components and materials requiring inspection, subject to the BKI Construction Rules

4. Systems not Built Under Survey

Installations which have not been built under BKI supervision, but which are submitted for classification, will be subject to design review and a special classification survey.

Where found satisfactory and thereafter approved by the BKI Head Office, they will be classed and distinguished in the Register by the symbols and special notations described above, but the mark + signifying survey during construction will be omitted.

5. Conversion of Existing Vessels

Modifications of existing floating structures intended for classification as Floating Installations are required to be converted under BKI design review and survey.

6. Conversion of Existing Structures

Modifications of existing structures intended for classification as Fixed Installations are required to be converted under BKI design review and survey.

C. Rules for Classification

1. Application

These requirements are applicable to features that are permanent in nature and can be verified by plan review, calculation, physical survey or other appropriate means. Any statement in the Rules regarding other features is to be considered as guidance to the designer, builder, owner, etc.

D. Recognition of Risk Based Techniques to Justify Alternatives

1. General

The requirements detailed herein provide an alternative route for an owner to obtain and maintain BKI Class. Any alternatives to the requirements of this Rule may be specially considered by BKI on the basis of a risk assessment submitted for review.

- i)* In case of such alternatives, BKI approval will be contingent upon a demonstration of fitness for purpose and equivalent level of safety in accordance with the principles of BKI Guides and Rules, as well as recognized codes and standards.
- ii)* Risk acceptance criteria are to be developed in line with the principles of the BKI Rules and will be subject to BKI approval. In instances where a direct alternative recognized code or standard is used, BKI verification of compliance with the standard will be considered demonstration of fitness for purpose.
- iii)* The BKI publication, Reference Notes on Risk Assessment Application for the Marine and Offshore Oil and Gas Industries, provides an overview of risk assessment techniques and additional information.

2. Application

A risk-based approach may be applicable either to the installation as a whole or to individual systems, subsystems, equipment or components.

- i)* The boundaries of the components and systems of the installation to which a risk-based assessment is applied are to be logical.
- ii)* As appropriate, account must be given to remote hazards outside the bounds of the system under consideration. Such account is to include incidents relating to remote hazards impacting on or being influenced by the system under consideration.
- iii)* BKI will consider the application of risk-based techniques in the design of the installation, surveys during construction, and surveys for maintenance of class.
- iv)* Portions of the installation not included in the risk assessment are to comply with the applicable parts of the BKI Rules and Guides.
- v)* The following are the responsibility of the owner/operator:
 - a)* Proposed risk acceptance criteria
 - b)* Hazard identification
 - c)* Risk assessment
 - d)* Risk mitigation and management
 - e)* Compliance of the system under consideration with the applicable requirements of Flag and Coastal State

3. Submittals

As a minimum, the following documents are to be submitted to BKI for review and approval for classification purpose:

- i)* Proposed risk acceptance criteria
- ii)* Methodology for risk assessment
- iii)* Details of risk assessment
- iv)* Risk management measures, wherever applicable

4. Risk Evaluation Methodology

The risk assessment is to consider the installation in all anticipated operating modes. The designer or owner is to apply a structured and systematic risk assessment process to identify all foreseeable incidents specific to his installation, making full consideration of the likelihood of occurrence of the incidents and their consequence. BKI review and approval of the methodology selected by the designer or owner is required. While various techniques/methods may be applied, the Owner is to justify the suitability and appropriateness of the particular method(s) selected. Some typical methods include:

- i)* Hazard and Operability Study (HAZOP)
- ii)* Failure Mode and Effects Analysis (FMEA)
- iii)* Failure Mode, Effects and Criticality Analysis (FMECA)
- iv)* Process Hazards Analysis (PHA)
- v)* Safety Reviews
- vi)* Checklists
- vii)* Experience from previous analyses

Where risk assessment techniques are used to cover only part of an installation, the designer or owner is to clearly define the boundary or extent of the item(s) being considered. The extent of the boundary is to subject to review and approval by BKI.

5. Identification of Hazards

The Owner is to identify and consider all hazards that may affect his Installation or any part thereof. The Owner is to apply a systematic process to identify such situations where a combination or sequence of events could lead to an Incident, with consideration given to all foreseeable causes (initiating events).

The risk assessments are to consider, at a minimum, the following:

- i) Fire and Explosion*
- ii) Hydrocarbon Release*
- iii) Blow-out*
- iv) Structural Failure*
- v) Loss of Stability*
- vi) Loss of Station Keeping /Mooring*
- vii) Loss of Electrical Power*
- viii) Toxicity*
- ix) Extreme Weather*
- x) Environmental Factors.*
- xi) Dropped Objects*
- xii) Ship & Helicopter Collision*

6. Other Requirements

Where it is intended that risk-based techniques are used as a basis for compliance with Flag and Coastal State requirements, the owner is directed to contact the Administration, either directly or through BKI, to obtain an understanding as to the extent to which the Administration is prepared to consider alternatives to such requirements. The Administration may require additional hazards to be considered.

E. Submission of Plans, Data, and Calculations

A generic list of plans and data to be submitted for facilities on floating installations is included in Section 3, B.

A generic list of plans and data to be submitted for facilities on fixed installations is included in Section 4, B.

It should be noted that due to the varying configurations of offshore facilities, all or portions of these requirements may be applicable to a given installation.

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Section 2

Definitions, References, Acronyms and Abbreviations

A. Definitions

The following definitions, references, abbreviations and acronyms are provided to clarify the use of terms in the context of these Rules.

Abnormal Condition - A condition which occurs in a process system when an operating variable (flow, pressure, temperature, etc.) ranges outside of its normal operating limits.

Accommodation Spaces (Living Quarters)

- Spaces used for public spaces, lavatories, cabins, offices, hospitals, cinemas, games and hobbies rooms, pantries containing no cooking appliances, and similar spaces.
- Public Spaces are those portions of the accommodation which are used for halls, dining rooms, lounges and similar permanently enclosed spaces.

Cargo Handling System - All piping and equipment used to drains from process components, such as pressure vessels, piping, liquid relief valves etc., to a closed drain tank without any break to atmosphere.

Classified Area - A location in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures (see *BKI Rules Part 5. Vol IV “Rules for Machinery Installations* , API RP 500 or API RP 505 for additional details).

Closed Drains - Rigid piping drains from process components, such as pressure vessels, piping, liquid relief valves etc., to a closed drain tank without any break to atmosphere.

Completed Wells - Wells fitted with Christmas trees attached to the wellhead, such that the flow of fluids into and out of the reservoir may be controlled for production purposes.

Control Stations - Spaces containing:

- i) Radio or main navigation equipment
- ii) Central Process Control Rooms
- iii) Dynamical positioning control system
- iv) Centralized ballast control station
- v) Battery Room
- vi) Fire recording or fire control equipment
- vii) Fire-extinguishing system serving various locations
- viii) Emergency source of power
- ix) CO2 Bottle Room
- x) Fire Pumps

Corridors - Passageways, generally with rooms or compartments opening onto them. For the fire protection purposes, lobbies are considered parts of corridors.

Critical Equipment - Refers to vessels, machinery, piping, alarms, interlocks, and controls determined by management to be vital in preventing the occurrence of a catastrophic release.

Divisions - Divisions formed by bulkheads and decks which are constructed of steel or other equivalent material, suitably stiffened, and designed to withstand and prevent the passage of smoke and flame for the duration of the one-hour standard fire test. Divisions are classified as follows:

- i) “A” *Class Divisions* - Insulated with approved non-combustible materials such that the average temperature of the unexposed side will not rise more than 139°C (282°F) above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C (356°F) above the original temperature, within the time listed below:

Class “A-60”:	60 minutes
Class “A-30”:	30 minutes
Class “A-15”:	15 minutes
Class “A-0”:	0 minutes

This division is to remain intact with the main structure of the vessel, and is to maintain its structural integrity after one (1) hour. *Structural Integrity* means that the structure will not fall under its own weight, nor will it crumble or break upon normal contact after exposure to the fire.

- ii) “B” *Class Divisions* - divisions formed by bulkheads, decks, ceilings or linings which are designed to withstand and prevent the passage of flame for at least the first half hour of the standard fire test. They are to have an insulation value such that the average temperature of the unexposed side will not rise more than 139°C (282°F) above the original temperature, nor will the temperature at any one point, including any joint, rise more than 225°C (437°F) above the original temperature, within the time listed below:

Class “B-15”:	15 minutes
Class “B-0”:	0 minutes

“B” class divisions, unless specified in the design, are not required to be load bearing or maintain their structural integrity beyond 30 minutes of exposure. The only requirement outside of the design specification is to prevent the passage of flames for 30 minutes and maintain thermal requirements as described above.

- iii) “C” *Class Divisions* - Divisions constructed of approved non-combustible materials. They need meet neither requirement relative to the passage of smoke and flame, nor limitations relative to the temperature rise. The only requirement is that they do not add to the fire.

- iv) “H” *Class Divisions* - Divisions formed by bulkheads and decks that are constructed of steel or other equivalent material, suitably stiffened, and are designed to withstand and prevent the passage of smoke and flame for the 120-minute duration of a hydrocarbon fire test. “H” class divisions are to be insulated so that the average temperature of the unexposed face will not increase by more than 139°C (282°F) any time during the two-hour hydrocarbon fire test, nor will the temperature, at any point on the face, including any joint, rise more than 180°C (356°F) above the initial temperature, within the time listed below:

Class “H-120”:	120 minutes
Class “H-60”:	60 minutes
Class “H-0”:	0 minutes

This division is to remain intact with the main structure of the vessel, and is to maintain its structural integrity after two (2) hours. *Structural Integrity* means that the structure will not fall under its own weight, nor will it crumble or break upon normal contact after exposure to the fire.

Escape Route - This is a designated path used by personnel to evade an immediate danger and ultimately leads to a temporary refuge or muster station.

Explosive Mixture - A vapor-air or gas-air mixture that is capable of being ignited by an ignition source that is at or above the ignition temperature of the vapor-air or gas-air mixture.

Fire Wall - A wall designed and constructed to remain structurally intact under the effects of fire and insulated so that the temperature on the unexposed side will remain below a specified temperature for a determined amount of time.

Fired Vessel - A vessel in which the temperature of the fluid is increased by the addition of heat supplied by a flame within the vessel. Specifically for hydrocarbon services, there are two (2) types of fired vessels:

- i) *Direct Fired Vessel* - A vessel in which the temperature of process hydrocarbon fluids is increased by the addition of heat supplied by a flame. The flame is applied directly to the fluid container. The combustion takes place in the heater.
- ii) *Indirect Fired Vessel* - A vessel in which the energy is transferred from an open flame or product of combustion (such as exhaust gases from turbines, engines, or boilers) to the hydrocarbon, through a heating medium, such as hot oil. The heating medium is usually non-combustible or has a high flash point. The combustion may, but does not necessarily, take place in the heater.

Fixed Installation - A bottom-fixed offshore facility permanently affixed to the sea floor. The term includes, but is not limited to, fixed platforms, guyed towers, jack-ups, converted fixed installations, etc.

Flammable Fluid - Any fluid, regardless of its flash point, capable of feeding a fire, is to be treated as *Flammable Fluid*. Aviation fuel, diesel fuel, hydraulic oil (oil based), lubricating oil, crude oil and hydrocarbon, are to be considered flammable fluids.

Flash Point - The minimum temperature at which a combustible liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid or within the vessel used, as determined by the test procedure and apparatus specified in NFPA 30. *Ignitable Mixture* means a mixture that is within the flammable range (between the upper and lower limits) and is therefore capable of propagation of flame away from the source of ignition.

Floating Installation - An offshore facility designed to provide hydrocarbon processing and/or hydrocarbon storage, and offload hydrocarbons. The term *Floating Installation* is used to generically identify a buoyant facility that is site-specific. This installation is securely and substantially moored so that it cannot be moved without a special effort. The term includes, but not limited to Tension Leg Platforms (TLP), Spar Buoy, Permanently Moored Shipshape Hulls and Semisubmersibles.

Hydrocarbon - Organic compounds of hydrogen and carbon, whose densities, boiling points, and freezing points increase as their molecular weights increase. Although composed of only two elements. Hydrocarbons exist in a variety of compounds because of the strong affinity of the carbon atom for other atoms and for itself. The smallest molecules of hydrocarbons are gaseous; the largest are solids. Petroleum is a mixture of many different hydrocarbons.

Hydrocarbon Fire Test - A test in which specimens of the relevant bulkheads or decks are exposed, in a test furnace, to temperatures corresponding to the hydrocarbon fire time-temperature curve as defined by the EN 1363-2

Hazardous Area - See “Classified Area”.

High Integrity Pressure Protection System (HIPPS) - An efficient option to replace a mechanical safety device; an example is a pressure safety valve, with instruments, valves and logic.

Ignition Temperature - The minimum temperature required, at normal atmospheric pressure, to initiate the combustion of an ignitable mixture.

Inert Gas - A gaseous mixture, such as flue gas, containing insufficient oxygen to support the combustion of hydrocarbons.

Interim Class Certificate - A temporary representation to classification. The *Interim Class Certificate* is generally issued by the Surveyor attending commissioning of the facility and verification of compliance with this Rules. Issuance of an Interim Class Certificate is subject to the terms and conditions found therein.

Joiner Arrangement - Construction details showing the combination of all structural fire protection materials. For example, a detail showing the connection of the ceilings to decks, ceilings to bulkheads, bulkheads to bulkheads, bulkhead construction details, deck construction details, etc.

Jumper Ducts - Openings in bulkheads (usually in the top half) used for air balance or return air.

Lower Explosive Limit (L.E.L.) - The lowest concentration of combustible vapors or gases, by volume in mixture with air, which can be ignited at ambient conditions.

Machinery Spaces of Category A are spaces, and trunks to such spaces, which contain:

- i) Internal combustion machinery used for main propulsion; or
- ii) Internal combustion machinery used for other purposes where such machinery has, in the aggregate, a total power, or combined rating of 375 kW (500 hp) or more; or
- iii) Any oil-fired boiler or oil fuel unit

Manned Facility - A facility with permanent occupied living accommodations or one that requires continuous presence of personnel for more than 12 hours in successive 24-hour periods.

Marine Support Systems - For offshore installations, those functions required for maintaining the normal operations of a vessel (or MODU), such as power generation, propulsion, navigation, HVAC, water treating, etc.

These functions are neither directly nor indirectly related to the hydrocarbon production and process systems.

Non-ducted Return - Means of re-circulating conditioned air back to the air handler without the use of a dedicated duct.

Open Drains - Gravity drains from sources which are at or near atmospheric pressure, such as open deck drains, drip pan drains, and rain gutters.

Operating Conditions - A set of conditions (i.e., flowrates, compositions, temperatures and pressures) chosen for normal operation of a production facility at a particular point in the life of an oil or gas field.

Other Machinery Spaces (versus Machinery Spaces of Category A) - All spaces, other than machinery spaces of Category A, containing machinery, boilers and other fired processes, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery and similar spaces; and trunks to such spaces.

Pad Gas - Gas added to the vapor space of a vessel or tank to prevent an explosive or ignitable vapor-air mixture from forming.

Process Areas - Areas where processing equipment is located. This includes wellhead/manifold areas.

Process Design Conditions - A set of conditions used to design process components and systems.

Process Support Systems - Utility and auxiliary systems that complement the hydrocarbon production and process systems. A typical list of such systems is included in Section 3.D and Section 4.D. These systems do not directly handle hydrocarbons.

Produced Fluids - Fluids coming out of completed wells, which may consist of oil, water, gas, and condensable vapor.

Production Facilities - For the purpose of this Rule, *Production Facilities* are typically the processing, safety and control systems, utility and auxiliary equipment, for producing hydrocarbon liquid and gas mixtures from completed wells or other sources.

These facilities are generally inclusive from the inlet flange of the well fluid flowline above the water level to the point at which the departing pipeline enters the water. The facilities also include the safe disposal and/or collection of produced oil, gases and water.

For a floating installation with the storage and offloading capability to shuttle tanker, the production facility is terminated at the inlet flange discharge into the storage tank. The storage tank and offloading piping/electrical systems arrangement are considered marine systems.

Sanitary and Similar Spaces - Communal sanitary facilities such as showers, baths, lavatories, etc., and isolated pantries containing no cooking appliances. Sanitary facilities which serve a space and with access only from that space are to be considered a portion of the space where they are located.

Service Spaces (Low Risk) - Lockers, storerooms, and working spaces in which flammable materials are not stored, such as drying rooms and laundries.

Service Spaces (High Risk) - Lockers, storerooms, and working spaces in which flammable materials are stored, such as galleys, pantries containing cooking appliances, paint rooms and workshops other than those forming part of the machinery space.

Severe Environment - An environment in which regularly occurring conditions of wind, sea condition, ice, etc., would impede the orderly evacuation of an offshore facility.

Shut-in Condition - A condition resulting from a shutting-in of the facility (See API RP 14C) caused by the occurrence of one or more undesirable events.

Shut-in Tubing Pressure (SITP) - Pressure exerted by the well due to closing of the master valve.

Stairways - Interior stairways, lifts and escalators (other than those wholly contained within the machinery spaces) and enclosures thereto. In this context, a stairway which is enclosed only at one level is to be regarded as part of the space from which it is not separated by a fire door. Stairways penetrating only one level are required to be enclosed in “A” class bulkheads at one level. If penetrating more than one level, the requirement is for complete enclosure at all levels.

Standard Fire Test - A test in which specimens of the relevant bulkheads or decks are exposed in a test furnace to temperatures corresponding to the standard time-temperature curve and as defined by Annex 1 of Part 3 of the IMO Fire Test Procedures (FTP) Code.

Steel or Equivalent Material - For any material or combination of materials to be considered as equivalent to steel, the following four requirements are to be met:

- i) *Non combustibility*: The material is to be tested to the applicable section of the FTP Code, and approved as such.
- ii) *Integrity against the passage of flame of smoke*: The material is to be tested to the IMO FTP A.754(18) standards, and approved as such.
- iii) *Smoke and Toxicity*: The material is to be tested to the IMO FTP standard, and approved as such.
- iv) *Structural Integrity*: Based on its area of use, whether required to be load bearing or maintaining integrity, the material is to perform similarly to steel in similar situations. (For example, if required to be “A” class, material is to remain stable after the standard fire test of one hour.)

Suitably Stiffened - Stiffened according to requirements of the IMO FTP Code. When suitably stiffened, a bulkhead may be considered to be “A” class without having to be tested. If, however, a bulkhead is not stiffened according to the requirement of the IMO FTP Code, the bulkhead is to be tested.

Transient Condition - A temporary and short-lived condition (such as a surge) that usually does not cause an upset condition.

Upset Condition - A condition that occurs in a process component or system when an operating variable deviates substantially from its normal operating limits. If left unchecked, this condition can result in a threat to safety and may cause shutting-in of the process.

Ventilation - Adequate - Natural or artificial ventilation that is sufficient to prevent the accumulation of significant quantities of explosive mixtures in concentrations above 25% of their lower explosive limit (LEL).

Well Characteristics - The conditions of a well or reservoir defined by depth, temperature, shut-in pressure, flow rate, well fluid composition, etc.

Well Fluid Properties - The properties of a particular fluid stream defined by gas-oil ratio, flowing pressure and temperature, viscosity, density (API Gravity), composition, etc.

B. References

1. References

In addition to the BKI Rule, and Guides as listed in **1.C.2**, the additional requirements of the following Guides, codes or standards are referenced in this Rule:

- *BKI Guidance for Risk Evaluations for the Classification of Marine-Related Facilities*
- *BKI Reference Notes on Risk Assessment for the Marine and Offshore Oil and Gas Industries*
- *BKI Guidelines for Certification of Lifting Appliances*
- *BKI Guidance for Survey Using Risk-Based Inspections for the Offshore Industry*
- *BKI Guidance for Surveys Based on Reliability-Centered Maintenance*
- *AISC* - American Institute of Steel Construction
- *ANSI* - American National Standards Institute
- *API* - American Petroleum Institute
- *ASME* - American Society of Mechanical Engineers
- *ASNT* - American Society for Nondestructive Testing
- *ASTM* - American Society for Testing and Materials
- *AWS* - American Welding Society
- *ICEA* - Insulated Cable Engineers Association
- *IEC* - International Electrotechnical Commission
- *IEEE* - Institute of Electrical and Electronic Engineers
- *IACS* - International Association of Classification Societies
- *ISO* - International Organization for Standardization
- *NACE* - National Association of Corrosion Engineers
- *NEMA* - National Electrical Manufacturers Association
- *NFPA* - National Fire Protection Association
- *TEMA* - Tubular Exchangers Manufacturers Association
- *EN* - European Standard
- *IMO* - International Maritime Organization

BKI is prepared to consider other recognized codes, standards, alternative design methodology and industry practice, on a case-by-case basis, with justifications as indicated in Section 1, Subsection of this Rules.

C. Acronyms and Abbreviations

1. Acronyms and Abbreviations

The following acronyms and abbreviations are used in this Rules:

- BPVC Boiler and Pressure Vessle Code
- CoC Certificate of Conformity
- ESD Emergency Shutdown
- FMEA Failure Modes and Effects Analysis
- FMECA Failure Modes and Effects Criticality Analysis
- H₂S Hydrogen Sulfide
- HAZOP Hazard and Operability
- HAZID Hazard Identification
- HIPPS High Integrity Process Protection Systems
- ITP Inspection and Test Plans
- LEL Lower Explosive Limits
- LSL Level Safety Low
- MAC Manufacturer's Affidavit of Compliance
- MTR Material Test Report
- NDE Nondestructive Examination
- P&ID Piping and Instrumentation Diagram
- PSH Pressure Safety High
- PSV Pressure Safety Valve
- PQR Procedure Qualification Records
- RT Radiographic Examination
- SAC Safety Analysis Checklist
- SAFE Safety Analysis Function Evaluation
- SAT Safety Analysis Tables
- SSV Surface Safety Valve
- USV Underwater Safety Valve
- UT Ultrasonic Examination
- UTS Ultimate Tensile Strength
- WPS Welding Procedure Specifications

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Section 3

Floating Installations

A. General

1. Scope

This Section defines the minimum criteria for BKI Class applicable to hydrocarbon production and processing systems, subsystems and equipment on floating installations. See 1.B.1 of this Rule for Scope and Conditions of Classification.

Terms, definitions, references, abbreviations and acronyms, used in this Section are defined in Section 2.

2. Applicability

The requirements described in this section are applicable to facilities on floating installations of various configurations that provide hydrocarbon production and processing services. These services may include:

- Well fluid de-pressurization
- Phase separation
- Fluid cleaning, treatment and stabilization
- Dehydration
- Compression
- Reinjection
- Transfer
- Storage
- Metering
- Off-loading of processed hydrocarbon

3. Conditions of Classification

Refer to the BKI Rules for Classification and Construction of Offshore Installations – Volume 1 Rules for Classification and Survey and Section 1 of this Rule for information on Classification.

4. Design Considerations

4.1 Recognized Standards

The submitted design is to be in accordance with the requirements of the Rules and the specified codes and/or standards as referenced herein.

- i)* Designs complying with other international or national standards not listed in Appendix 4 will be subject to special consideration in accordance with Section 1.D of this Rule.
- ii)* BKI advises the designer/manufacture to contact the BKI Head office early in the design phase for acceptance of alternate design codes and/or standards.
- iii)* When alternate design codes and/or standards are proposed, justifications can be achieved through equivalency, gap analysis or appropriate risk analysis/philosophy to demonstrate that the proposed alternate design code and standard will provide an equivalent level of safety to the recognized standards as listed in Appendix 4 and are required to be performed in accordance with Section 1.D of this Rule.

4.2 Alternative Basis of Design

Designs based on manufacturer's standards may also be accepted. In such cases, complete details of the manufacturer's standard and engineering justification are to be submitted for review.

- i)* The manufacturer will be required to demonstrate by way of testing or analysis that the design criteria employed results in a level of safety consistent with that of a recognized standard or code of practice.
- ii)* Where strain gauge testing, fracture analysis, proof testing or similar procedures form a part of the manufacturer's design criteria, the procedure and results are to be submitted for BKI review.
- iii)* Historical performance data for production or process systems, subsystems, equipment or components is to be submitted for justification of designs based on manufacturer's standards.
- iv)* BKI will consider the application of risk evaluations for alternative or novel features for the basis of design in accordance with Section 1.D of this Rule, as applicable.

4.3 Design Conditions

The production and process systems, subsystems, equipment, and/or components are to be designed to account for all applicable environmental, operational, and test loads, or combination thereof. These include, but are not limited to, the following:

- i)* Environmental Conditions, as applicable :
 - Earthquake
 - Current, waves
 - Wind
 - Temperature
 - 1, 10, 50, 100 year storm event, as applicable
- ii)* Operational
 - Static pressure
 - Transient pressure excursion
 - Temperature excursion
 - Fluid static head and properties
 - Tension
 - Bending
 - Vibration
 - Acceleration loads due to movement of installation
- i)* Transportation
- iv)* Installation
- v)* Commissioning
- vi)* Test Loads

B. Design Plans and Data

1. Submissions of Design Plans and Data

The following sections describe the design plans and data submission requirements for BKI classing of floating installations and associated hydrocarbon production and processing systems, subsystems, equipment and/or components.

- i)* 3.B/Table 1 and 3.B.2 through 3.B.12, as applicable, identifies the hydrocarbon production and processing systems, subsystems, equipment and/or components that require approval for BKI Classification of the floating installations.
- ii)* The submitted design plans and data are to be in accordance with the requirements of this Rule and the latest edition of the specified codes and/or standards, as referenced herein and Appendix 4, from contract date.
- iii)* The design plans and data, as specified in this Rule, are to be generally submitted electronically to BKI. However, hard copies will also be accepted.

- iv) All plan submissions originating from designers or manufacturers are understood to be made with the knowledge of the main contracting party.
- v) For production and processing systems, subsystems, equipment or components not listed in 3.B/Table 1 or 3.B.2 through 3.B.14, the designers or manufacturers should contact the appropriate BKI Head Office for guidance on technical and survey requirements and completion of the approval process.
- vi) All plan submissions originating from manufacturers are understood to be made with the cognizance of the main contracting party. A fee may be charged for the review of plans that are not covered by the contract of Classification.

It should be noted that due to the varying configurations of offshore production facilities, portions of these requirements may not be applicable to a given installation.

Table 1. Design Plans and Data Submission Requirements

BKI technical documentation requirements for classing facilities on floating installations:

1. Facility Documentation

1. Project Specifications
2. General Arrangement and Equipment Layout Drawings
3. Area Classification and Ventilation Drawings

2. Hydrocarbon Production and Processing Systems

1. Process Flow Sheets
2. Heat and Mass Balance
3. Piping and Instrument Diagrams (P & ID's) for all facility systems and subsystems
4. Safety Analysis Function Evaluation (SAFE) Charts
5. Packaged Process Units
6. Process Equipment Documentation
7. Process Piping Specifications
8. Pressure Relief and Depressurization Systems
9. Flare and Vent Systems
10. Spill Containment, Closed and Open Drain Systems
11. Sub-sea Production Systems (Optional)

3. Process Support Systems

1. Piping and Instrument Diagrams (P & ID's) for each system or subsystem
2. Equipment Documentation
3. Process Support Piping Specifications
4. Internal-Combustion Engines and Turbines
5. Cranes (Optional)

4. Marine Support Systems

as applicable :

1. Steam System
2. Power Generation
3. Fuel and Lube Oil
4. Compressed Air System
5. Essential Control Air System
6. Hydraulic Power Piping System
7. System conveying toxic liquids, low flash point below 60° C (140° F) liquids or flammable gas
8. Description of Ballast System for Column – Stabilized Unit
9. Diagram plan of all piping system used solely for drilling operation including cross connection where applicable with other non-drilling related system
10. Sanitary System

Table 1. Design Plans and Data Submission Requirements (continued)

11. Fresh Water
12. Ballast and Bilge System
13. Cargo Handling System
14. Sea Water System
15. Propulsion and/or Thruster System
16. Steering Gear System
17. Sewage Treatment System
18. Helicopter Refueling System
19. Drainage System
20. Inert System
21. Internal Cargo Storage Tank Venting System
22. Oil Fired Inert Gas Generator

5. Electrical Installations

1. Electrical One-line Diagrams
2. Short-Circuit Current Calculations
3. Coordination Study
4. Specifications and Data Sheets for Generators and Motors
5. Specifications and Data Sheets for Distribution Transformers
6. Details of Storage Batteries
7. Details of Emergency Power Source
8. Standard Details of Wiring Cable and Conduit Installation Practices
9. Switchboard and Distribution Panel
10. Panelboard
11. Installations in Classified Areas

6. Instrumentation and Control Systems

1. General Arrangements
2. Data Sheets
3. Schematic Drawings - Electrical Systems
4. Schematic Drawings - Hydraulic and Pneumatic Systems
5. Programmable Electronic Systems
6. FMEA or FMECA for Computer-Based Systems

7. Fire Protection and Personnel Safety

1. Firewater System
2. Water Spray (Deluge) Systems for Process Equipment
3. Foam Systems for Crude Storage Tanks
4. Fixed Fire Extinguishing Systems
5. Paint Lockers and Flammable Material Storerooms
6. Emergency Control Stations
7. Portable and Semi-Portable Extinguishers
8. Fire and Gas Detection and Alarm Systems
9. Fire and Gas Cause and Effect Chart
10. Structural Fire Protection (which indicates classification of all bulkheads for: quarters section, machinery spaces and processing facilities)
11. HVAC plan (including AHU location, duct layout, duct construction and bulkhead penetration details)
12. Joiner detail arrangement and structural fire protection material certification
13. Guard Rails
14. Escape and Egress Routes (may be included on the fire control plan or separate plan)
15. Muster Stations
16. Lifesaving Appliances and Equipment Plan (escape routes must be indicated)
17. Insulation of Hot Surfaces

Table 1. Design Plans and Data Submission Requirements (continued)**8. Specific Arrangements**

1. Arrangements for Storage Tank Venting and Inerting
2. Arrangements for Use of Produced Gas as Fuel

9. Start-up and Commissioning Manual**10. Topside Structure and Structural Arrangements****2. Details**

Plans and data for equipment and components are to provide the following, as applicable:

- i)* Model and size
- ii)* Design specifications, including design codes, standards, and references
- iii)* Design parameters: loads, temperature, environmental conditions, etc.
- iv)* Design analysis and/or calculations, as applicable
- v)* Dimensional details and drawings
- vi)* Fabrication details and welding configurations
- vii)* Material specifications and material properties

3. Facility Documentation**3.1 Project Specifications**

Project specifications are to provide the following, but not limited to:

- i)* Brief descriptions of field location
- ii)* Environmental conditions
- iii)* Well shut-in pressure
- iv)* Well fluid properties
- v)* Production plans
- vi)* Hydrocarbon (oil/gas) storage and
- vii)* Hydrocarbon (oil/gas) transportation arrangements

3.2 General Arrangement and Equipment Layout Drawings

General arrangement and layout drawings are to show:

- i)* Arrangements and locations of living quarters, control rooms, and machinery spaces, including all entrances, exits and openings to these spaces
- ii)* Arrangements and locations of machinery, process equipment, cargo storage, etc.

3.3 Area Classifications and Ventilation Drawings

- i)* Plans for area classifications and ventilation are to show, as applicable:
 - Extent of all Class I, Division 1 and 2, areas and spaces; or
 - Extent of all Class 1, Zone 0, Zone 1 and Zone 2 areas and spaces
- ii)* Arrangements for ventilation of enclosed spaces, and
 - Locations of all ventilation inlets and outlets, with respect to the hazardous areas
 - Locations of all entrances, exits and openings, with respect to the hazardous areas

3.4 Escape and Egress Route

Plans showing all escape and egress route on the complete facility.

3.5 Muster Locations

Plans showing all muster locations on the complete facility.

4. Hydrocarbon Production and Process Systems

4.1 General

To evaluate the process safety system, the assumptions as made by the designers and as provided in the following documents are to be submitted:

- Project Specification - See 3.B.3.1
- Process Flow Sheets - See 3.B.4.2
- Heat and Mass Balance - See 3.B.4.3

Although these documents will not be approved by BKI, they are critical to approval of the facility, and are to be kept for reference throughout the design review process.

4.2 Process Flow Sheets

Process flow sheets are to identify the following, as a minimum:

- i)* Each process stream
- ii)* Process equipment
- iii)* Planned addition
- iv)* Symbols used

4.3 Heat and Mass Balance

Heat and mass balance specifications for each process stream under normal operating and upset conditions are to include the following, as a minimum:

- i)* Flow rate
- ii)* Composition
- iii)* Conditions (temperature, pressure, and vapor/liquid ratio)

4.4 Piping and Instrument Diagrams (P & ID's)

P & ID's diagrams showing:

- i)* Design, and operating conditions
- ii)* Designation and size of all major process equipment
- iii)* Piping class specifications (designation and size) for:
 - Piping
 - Valves
 - Pipe fittings and in-line equipment/components such as strainers, filters, etc.
 - Sensing and control instrumentation,
- iv)* Shutdown and pressure relief devices with set points specified
- v)* Signal circuits
- vi)* Set points for controllers
- vii)* Continuity of all line pipes
- viii)* Boundaries of skid units and process packages

Safety Analysis Function Evaluation (S.A.F.E.) Charts (see 3.B.4.5) are preferably to be submitted in conjunction with the P & ID's.

4.5 Safety Analysis Function Evaluation (S.A.F.E.) Charts and Cause and Effect Matrix

4.5.1 S.A.F.E. Chart

S.A.F.E. chart is to list all process systems, subsystems, equipment, components and associated emergency support systems with their required instruments, controls, safety devices, and is to list the functions to be performed by each device. See API RP 14C and API RP 14J.

4.5.2 Cause and Effect Matrix

Cause and Effect Matrix establishes the relation between the causes of a hazardous event and the effects of that event. Cause-and-Effect Matrix is to list all causes and the associated resulting effect or event. Cause-and-Effect Matrix can also uncover the interdependencies between the initiating causes and the resultant event or events (effect). Cause and Effect Matrix can be in the form of table, chart, or diagram format.

4.6 Packaged Process Units

Packaged process units include, but are not limited to, the following:

- Dehydration
- Separation
- Sweetening
- Stabilizing
- Vapor recovery
- Gas compression for fuel or re-injection.

Documentation requirements for packaged process units include:

- i)* Skid arrangements and assembly drawings
- ii)* P & ID's - See 3.B.4.4
- iii)* S.A.F.E. charts and Cause and Effect Matrix - See 3.B.4.5
- iv)* Process equipment documentation - See 3.B.4.7
- v)* Process piping system documentation - See 3.B.4.8
- vi)* Pressure relief and depressurization systems - See 3.B.4.9
- vii)* Electrical one-line diagrams - See 3.B.7.1
- viii)* Control schematics - See 3.B.8.3
- ix)* Structural design calculations for skid units in dry condition with a center of gravity height of more than 1.5 m (5 ft.), or a maximum operating weight in excess of 10 MT (metric tons) or 22.05 Kips.

4.7 Process Equipment Documentation

Complete design specifications including, but not limited to, the following documents for verification of compliance to recognized codes and/or standards for equipment as listed in 3.B/Table 2, as applicable.

- i)* Equipment technical specifications
- ii)* Design data (data sheets) such as pressure, temperature, corrosion allowances, service conditions, external loads etc.
- iii)* Design calculations or analysis
- iv)* Details of pressure relief arrangement
- v)* Dimensional details/drawings covering arrangements and details
- vi)* Corrosion allowances
- vii)* Material specifications
- viii)* Weld details and welding procedure specifications and qualifications
- ix)* Extent and method of non-destructive testing
- x)* Test pressure
- xi)* Factory acceptance test procedures

Table 2. Major Equipment Plans/Calculations and Technical Documentation for Class Requirements

	A	B	C
HYDROCARBON PRODUCTION PROCESS SYSTEMS and EQUIPMENT			
Production/Process Pressure Vessels	X		
Fired Vessels	X		
Heat Exchangers	X		
Storage Tanks	X		
Meters, Stainers, Filters and Other Fluid Conditioners			
< 254 mm (10 in.) and 10.54 kg/cm ² (150 psi)		X	
≥ 254 mm (10 in.) or 10.54 kg/cm ² (150 psi)	X		
Pumps			
< 7 kg/cm ² (100 psi) and 757 liters/min (200 gpm)		X	
≥ 7 kg/cm ² (100 psi) or 757 liters/min (200 gpm)	X		
Compressors			
< 7 kg/cm ² (100 psi) and 28.3 m ³ /min (1000 scfn)		X	
≥ 7 kg/cm ² (100 psi) or 28.3 m ³ /min (1000 scfn)	X		
Flowlines and Manifolds	X		
Scraper Launchers/Receivers	X		
Packaged Process Units	X		
Flare Systems	X		
Subsea Systems	X		
PROCESS SUPPORT SYSTEMS and EQUIPMENT			
Pressure Vessels			
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)		X	
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X		
Heat Exchangers			
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)		X	
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X		
Pumps			X
Air Compressors		X	
Engines and Turbines			
< 100 kW (134 hp)		X	
≥ 100 kW (134 hp)	X		
Packaged Support Systems			
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)		X	
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X		
MARINE SUPPORT SYSTEM and EQUIPMENT			
All systems, subsystems, equipment and components are to comply with BKI Rules			
ELECTRICAL SYSTEMS and EQUIPMENT			
Generators			
< 100 kW (134 hp)			X
≥ 100 kW (134 hp)		X	

Table 2. Major Equipment Plans/Calculations and Technical Documentation for Class Requirements (continued)

	A	B	C
ELECTRICAL SYSTEMS and EQUIPMENT			
Motor			
< 100 kW (134 hp)			X
≥ 100 kW (134 hp)	X		
Distribution Transformers			X
Switchboard, MCC, Panel boards	X		
Storage Batteries	X		
INSTRUMENT and CONTROL SYSTEMS			
Control Panels	X		
FIRE PROTECTION & SAFETY SYSTEMS and EQUIPMENT			
Fire Pumps		X	
Fire Pump Skid Package	X		
Alarm Panels		X	
Fixed Fire Extinguishing Systems (Nozzles, Controls, Bottles, etc)	X		
Fire and Gas Detection Systems (Sensors, Panel, Cables, etc)	X		
EQUIPMENT and STRUCTURE			
For modules that require design review, see 3.C.4 and 3.B.3, 3.B.4.6	X		

Index :

- A. Technical specifications, data sheets, dimensional details/drawings, design calculations/analysis, including manufacturer's affidavit of compliance are to be submitted for BKI Head Office review.
- B. Manufacturer's affidavit of compliance to the applicable codes and/or standards are to be submitted to BKI.
- C. Documentations are to be verified by the attending Surveyor at the location of installation

4.8 Process Piping Specifications

Process piping line list including, but not limited to, the following:

- i) Design specifications such as pressure rating, temperature rating, service rating, etc.
- ii) Pipe and fitting material lists
- iii) Sizes

4.9 Pressure Relief and Depressurization Systems

Pressure relief valves and depressurization systems plans and data including, but not limited to:

- i) Design and capacity calculations
- ii) Sizes and arrangements
- iii) Set points
- iv) Materials

4.10 Flare and Vent System

Flare and vent system details including, but not limited to:

- i) Sizing and arrangements
- ii) Gas dispersion analysis including basis of analysis
- iii) Radiant heat intensities

- iv)* Design calculations for blow-down rates
- v)* Water seals and gas purging systems
- vi)* Knockout drum sizing details
- vii)* Details of flare tips
- viii)* Details of pilots
- ix)* Details for ignition system
- x)* Details of pressure relief and depressurizations systems

In the case of proprietary flare tips, validation reports to supplement the radiant heat intensity values are to be specified and submitted.

4.11 Spill Containment, Closed and Open Drain Systems

Arrangements for spill containment, details of piping connections to all process equipment, and slope of drains are to be specified and submitted.

4.12 Subsea Production Systems (Optional)

Provide plans and data for subsea production systems including, but not limited to, the following:

- i)* Stress calculations for structural components
- ii)* P & ID's - See 3.B.4.4
- iii)* S.A.F.E. charts - See 3.B.4.5
- iv)* Equipment technical specifications and data sheets - See 3.B.4.7
- v)* Control schematics - See 3.B.8.3
- vi)* Assembly drawings
- vi)* Installation and operation procedures

5. Process Support Systems

As defined in Section 2A. of this rule, process support systems are utility and auxiliary systems that complement the hydrocarbon production and process systems.

These systems do not handle hydrocarbons, but serve and support the hydrocarbon production and process operations, or the drilling operations, as applicable.

A typical list of process support systems includes, but is not limited to, the following:

- i)* Utility/Instrument Air System
- ii)* Fuel/Instrument Gas System
- iii)* Purging System
- iv)* Use of Produced Gas as Fuel
- v)* Inert Gas Supply
- vi)* Fuel Oil System
- vii)* Hydraulic System
- viii)* Chemical Injection System
- ix)* Material Handling System (Cranes) (Optional)
- x)* Drilling Systems
- xi)* Heating & Cooling Systems

Plans and data requirements for process support systems are as follows.

5.1 Piping and Instrument Diagrams (P & ID's)

Piping and Instrument Diagrams (P & ID's) for each process support system. See 3.B.4.4.

5.2 Equipment Documentation

Equipment technical specifications, for each process equipment such as pressure vessels, heat exchangers, pumps and compressors. See 3.B.4.7.

5.3 Piping Specifications

Submit specifications, materials, sizes, and pressure ratings for all pipes, valves and fittings, and calculations for pipe wall thickness. See 3.B.4.8.

5.4 Internal-Combustion Engines and Turbines

Technical specifications for internal-combustion engines and turbines including, but not limited to, the following:

- i)* Types
- ii)* Horsepower
- iii)* Rated speed / revolutions per minute
- iv)* Shutdown arrangements
- v)* Manufacturer's affidavit of compliance verifying compliance with recognized standards

5.5 Cranes (Optional)

Technical specifications for cranes including, but not limited to, the following:

- i)* Dimensional details/drawings
- ii)* Structural design calculations
- iii)* Load rating chart
- iv)* Test certificates for wire rope

6. Marine Support Systems

Submissions are to be as required by the applicable parts of the as listed in Table 1. See Section 2 for "Marine Support Systems" definition.

Typical marine support systems include, but are not limited to, the following:

- Steam Systems
- Power Generations
- Fuel Oil and Lube Oil
- Fresh Water
- Ballast and Bilge Systems
- Helicopter Refueling System
- Integral Cargo Storage Tank Venting System
- Cargo Handling System
- Sea Water System
- Propulsion and/or Thruster Systems
- Steering Gear System
- Sewage Treatment System
- Drainage System
- Inert Gas Supply
- Oil Fired Inert Gas Generator

7. Electrical Systems

7.1 Electrical One-Line Diagrams

Electrical one-line diagrams are to indicate, but not limited to, the following:

- i)* Ratings of generators, transformers, motors, and other loads
- ii)* Rated load current of each branch circuit
- iii)* Type and size and temperature rating of cables
- v)* Interrupting capacity of switchgear, motor control centers, and distribution panels
- iv)* Rating or settings of circuit breakers, fuses, and switches

7.2 Short-circuit Current Calculations

To establish that the protective devices have sufficient short-circuit breaking and making capacities, data is to be submitted giving:

- i)* The maximum calculated short-circuit current in symmetrical r.m.s. and asymmetrical peak values available at the main bus bars,
- ii)* The maximum allowable breaking and making capacities of the protective device.
- iii)* Similar calculations are to be made at other points in the distribution system where necessary, to determine the adequacy of the interrupting capacities of protective devices.

7.3 Coordination Study

A protective device coordination study is to be submitted and to include the following:

- i)* The protective device coordination study is to consist of an organized time-current study of all protective devices in series.
- ii)* The study is to be from the utilization equipment to the source for all circuit protection devices having different settings or time-current characteristics.
- iii)* Where an over-current relay is provided in series and is adjacent to the circuit protection device, the operating and time-current characteristics of the relay are to be considered for coordination.

7.4 Specifications and Data Sheets for Generators and Motors

7.4.1 100 kW and Over

For generators and motors of 100 kW (134 hp) and over, submit the following:

- i)* Assembly drawings
- ii)* Seating arrangements
- iii)* Terminal arrangements
- iv)* Designed ambient temperature, temperature rise
- v)* Data for complete rating, and class of insulation
- vi)* Shafts, coupling, coupling bolts, stator and rotor details
- vii)* Weights and speeds for rotating parts

7.4.2 Less than 100 kW

For generators and motors under 100 kW (134 hp), submit nameplate data along with degree of enclosure.

7.5 Specifications and Data Sheets for Distribution Transformers

Submit the following documents for transformers:

- i)* Rating
- ii)* Class of insulation
- iii)* Rated ambient temperature
- iv)* Rated temperature rise
- v)* Details of enclosure and standard to which manufactured

Test reports in accordance with the standard of construction are to be made available upon request.

7.6 Details of Storage Batteries

Details of storage batteries are to include, but not limited, the following:

- i)* Arrangement
- ii)* Ventilation
- iii)* Corrosion protection
- iv)* Types and capacities
- v)* Conductors and charging facilities
- vi)* Over-current protection
- vii)* Reverse current protection

7.7 Details of Emergency Power Source

Submit location, arrangement, and services required to maintain the integrity of the facility in the event of primary power loss.

7.8 Standard Details of Wiring Cable and Conduit Installation Practices

Standards and procedures for wiring practices and details are to be submitted, and are to include, but not limited to, the following:

- i)* Cable supports
- ii)* Earthing details and connections
- iii)* Bulkhead and deck penetrations
- iv)* Cable joints and sealing
- v)* Cable splicing
- vi)* Watertight and explosion-proof connections to equipment
- vii)* Bonding connections

7.9 Switchboard, Distribution Boards and Motor Control Centers

- i)* Complete list and specifications for:
 - Materials
 - Manufacturer's name
 - Model number
 - Rating, size, and type
 - Testing laboratory's listing number (if any), or indication of construction standard for components such as:
 - Switchboard enclosure
 - Circuit breakers
 - All types of fuses
 - Power and control wiring
 - Bus bars
 - Connectors and terminals
 - Power switches
- ii)* An outline and details of the switchboard, to include:
 - Overall dimensions
 - Front view indicating instrumentation
 - Circuit breakers
 - Switches
 - Drip-shields
 - Hand-rail
 - Securing supporting details

- iii)* Bracing arrangements and calculations to determine that bus bars and short runs of power cables are adequately braced to withstand the mechanical forces that the switchboard may be subjected to under fault conditions.
- iv)* A complete wiring schematic, including type of wiring, size, and setting of protective devices.
- v)* One-line schematic of the bus bars, indicating rating for each of the horizontal and vertical buses, the exact connection of circuit breakers to the bus bars, setting of the power circuit breakers and loads ampacities and power cable sizes, if available.
- vi)* Actual bus bar arrangement of the horizontal, vertical, and ground buses, including:
 - Bus bar material
 - Size and rating
 - Separation distances between bus bars
 - Separation distances between bus bars and bare metal parts
- vii)* Grounding details
- viii)* If applicable, details of metal barriers provided to isolate bus bars, wiring, and associated components

7.10 Panel board

The information as specified in 3.B.7.9i), ii), v) and vii), as applicable.

7.11 Installations in Classified Areas

List of all electrical equipment installed in classified areas, together with documentation issued by an independent accredited testing laboratory certifying suitability for intended services or classified areas.

8. Instrumentation and Control Systems

8.1 General Arrangements

Submit layout plans for local controllers, central controllers, displays, printers, and other instrumentation and control devices.

8.2 Instrumentation List

Submit a listing of instrumentation and control equipment, including monitoring, control, and alarm set points and ranges.

8.3 Schematic Drawings - Electrical Systems

Schematic drawings/details of electrical systems are to include types and sizes of electrical cables and wiring, voltage rating, service voltage and current, overload and short-circuit protection for the following systems:

- i)* Process control panels
- ii)* Emergency shutdown (ESD) panels
- iii)* Intrinsically safe systems
- iv)* Fire and gas detection and alarm panels
- v)* Fire alarm circuits
- vi)* Emergency generator or fire pump drive starting circuit

8.4 Schematic Drawings - Hydraulic and Pneumatic Systems

Submit system description of hydraulic and pneumatic control systems, including pipe sizes and materials, pressure ratings, and relief valve settings.

8.5 Programmable Electronic Systems

Submit the following documentation:

- i)* Control philosophy
- ii)* Schematic alarm
- iii)* Monitoring and control arrangements
- iv)* Redundancy arrangements
- v)* Failure modes of the system components

See also API RP 14J.

9. Fire Protection and Personnel Safety

9.1 Firewater System

Firewater system plans are to include, but not limited to, the following:

- i)* Pump and piping arrangements
- ii)* Location of isolation valves
- iii)* Locations of firewater stations
- iv)* Details of fire pumps including pump drivers, pump capacity and pressure
- v)* Hydraulic calculations for sizing of fire pump capacity and fire main

9.2 Deluge Systems (Water Spray for Process Equipment)

Submit plans showing the arrangement for firewater piping and spraying nozzles, as well as detailed hydraulic calculations.

9.3 Foam Systems (for Crude Storage Tanks)

Foam system plans are to indicate the arrangement for:

- i)* Firewater supply
- ii)* Foam supply and delivery
- iii)* Type of foam and expansion ratio
- iv)* Capacity calculations for areas protected.

9.4 Fixed Fire Extinguishing Systems

Fixed fire extinguishing plans showing the following:

- i)* Arrangement of piping
- ii)* Arrangement of spraying nozzles
- iii)* Storage of the extinguishing medium
- iv)* Details of control and alarm for release of the extinguishing medium
- v)* Capacity calculations and discharge time calculations for areas protected

9.5 Paint Lockers and Flammable Material Storerooms

Submit plans and calculations showing details of fixed fire extinguishing systems for the paint lockers and flammable material storerooms.

9.6 Fire Control and Life Saving Equipment Plan

Fire control and life saving equipment plans for the process area are to be submitted. For a floating installation, additional requirements for the fire control and life saving equipment plan may also be found in the BKI Rules Part 1, Seagoing Ship Volume III section 12 and Volume IX section 11 as applicable.

Fire control plan and life saving equipment plans for a process area are to include the following:

- i)* Portable and Semi-Portable Extinguishers. The plan is to show types, quantities and locations of portable and semi-portable extinguishers for the production facility.
- ii)* Fixed Fire Extinguishing Systems. The plan is to show locations, controls, protected spaces/areas and types of extinguishing system.
- iii)* Fire and Gas Detection and Alarm Systems. The plan is to show:
 - The location and type of fire detectors and gas detectors
 - The location of indicating panels
- iv)* Emergency Control Stations. The plan is to show location and equipment.
- v)* Lifesaving Appliances and Equipment. The plan is to show type, capacity, quantity and location.
- vi)* Structural Fire Protection. The plan is to show arrangements, locations, and types of firewalls for buildings and bulkheads installed in or adjacent to the process area.
- vii)* Guard Rails and Escape Routes. The plan is to show arrangement of protective guardrails, toe plates, and means of escape from normally manned spaces.

9.7 Fire and Gas Detection and Alarm Systems

Plans are to indicate:

- i)* Locations and details of power supplies
- ii)* Sensors
- iii)* Annunciation and indicating equipment
- iv)* Set points of alarm systems
- v)* Data sheets for detectors

9.8 Fire and Gas Cause and Effect Chart

Relate all fire and gas sensors to shutdowns, operation of fixed systems and fire control plans.

9.9 Insulation of Hot Surfaces

Submit details of insulation and shielding provided for personnel safety and fire protection.

10. Arrangements for Storage Tank Venting and Inerting

Submit piping and control arrangements for storage tank venting and inerting systems.

11. Arrangements for Use of Produced Gas as Fuel

Submit piping and control arrangements for use of produced gas as fuel, showing details of double wall or ducting arrangements for the pipe runs in way of the safe space. See also 3.D.3.4.

12. Start-up and Commissioning Procedures and Manual

The manual outlined in Section 5.A.4 is to be submitted for review as early as possible, prior to the commissioning of the installation.

13. Modifications

Details of modifications to machinery, piping, process equipment, etc., which may affect classification are to be submitted for approval. Typically, these include the following, but not limited to:

- i)* Equipment changes and modifications, including changes in alarms, instrumentation, and control schemes
- ii)* Facility throughput changes, and changes in feed and product compositions
- iii)* Changes in operating conditions, including pressures, temperatures, flow rates, or process conditions different from those in the original process or mechanical design
- iv)* Changes in pressure relief requirements due to factors such as increased process throughput, operation at higher temperatures or pressures, increased size of equipment, or addition of equipment
- v)* Changes to process support systems, such as changes to chemical injection, gas dehydration, etc.

C. Hydrocarbon Production and Process Systems

1. General

1.1 Scope

This Section defines the minimum criteria applicable to equipment and systems for handling and processing produced fluids from completed wells.

These requirements address process equipment such as process vessels, heat exchangers, fired vessels (heaters), compressors and pumps, as well as the associated piping, process control, and process safety systems.

The documentation requirements for design review are given in Section 3.B.

1.2 Process Safety Principle

The overall process safety principle is that hydrocarbon production and processing systems be designed to minimize the risk of hazards to personnel, property and environment.

Implementation of this principle to production systems and associated facilities design is intended to:

- i)* Prevent an abnormal condition from causing an upset condition
- ii)* Prevent an upset condition from causing a release of hydrocarbons
- iii)* Safely collect and dispose of hydrocarbon gasses and vapors released
- iv)* Prevent formation of explosive mixtures
- v)* Prevent ignition of flammable liquids or gases and vapors released
- vi)* Limit exposure of personnel to fire hazards

1.3 Governmental Regulations

The designer is directed to governmental regulations or guidance notes, which may exceed these provisions, depending on the size, type, location, and intended services of the floating installation.

2. Process Design

2.1 Design Basis

Production process design is to be based on production plans, expected well fluid properties, required pipeline or product custody transfer specifications, and other considerations.

The floating processing drainage, production water discharge and displacement water discharge are to be in

accordance with national/regional regulations. The Administration are to be consulted, if necessary.

2.2 Process Design Conditions

Process design conditions specified for equipment and systems are to include provision for handling short term and transient conditions, such as pipeline-riser slugging, cyclic pump operation, or pressure spikes, and to meet the required product specifications.

Each process equipment or piping element is to be designed for conditions as specified in 3A. 4.3 of this Rule, as applicable.

Due consideration is to be given to the well fluid properties, such as presence of hydrogen sulfide (H₂S), carbon dioxide (CO₂), etc., for selection of materials. The following standards are to be used for consideration of various well fluid properties:

- i)* NACE MR 0175/ISO 15156 “Materials for use in H₂S containing environment in oil and gas production” (latest edition) is to be used for design, procurement, and fabrication of equipment and components that may be exposed to hydrogen sulfide under conditions conducive to Sulfide Stress Cracking (SSC), as defined by the NACE Standard.
- ii)* API RP 55 “Recommended Practices for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide,” or other recognized standards, may be used as reference for the system design if the system is intended to handle H₂S.

2.3 Process Flow Sheets

Process flow sheets are to indicate all process equipment with associated piping systems, and define operating conditions for each component.

Each flow stream is to be labeled by composition, flowrates, phase, pressure, and temperature.

3. Facility Layout

3.1 General Arrangement

Machinery and equipment are to be arranged in groups or work areas in accordance with API RP 14J.

To enhance the overall safety of personnel, and facility, the following design principles and objectives are to be followed throughout the development of the facility:

- i)* Separation of nonhazardous areas from those classified as hazardous areas
- ii)* Minimizing the likelihood of uncontrollable releases of hydrocarbon to the environment
- iii)* Minimizing the spread of flammable liquids and gases which may result in a hazardous event and facilitating rapid removal of any accumulations
- iv)* Minimizing the probability of ignition
- v)* Minimizing the consequences of fire and explosions
- vi)* Preventing fire escalation and equipment damage
- vii)* Providing for adequate arrangements for escape and evacuation
- viii)* Effective emergency response
- ix)* Protection of safety systems, critical systems, subsystems, equipment and/or components from damage
- x)* Equipment arrangements are to provide access for inspection and servicing and safe means of egress from all machinery spaces.
- xi)* Additional requirements related to general arrangement and equipment layout are also to consider the applicable requirements of the Part 1 – Seagoing Ship.
- xii)* In case of a fire onboard the unit, the means of escape is to permit the safe evacuation of all occupants to a safe area, even when the structure they occupy can be considered lost in a conflagration.

- xiii)* With safety spacing, protective firewalls and equipment groupings, a possible fire from a classified location is not to impede the safe exit of personnel from the danger source to the lifeboat embarkation zone or any place of refuge.
- xiv)* Equipment items that could become fuel sources in the event of a fire are to be separated from potential ignition sources by space separation, firewalls or protective walls. See 3.C/Table 1 for typical fuel and ignition sources.

Table 1. Fuel and Ignition Sources**Fuel Sources**

- Wellheads and Manifolds
- Separators and Scrubbers
- Coalesces
- Gas Compressors
- Liquid Hydrocarbon Pumps
- Heat Exchangers
- Hydrocarbon Storage Tanks
- Gas Metering Equipment
- Oil Treaters (unfired vessels)
- Process Piping
- Risers and Pipelines
- Vents
- Pig Launchers and Receivers
- Drains
- Portable Fuel Tanks
- Chemical Storage Tanks
- Laboratory Gas Bottles
- Sample Pots

Ignition Sources

- Fired Vessels
- Combustion Engines & Gas Turbines
- Living Quarters
- Flares
- Welding Machines
- Grinding Machines
- Cutting Machinery or Torches
- Static Electricity
- Electrical Equipment
- Waste Heat Recovery Equipment
- Mobile phones
- Lightning
- Spark Producing Hand Tools
- Portable Computers
- Cameras
- Non-Intrinsically Safe Flashlights

3.2 Accommodation Spaces (Living Quarters)

Accommodation spaces or living quarters are to be located outside of hazardous areas and may not be located above or below crude oil storage tanks or process areas.

- i)* “H-60” ratings are required for the bulkheads of permanent living quarters, temporary living quarters and normally manned modules that face hazardous areas such as wellheads, oil storage tanks, fired vessels (heaters), crude oil processing equipment, and other similar hazards. If such bulkhead is more than 33 m (100 ft) from this source, then this can be reduced to an “H-0” rating.
- ii)* “A-60” and “A” rated bulkheads may be utilized provided that a risk or fire load analysis was performed and reviewed by BKI Head office, indicating that these bulkheads are acceptable. See Section 3.H.

3.3 Emergency Shutdown (ESD) Stations

Emergency shutdown (ESD) stations are to be provided for manual activation of the process safety shutdown system for shutdown of all wells and process systems. These manual activation stations are to be protected against accidental activation, and conveniently located at the primary evacuation points (i.e., boat landing, helicopter deck, etc.) and the emergency control stations (see 3.H.3.6 and 4.H.3.5, as applicable).

For design guidance, the following additional locations may be considered appropriate for emergency shutdown stations:

- i)* Exit stairway at each deck level
- ii)* Main exits of living quarters

- iii) Main exits of production (process) facility deck

3.4 Wellhead Areas

- i) Wellhead areas are to be separated or protected from sources of ignition and mechanical damage.
- ii) “A-0” firewalls around wellheads are to be used to provide protection from potential uncontrolled flow from wellheads with shut-in pressures exceeding 42 kg/cm² (600 psig).

3.5 Storage Tanks and Slop Tanks

3.5.1 Supported Storage Tanks

Supported storage tanks for crude oil or other flammable liquids are to be located as far as possible from wellheads. In addition, they are to be located as far as possible from potential ignition sources such as gas and diesel engines, fired vessels, and buildings designated as unclassified areas, or areas used as workshops, or welding locations.

3.5.2 Storage and Slop Tanks

- i) For crude storage tanks, slop tanks, and low flash point flammable liquid storage tanks flash point of 60°C (140°F) or less], such as methanol storage tanks built as hull or integral tanks, are to be separated from machinery spaces, service spaces, and other similar source of ignition spaces by cofferdams of at least 0.76 m (30 in.) wide.
- ii) Pump rooms, ballast tanks and fuel oil tanks may be considered cofferdams for this purpose.

3.6 Fired Vessels

3.6.1 Fired Vessels

- i) Fired vessels, such as glycol reboilers, hot oil heaters, etc., are considered ignition sources. They are to be installed away from wellheads and other unfired hydrocarbon processing and storage equipment.
- ii) If it is not be possible to comply to the above requirement, particularly when the space of the process area is limited, causing fired vessels to be located in the unfired process areas, then the fired vessel is to be surrounded on all sides by a minimum of “A-0” rated firewall, except on the outboard side of the unit mounted on the perimeter of a platform or FPSO.

3.6.2 Direct Fired Vessels

For direct fired vessels such as crude oil treater that is considered both as fuel and ignition source, a minimum of “A-0” rated firewall is to be provided as described in 3.C.3.6.1ii), regardless of where the unit is installed within the production or process areas (Fired or Unfired Process Areas).

4. Packaged Process Units

4.1 General

- i) Packaged process units are considered subsystems of the total production process systems.
- ii) Subsystems are to comply with 3.C.6, 3.C.7, 3.C.8, 3.C.9, and 3.F.15 for process system *requirements* and 3.C.5 for *major equipment requirements*.
- iii) The electrical installation and instrumentation and control systems are to comply with Section 3, E and F.
- iv) Fire protection systems are to comply with Section 3.H of this rule.

4.2 Skid Structures

- i)* The skid structure is to be sufficiently rigid to support the mounted equipment and piping and, as required, to permit lifting during shipment without damage to the equipment or piping.
- ii)* Structural design calculations for skid units with a center of gravity height of more than 1.5 m (5 ft), or a maximum operating weight in excess of 10 MT (metric tons) or 22.05 Kips, calculated in dry conditions, are to be submitted for review.

4.3 Drip Pans

- i)* Drip pans are to be provided to contain liquid spills and leaks from skid mounted equipment and piping, and to drain the liquid with adequate slope of 1 cm per meter (1/8 inch per foot) into open drain systems.
- ii)* A minimum 150 mm (6 in.) coaming around the entire perimeter of a skid is to be provided.
- iii)* Skid beams that extend above the drip pan may be considered as meeting the coaming requirement, provided that the drip pan is seal-welded to the skid beams.
- iv)* A spill containment with less than 150 mm (6 in.) coaming arrangement is subject to special consideration.
- v)* Calculations showing sufficient spillage containment for the skid are to be submitted for verification.

5. Major Equipment Requirements

This Subsection provides requirements for process equipment that are typically utilized in floating facilities. Conformance to standards or codes different from those listed will be considered where applicable.

The design specifications for process equipment are to consider as a minimum, but not limited to, the most adverse combination of applicable loads listed in 3.A.4.3, as applicable, and is to consist of design plans, drawings, data, and calculations, as outlined in 3.B/Table 2, to substantiate the design.

5.1 Process Vessels

5.1.1 General

- i)* Pressure vessels are to be designed, constructed, and tested in accordance with the ASME Boiler and Pressure Vessel Code (BPVC) Section VIII Division 1 or Division 2 or equivalent recognized codes and/or standards.
- ii)* Consideration will be given to arrangements and details of pressure vessels which can be shown to comply with other recognized codes and/or standards, provided they are of equivalent level of safety with the ASME BPVC Code.
- iii)* All process vessels are to be suitably supported and properly secured.

5.1.2 Design Load

In addition to the design loads specified in 3.A. 4.3, as applicable, the design is also to ensure that stresses due to external nozzle loads and moments, stresses due to acceleration forces arising out of the motion of the floating installation, and stresses due to any other applicable external forces, such as wind, are within the limits allowed by the design code and standard.

5.1.3 Materials

Low melting point or brittle materials such as cast iron, aluminum, brass, copper, or fiberglass, are not to be utilized in pressure retaining parts of vessels containing flammable or toxic fluids.

5.1.4 Thermal Considerations

Supports and insulation of vessels subject to change in temperature are to be designed to accommodate the resulting thermal movement.

5.2 Process Heat Exchangers

5.2.1 General

Process heat exchangers with a design pressure in excess of 1.05 kg/cm² (15 psig) and handling flammable fluids are subject to the requirements of 3.C.5.1 and the following applicable requirements:

5.2.2 Design Load

See 3.C.9.1.2 for design load requirements.

5.2.3 Shell and Tube Heat Exchangers

Process heat exchangers of tubular design are to conform to applicable sections of ASME Section VIII, Division 1 or Division 2, TEMA Standards or API Std. 660.

5.2.4 Plate and Frame Exchangers

Plate and frame exchangers may be employed for handling flammable liquid, with the following restrictions:

- i)* Safety or protective devices are to be provided as required in accordance with of API RP 14C.
- ii)* Each exchanger is to be provided with an exchanger enclosure, protective wall, shield or similar barrier, capable of containing spray in case of gasket leakage during operation.
- iii)* Each exchanger is to be provided with spill containment and drain capable of handling a liquid release of at least 10% of the maximum flammable stream flowrates.

5.2.5 Air Cooled Heat Exchangers

Air-cooled heat exchangers are to comply with API Std. 661.

5.3 Process Electric Heater

5.3.1 General

Process electric heater shells with a shell operating pressure greater than 1.05 kg/cm² (15 psig) are to be designed and constructed in accordance with applicable ASME BPVC Code.

5.3.2 Design Load

See 3.C.5.1.2 for design load requirements.

5.3.3 Over Temperature Protection

Process electric heaters in hydrocarbon service are to be provided with heater element skin high temperature alarms.

5.3.4 Overpressure Protection

Where the vessel, tank or piping segment containing an electric heater can be isolated, a relief valve is to be provided for overpressure protection. It is to be sized for a blocked-in condition with the heater operating at full power.

5.3.5 Low Level, Low Flow or High Temperature Protection

Process electric heaters in liquid service are to be protected by low level, low flow, or high liquid temperature sensor to shut off electrical input.

5.4 Fired Vessels (Heaters)

5.4.1 General

- i)* All fire-tube type fired vessels, with a shell operating pressure greater than 1.05 kg/cm² (15 psig), are to be designed in accordance with Section I of ASME BPVC Code.
- ii)* Fired vessel (heater) shells, (heater) coils or other equipment designed in accordance with ASME BPVC Code are to conform to all applicable requirements of 3.C.9.1.

5.4.2 Design Load

See 3.C.9.1.2 for design load requirements.

5.4.3 Indirect Fired Vessels (Heaters)

- i)* Indirect fired water bath heaters with working pressures lower than 1.05 kg/cm² (15 psig) are to be designed and fabricated in accordance with API Spec. 12K.
- ii)* Similar types of indirect fired vessels (heaters), such as steam bath heaters, are to be in full compliance with API Spec. 12K.

5.4.4 Direct Fired Vessels (Heaters)

Direct fired vertical or horizontal emulsion treaters are to be designed and constructed in accordance with API Spec. 12L.

5.4.5 Ignition Control

Where burner ignition or light-off is part of an automatic sequence, the following control functions are to be provided:

- i)* Automatic timed purge interval prior to admitting pilot fuel. Purge may be by fan if equipped, or by time delay to allow natural draft purge.
- ii)* Firing limit on a trial for ignition (15 seconds maximum) on each attempted pilot light-off.
- iii)* Confirmation of pilot lighting prior to admitting main burner fuel.

5.4.6 Manual Light-off

- i)* Each burner designed for manual light-off of the pilot is to be designed to allow an operator to light the pilot from a location which limits his exposure to flame flashback, should it occur.
- ii)* Burners are to be equipped with a sight-glass suitable for verifying pilot light-off and for viewing of main flame.

5.4.7 Combustion

Combustion air intakes for fired vessels are to be located in, or ducted from, a safe area.

5.4.8 Fired Vessel (Heater) Arrangement

Any fired vessel (heater) installed within a firewall is to be arranged with means of shutdown from outside the firewall enclosure.

5.5. Atmospheric Storage Tanks

5.5.1 General

Atmospheric and low pressure storage tanks for flammable liquids are to be designed and fabricated in accordance with one of the following standards, as applicable:

- i)* Section 2 and 3 of the Part 5 - Offshore Technology, Volume 6 - Rules for Mobile Offshore Unit and Section 2 and 3 of the Volume 7 – Rules for Fixed Offshore Installations for floating and offshore installations..
- ii)* Section 3.B.10 of the Part 1 Seagoing Ship, Volume II Rules for Hull Section 24, Volume IX Rules for Ship Carrying Liquified Gases in Bulk and Volume X Rules for Ship Carrying Dangerous Chemical in Bulk for ship-shape FSO and FPSOas applicable.
- iii)* Part 1 – Seagoing Ship , Volume V - Rules for Materials for material requirement..

5.5.2 Overflows

Any storage tank larger than 20 barrels (2,312 liters) and operating at or near atmospheric pressure is to be equipped with one or more overflow connections, sized sufficiently to remove all incoming fluid in excess of the design operating level.

5.6 Compressors

Natural gas compressors are to comply with applicable API standards such as:

- API Std. 617 for centrifugal compressors,
 - API Std. 618 for reciprocating compressors, and
 - API Std. 619 for rotary type positive displacement compressors.
- i)* Compressors rated for less than 7 kg/cm² (100 psig) and 28.3 m³/min (1000 scfm) can be accepted on the basis of manufacturer's affidavit of compliance and test reports.
 - ii)* A fusible plug fire detection system complying with 3.H.4 and 4.H.4 as applicable, and directly activating the emergency shutdown system, is to be installed in the compressor package.
 - iii)* The emergency shutdown system is to be interlocked to shutdown the compressor.

5.7 Pumps

Centrifugal pumps intended for hydrocarbon service are to comply with API Std, 610.

- i)* Centrifugal pumps having stuffing box pressures in excess of 14 kg/cm² (200 psig) are to be provided with either single-balanced mechanical seals with means to collect and contain seal leakage, or tandem-balanced mechanical seals with alarm, to indicate primary seal failure.
- ii)* Pumps rated for 7 kg/cm² (100 psig) and 757 liters/min (200 gpm) or less may be accepted for hydrocarbon service, on the basis of a manufacturer's affidavit of compliance with the requirement of API Std. 610.
- iii)* Pumps rated above 7 kg/cm² (100 psig) and 757 liters/min (200 gpm) are to meet the following requirements:

- a) The manufacturer is to supply a manufacturer's affidavit of compliance to API Std. 610 to the BKI Head Office, regardless of size and is to include documentation on the seal arrangement of the pump.
- b) The manufacturer is to furnish, in accordance with of API Std. 610, a statement indicating any system or components not in compliance with the requirements, detailing and clarifying all deviations to the Standard to the BKI Head Office. (This is to include alternative designs or systems that are specified for specific duties).
- c) Survey guidelines are to be in accordance with 5.A/Table 1 of this rule.

5.8 Scraper Launchers/Receivers

Closures and barrels for scraper launchers/receivers are to be designed and constructed in accordance with ASME Section VIII Division 1, or other equivalent recognized standard/code.

- i) Block valves are to be provided for isolation of process elements subject to pressure, to enable their safe removal when required.
- ii) Means are to be provided to relieve pressure and to confirm the scraper launchers/receivers are not pressurized before opening the "quick opening closure".

5.9 Flare and Vent Structures

Flare and vent booms and ground flare structures are to be designed and constructed in accordance with API RP 2A WSD for secondary structures.

6. Process Piping Systems

6.1 General

Process piping design, selection of valves, fittings and flanges, are to be in accordance with API RP 14E, ASME B31.3 and other recognized standards.

6.2 Thermal Relief

Sections of piping systems that can be isolated with block valves, while they may be filled with cold liquid or liquid at near ambient temperature, are to be provided with thermal relief valves. This is to protect the piping from overpressure caused by solar heating or exposure to fire.

6.3 Isolation Valves

- i) Block valves are to be provided for isolation of process elements subject to pressure to enable their safe removal when required.
- ii) Means are to be provided to relieve pressure from the blocked piping segment before removal of the control element.

6.4 Flexible Hoses

- i) Hose assemblies may be installed between two (2) points where flexibility is required, if they will not be subject to twisting under normal operating conditions.
- ii) Hoses carrying flammable fluids are to be fire-resistant rated for maximum working pressure and temperature, and reinforced with wire braid or other suitable material.
- iii) To be considered fire resistant, hoses for flammable fluid service are to pass industry recognized fire

test such as those listed in API Spec 16C “Specification for Choke and Kill Systems” (1300°F/704°C - Pressurized full water to normal working pressure for minimum 5 minutes). For details, see Appendix 2.

For flexible hoses in hydraulic control system requirements, see 3.D.3.7.

- iv) Burst pressure of the hose is not to be less than three (3) times the relief valve setting.

6.5 Plastic Pipe Installations

All non-metallic piping materials used in the piping systems for conveying hydrocarbon fluid must meet Level 1 fire endurance test, as referenced in Appendix 1 of this Rule, except as modified herein.

For a produced water piping system, a plastic pipe which passes a Level 3 fire endurance test or any equivalent fire endurance standard (such as the testing specified in Section 10.5.1 of API Spec 16C) may be considered, provided the following conditions are met:

- i) A metallic isolation valve (ESD Valve), arranged to close in the event of a fire, is to be connected by metallic piping to hydrocarbon containing vessels, where the failure of the plastic piping would result in the uncontrolled release of hydrocarbons. Non-metallic piping materials may only be used beyond the ESD valve. See 3.C/Fig. 1 for reference.
- ii) Fire detection, fire fighting and shutdown systems are provided. See 3.C/Fig. 1 for typical detailed arrangement.

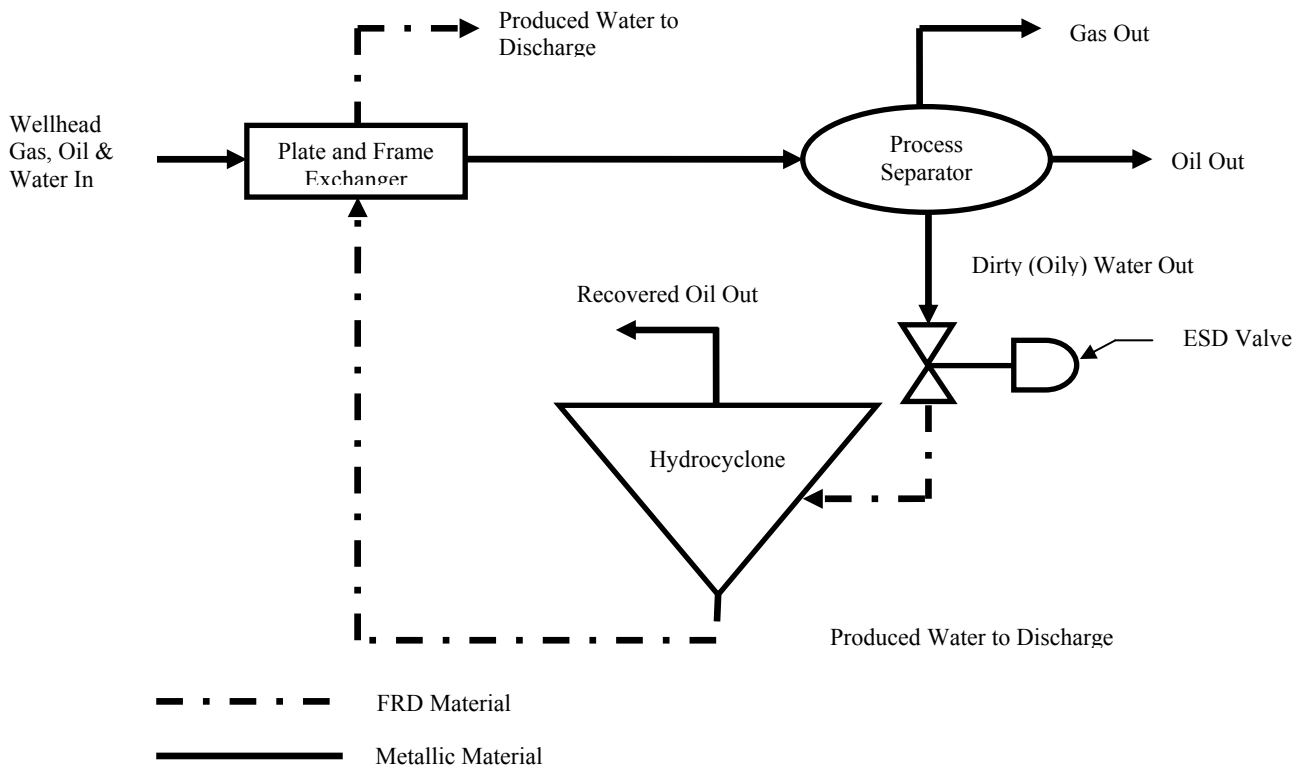


Fig. 3.1 Typical FRP/GRP Arrangement in a Process Piping Layout

7. Piping and Instrumentation Design

7.1 Process Control System

- i)* Essential process parameters (such as flow rate, pressure, temperature and liquid level) are to be automatically monitored and controlled, and the abnormal conditions are to be alarmed with visual and audible devices.
- ii)* The process control system used to maintain process variables within normal operating ranges is to be capable of accommodating a reasonable range of abnormal or transient conditions without creating an upset condition.

7.2 Safety System

Safety system is to be provided and comply with API RP 14C. Essential elements of the safety system are to include:

7.2.1 Safety Sensing and Self-acting Devices

- i)* The safety system is to be provided with two (2) levels of protection, primary and secondary, with sensing and self-acting devices, which are functionally different types of devices. They are to be in addition to process control devices used to maintain normal process parameters.
- ii)* The safety system is to be capable to sense process variables. It reacts to a condition outside acceptable limits by automatically activating an alarm and initiating the necessary protective response.
- iii)* Pressure vessels are generally fitted with pressure control valves to protect against overpressure. Additionally, they are to be fitted with a safety system device such as Pressure Safety High (PSH) (primary) and a Pressure Safety Valve (PSV) (secondary).
- iv)* Loss of any single control or safety system component is not to cause an unsafe condition. Example: If a production separator liquid outlet control valve sticks open, a Level Safety Low (LSL) can protect against gas blow-by.
- v)* Where High Integrity Process Protection Systems (HIPPS) are used, these systems are subject to special consideration. Use of these systems will only be considered up to the inlet of the low pressure shutoff valve upstream of the first stage separator/heater.

7.2.2 Fire Detection

A fusible plug system, or other means of automatically detecting fire, is to provide a shutdown signal for production facilities, as per 3.H.4.1 and API RP 14C, Appendix C.

7.2.3 Gas Detection

Combustible and hydrogen sulfide gas detectors are to be provided, as per 3.H.4.2, to initiate alarms and shutdowns.

7.2.4 Process Emergency Shutdowns (ESD)

- i)* An emergency shutdown (ESD) system with manual stations is to be provided, in accordance with 3.C.3.3 and API RP 14C, Appendix C, to shut down the flow of hydrocarbon from all wells and pipelines, and to terminate all production and injection activities of the facility.
- ii)* The emergency shutdown system is to be automatically activated by:
 - a)* The detection of an abnormal operating condition by flowline pressure sensors and sensors on any downstream component through which the pipeline fluids flow;

- b) The detection of fire in the wellhead and process areas;
 - c) The detection of combustible gas at a 60% level of the lower explosive limit (LEL);
 - d) The detection of hydrogen sulfide (H₂S) gas at a level of 50 ppm.
- iii) Emergency shutdown (ESD) valves for flowlines and pipelines are to be located as far away from the facility as practical. (See 3.H.3.6 and 4.H. 3.5, as applicable).

7.2.5 Safety Analysis

- i) Safety Analysis Tables (SAT) and Safety Analysis Checklists (SAC), in accordance with API RP I4C, are to be used to verify that the safety devices provided to protect each process component and piping segment are adequate.
- ii) Safety Analysis Function Evaluation (SAFE) Charts are to be prepared to show the integration of all safety devices and self-protected equipment into a complete facility safety system.

8. Pressure Relieving and Hydrocarbon Disposal Systems

8.1 Pressure Relief Systems

8.1.1 Pressure Relief Valves

- i) Pressure relief valves are to be installed in accordance with API RP 14C to protect all vessels and pressure-rated equipment from overpressurization.
- ii) Pressure relief valves are to be sized and installed in accordance with API RP 520 and ASME Section VIII, Division 1 Appendix M.
- iii) If block valves are installed in the relieving lines, means are to be provided to ensure that pressure relief valves are not isolated from the protected equipment.
- iv) The practice of locking open block valves to eliminate the need for higher design pressures or additional relief protection is allowed if:
 - a) Closure of the valve would not result in the pressure rising more than 1.5 times the design pressure of the equipment or component under consideration, or
 - b) Can be otherwise demonstrated that the proposed installation is safe and would not, in any circumstance, planned or unplanned, inadvertent or intentional, result in a risk to personnel or facilities.

See also 3.G.9.3 of this Rule for reference on block valve locking devices.

8.1.2 Gas Service

- i) Pressure relief valves in hydrocarbon gas service are to discharge to one or more closed relief headers for atmospheric discharge at either a flare or vent. Such flare or vent discharges are to meet the requirements of 3.C.8.3.
- ii) Pressure relief headers are to be sized to handle the maximum anticipated discharges that could occur at any time.
- iii) Relief header sizing is to be sufficient so that excessive back-pressure does not develop, which may prevent any pressure relief valve from relieving at its design rate.
- iv) Where necessary, separate high and low pressure relief headers are to be employed to meet this requirement.

8.1.3 Liquid Service

- i)* Pressure relief valves in liquid hydrocarbon service are to discharge to a lower pressure system such as a tank, pump suction, sump vessel, or closed drain system.
- ii)* Discharges to drip pans or other open drains are to be limited to small volume thermal releases.

8.1.4 Rupture Discs

The use of rupture discs is limited to the following:

- i)* In gas or gas/liquid service, rupture discs may be utilized only as backup to pressure relief valves and they are sized for the maximum relieving conditions.
- ii)* In liquid service, rupture discs may be utilized only as backup to pressure relief valves that are sized for the maximum relieving condition. They may be installed as primary relief devices for non-flammable, non-hazardous liquids at relieving pressures no greater than 10.5 kg/cm² (150 psig).
- iii)* In applications where use of other relieving devices is not practical, requests for such exceptions will be specially considered by BKI.

8.1.5 Vapor Depressurizing

- i)* An emergency vapor depressurizing system is to be provided for all equipment processing light hydrocarbon with operating pressures of 17.5 kg/cm² (250 psig) and above, as specified in API Std. 521.
- ii)* To gain rapid control of a situation in which the source of a fire is the leakage of flammable fluids from the equipment to be depressurized, the equipment is to be depressurized to 7 kg/cm² (100 psig).
- iii)* In cases where the equipment is handling high pressure and large inventories of hydrocarbon, and depressurizing to 100 psig is impractical, it is acceptable to depressurize to 50% of the equipment design pressure if such depressurization is achieved within 15 minutes. This is provided the equipment has been designed with ample margin of safety to prevent the vessel from failing due to overheating.
- iv)* Calculations, showing the maximum allowable temperature of the equipment would not exceed the equipment rated temperature, are to be submitted for verification. See API Std. 521 for information on the effect of heat input to uninsulated steel vessels.

8.2 Pressure/Vacuum Venting System for Atmospheric and Low Pressure Storage Tanks

- i)* All atmospheric and low pressure storage tanks and similar equipment, such as flotation cells and atmospheric corrugated plate interception (CPI) separators, are to be provided with pressure and vacuum relief protection, as required.
- ii)* Sizing criteria for pressure and vacuum relief protection is to be in accordance with API Std. 2000.
- iii)* Vent lines are to be routed to an atmospheric vent header, or to individual vents. These vent discharges are to meet the requirements of 3.C.8.3.4.

8.3 Flares and Vents

8.3.1 Location

Flares and vents for hydrocarbon gas disposal are to be located with respect to prevailing winds. This is to limit exposure of personnel, equipment and helicopter traffic to vented gas, flare exhaust, or flame radiation.

8.3.2 Atmospheric Conditions

- i) Worst-case atmospheric conditions are to be used for radiation and gas dispersion calculations.
- ii) Flame radiation calculations are normally to assume a strong wind, 32.2 km per hour (20 miles per hour), or worst-case scenario based on the project specification, distorting the flame pattern toward the facilities.
- iii) Dispersion calculations are normally to assume still air and low vent velocity as a worst-case condition.

8.3.3 Heat Radiation from Elevated Flares

- i) The calculated radiant heat intensity from flaring (including solar radiation), at any deck level or location where normal maintenance or operating activity could take place, is not to exceed API Std. 521 recommendations.
- ii) The flare evaluation or analysis can be based on API Std. 521 method or other recognized industrial method. However, if an industrial method is selected, a validation study of the model is to be made available in support of the modeling results:
 - a) At the design continuous flaring rate: 1.58 kW/m² (500 BTU/hr/ft²)
 - b) At the design short duration (2 to 3 minutes) maximum flaring rate: 4.73 kW/m² (1,500 BTU/hr/ft²).

Note: These radiation levels (500 and 1500 BTU/hr/ft²) are only applicable to personnel, and not equipment. Higher radiation levels may be considered on deck areas if these areas are off-limit to personnel during normal or emergency operations, respectively.

8.3.4 Atmospheric Discharge

For hydrocarbon vapor disposal by atmospheric dispersion from a vent stack, the vent outlet is to be of sufficient height or distance from the facilities to accomplish the following:

- i) The calculated radiant heat intensity (including solar radiation) in case of accidental ignition is not to exceed 4.73 kW/m² (1500 BTU/hr/ft²) at the maximum venting rate, at any deck level or location where normal maintenance or operating activity could take place.
- ii) The following concentration of hazardous vapors, calculated in accordance with API Std. 521 or other industrial model, is not to be exceeded at any deck level where normal maintenance or operating activity could take place, based on the reasonable worst-case conditions (e.g., still air and low vent velocity).

H ₂ S	:10 ppm
Combustible Vapors	:20% LEL

- iii) The vent outlet is to be at least 8 m (25 ft) above any immediately adjacent process vessel or hydrocarbon processing equipment, and at least 3 m (10 ft) above the top of any vessel or equipment within an 8 m (25 ft) radius of the vent.
- iv) When a short vent stack is used in lieu of a vent boom arrangement as normally found on the FPSO, the vent outlet is to be provided with devices to prevent the passage of flame into the system. The pressure drop of the flame arrestor is to be considered in the vent diameter sizing calculations. When a dispersion model based on a modeling method other than API Std. 521 is used, a validation study of the model is to be made available for verification.

8.3.5 Fire Extinguishing Systems for Atmospheric Vent

When a venting system is selected for disposal of hydrocarbon vapors, a vent snuffing system is to be provided to extinguish vented gases, should they ignite.

8.3.6 Liquid Droplet Scrubbers

- i)* Flare scrubber or vent scrubber vessels are to be provided and sized to separate liquid droplets greater than 450 micrometers in diameter from the maximum calculated gas relieving rate of the system, in accordance with API Std. 521.
- ii)* Piping between the scrubber and flare or vent is to be self-draining back to the scrubber. If a piping low point is unavoidable, it is to be equipped with an automatic drain (e.g., a loop seal type) with connection to the open drain system.

8.3.7 Ground Flares

- i)* Ground flares may be used in place of the high stack flare.
- ii)* Ground flares are to be provided with automatic controls which will divert the flow of flare gas to a vent stack upon detection of flame failure, unless gas dispersion calculations show that the vapor concentrations do not exceed those specified in 3.C.8.3.4ii) under flame-out conditions.
- iii)* Draining connections are to be provided, to remove accumulated condensate or water to the open drain system.

8.3.8 Flashback Protection

- i)* Burn-back and flashback protection for flares is to be provided by sufficient purge gas rate maintained from a reliable source, or by a seal drum to prevent air intrusion.
- ii)* The purge gas source is to have sufficient gas supply for continuous purging during production shutdown, or for a complete purging of the flare system before re-ignition of the flare.
- iii)* The sizing of a seal drum is to be in accordance with API Std. 521.

8.3.9 Flare Ignition

The flare system is to be provided with means for purging sufficiently (below 5% of oxygen content) before ignition to prevent explosion inside the flare system.

9. Spill Containment, Open and Closed Drain Systems

9.1 Spill Containment

9.1.1 General

Spill containment is to be provided in areas subject to hydrocarbon liquid or chemical spills, such as areas around process vessels and storage tanks with drain or sample connections, pumps, compressors, engines, glycol systems, oil metering units, and chemical storage and dispensing areas.

9.1.2 Containment

- i)* Spill containment is to utilize curbing or drip edges at deck level, recessed drip pans, and containment by floor gutters, firewalls or protective walls, or equivalent means to prevent spread of discharged liquids to other areas and spillover to lower levels.

- ii)* Where equipment is protected by a fixed foam fire extinguishing system, a minimum of 150 mm (6 in.) coaming is to be provided.

9.2 Open Drain Piping

9.2.1 General

Each containment area, as well as any other plated deck or skid area subject to rainwater or other liquid accumulation, is to be equipped with drains connected to an open drain system, and installed and located so as to prevent the accumulation of standing liquid.

9.2.2 Line Sizing and Arrangement

- i)* Open drain piping is to be self-draining with a slope of not less than 1:100.
- ii)* Lines are to be sized for gravity drainage without backup or overflow, based on a full drainage rate from any single source, with consideration given to the maximum rainfall condition.

9.2.3 Cleanouts

Cleanouts or flushing connections are to be provided for removal of sediment or solids from open drains subject to potential blockage.

9.2.4 Disposal

Open drains are to be piped individually or collected in one or more piping systems, which are to convey the fluids, by gravity or pumping, to oily water treatment or final disposal location.

9.3 Sealing of Open Drains

9.3.1 General

Piping drain traps, floor drains with integral drain seal, submerged open-ended pipes, or other means of utilizing liquid head, are to be provided to prevent vapor release from the sump or drain vessel to atmosphere.

9.3.2 Drain Seals

- i)* A seal is to be provided at each open drain location where flammable liquids (diesel fuel, tube oil, glycol, crude oil, etc.) could be present in an open drain system, except as permitted by 3.C.9.3.4 below. This is to prevent flammable vapors evolving from the liquids in the drain system from being released to atmosphere.
- ii)* Each such seal is to have a minimum effective water seal height of 3.8 cm (1.5 in.).

9.3.3 Pressure Seals

- i)* Where an open drain system is subject to an applied pressure, such as pad gas on the sump or drain vessel which receives the open drainage, a liquid seal is to be provided on each drain header or drain line connected to the source of pressure.
- ii)* Minimum effective liquid seal height (unless increased by provisions of 3.C.9.3.4 below) is to be 150 mm (6 in.), or 80 mm (3 in.) over the pad gas pressure, whichever is greater.
- iii)* Where such sealing is accomplished by submerging the open end of each line feeding the sump or

drain vessel, the minimum operating liquid level in the vessel is to be maintained and minimum seal height is to be increased proportionally for submergence in liquids of specific gravity less than 1.0.

9.3.4 Hot and Dry Climates

For installations located in hot, dry climates, it is recognized that water seals on open drain systems exposed to ambient conditions are of limited use, since the seals quickly evaporate and are rarely replenished by rainfall. For such installations, the following provisions apply:

- i)* Individual local drain seals per 3.C.9.3.2 above are not required.
- ii)* Drain header seals per 3.C.9.3.3 above are to be provided on each open drain line or header connected to a hydrocarbon containing sump or drain vessel.
- iii)* Where pad gas or other imposed pressure is present, the minimum effective seal height is to be increased by 50 mm (2 in.).

9.3.5 Protection Against Freezing

In areas where drain seals are subject to freezing, means are to be provided to prevent the drain seal from freezing.

9.4 Segregation of Open Drain Systems

Drains from classified and unclassified areas are to be separate. When this requirement cannot be met, drains from classified and unclassified areas or between different zone areas are to be connected or led to a drain tank in a hazardous area. The following requirements are applicable:

- i)* Non-hazardous area drain header is to be equipped with a stop check valve at the safe area bulkhead, together with a loop seal with a leg length of at least 762 mm (30 in) installed before the inlet to the drain tank.
- ii)* The loop seal is to be so installed as to prevent freezing.
- iii)* Where drainage arrangement is such that the drain header from the classified areas are physically located lower than the unclassified areas, and there is no possibility of back flow into the safe areas, the check valve may not be needed.
- iv)* Drain outlets within the tank are to discharge against the tank side.
- v)* Vent outlets from the subject drain tank are to be led to the main deck, be equipped with a flame screen, and treated as Zone 1 and/or 2, as applicable. When pumping systems are used to remove liquids from hazardous areas or from drain tanks mentioned above, branch suction from safe and hazardous areas are to be arranged so that such areas cannot be pumped simultaneously.

9.5 Closed Drain Systems

9.5.1 General

- i)* Drains or liquid relief from process vessels, piping or other sources that could exceed atmospheric pressure are to be hard piped without an atmospheric break to a drain vessel.
- ii)* The drain vessel is to be provided with pressure relief valve(s), which are to be sized to handle the maximum flow of gas or liquid that could occur under blocked outlet condition.

9.5.2 Connection to Open Drain System

Drains or liquid relief from vessels containing non-toxic, non-flammable liquids, may be connected to an unclassified open drain piping system if the open drain system is sized to accommodate these additional drains.

9.6 Overboard Discharges from the Production Treatment Plan

- i)* Although the overboard discharge from the production treatment plan onboard is not subject to MARPOL 73/78 (Annex I Regulations for the Prevention of Pollution by Oil), the discharge is to conform to the national and/or regional regulations.
- ii)* In accordance with MARPOL 73/78, only discharges from machinery space, not from the offshore processing drainage, production water, or from displacement, are subject to the MARPOL regulations. See Appendix 5, Unified Interpretations of Annex I of MARPOL 73/78 for reference.

10. Structural Modules

10.1 General

The structural design of deck modules is to be in accordance with BKI Guide for Building and Classing Floating Production Installations (FPI Guide) and Part 5 ,Offshore Technology , as applicable, and to comply with the following:

- i)* Plans and calculations are to be provided for verification.
- ii)* Process liquid weights and dynamic loads due to vessel motions are to be considered.
- iii)* If the vessel hull girder deflection has significant effects on the structure, this is to be taken into account in the design.

10.2 Structural Design of Deck Modules and Supports

- i)* Structural design of deck modules and module supports are to be designed following guidelines given in 5A.1.5 of the FPI Guide.
- ii)* The design should include a finite element analysis of the deck module and supports considering loading which produce the most unfavorable effects on the module for pre-service and in-service conditions.
- iii)* The module structures above their supports are to be analyzed and shown explicitly on the drawings so that the construction of the module supports can be consistent with those assumed in the structural analysis.
- iv)* Loading criteria to be considered in the design are given in 3.A.4.3 of this Rule.
- v)* Linear elastic methods (working stress method) are generally employed in the analysis. The resulting structural responses are not to exceed the safety criteria given in 5B-3-3/5.3.4 of the FPI Guide. Acceptance criteria for module supports are given in 5A-1-4/7 of the FPI Guide.
- vi)* Fatigue analysis of the modules is generally not required. However fatigue analysis is required for the deck supports at the module/ship deck interface in accordance with 5A-1-4/7.5 of the FPI Guide.
- vii)* Material and Welding are to be in accordance with 5A-1-3/1.13 of the FPI Guide.

11. Subsea Production

11.1 General

The subsea production systems and associated equipment are to comply with API 17s Series and the requirements of this rule, as applicable.

11.2 Flowlines and Manifolds

Flowlines and manifolds transporting gas and liquid in two-phase flow are to be designed and sized in accordance with API RP 14E. Flowline valves are to be in accordance with API Spec. 6A.

- i)* Flow lines are to be fitted with a remotely operated shutoff valve at the first flange (as close as possible) on the loading manifold connecting the flexible lines that lead to the installation. These remote operated valves are to close upon actuation of the ESD System.
- ii)* Bypassing valves or first shutdown valves on board the installation are to be fire safe and tested to API Spec 6FA.

11.3 Wellheads and Subsea Equipment

Christmas tree assemblies and subsea equipment are not part of the classification boundaries for a normal production facility. However, the equipment may be classed if desired by the owner. The following requirements are applicable :

11.3.1 Wellheads

- i)* Christmas tree assemblies including tubing head adapters, valves, tees, crosses, and chokes, are to comply with API Spec. 6A.
- ii)* Wellhead surface safety valves (SSV) and underwater safety valves (USV) are to comply with ISO 10418.

11.3.2 Subsea Equipment and Production Systems

- i)* Subsea production systems include, but are not limited to, template, wet or dry tree assemblies, well manifold, subsea production equipment, riser base or pipeline end manifold, riser, control pods and umbilicals, chokes and subsea safety valves.
- ii)* The design of each component is to be in accordance with a recognized standard such as API 17s Series for subsea production systems.
- iii)* The design is to take into consideration the mechanical loads due to buoyancy, pressure (internal and external), thermal expansion and contraction, and pre-stressing, and environmental loads due to wave current, ice, and earthquake.
- iv)* Subsea completion wells are to be designed for automatic shutdown upon detecting flow pressure outside a preset level, or upon receiving ESD signals from the topside facilities.
- v)* Subsea control system and equipment are to be designed and constructed per requirements of API 14s Series and 17s Series, where applicable.
- vi)* Where well fluid is not received on the installation directly from the well, means are to be provided to detect the actuation of ESD system, which will enable all subsea valves to shut-in.

D. Process Support Systems

1. General

This Section provides requirements for the design and installation of process support systems on floating installations.

Process support systems are utility and auxiliary systems that complement the hydrocarbon production and process systems. See 3.B.5 for list of typical process support systems.

Process and platform support piping design criteria are to be in accordance with API RP 14E, ASME 31.3 or other recognized codes and/or standards.

General arrangement of these systems is to comply with API RP 14J, or other recognized codes and/or standards.

The documentation requirements for design review are given in Section 3.B..

2. Equipment Requirements

The requirements listed below are intended for the equipment of process support systems not covered in Section 3.C.

2.1. Pressure Vessels

- i)* Pressure vessels are to be designed, constructed, and tested in accordance with the ASME Section VIII Division 1 or Division 2 or equivalent recognized codes and/or standards.
- ii)* The design is also to ensure that stresses due to external nozzle loads and moments, stresses due to acceleration forces arising out of the motion of the floating installation, and stresses due to any other applicable external forces, such as wind, are within the limits allowed by the design code.
- iii)* Consideration will be given to arrangements and details of pressure vessels that can be shown to comply with other recognized codes and/or standards, provided they are of equivalent level of safety.

2.2 Heat Exchangers

- i)* Heat exchangers are to be designed, constructed, and tested in accordance with the ASME Section VIII Division 1 or Division 2, TEMA Standards, API Std. 660, or API Std. 661, as applicable, or equivalent recognized codes and/or standards.
- ii)* See 3.D.2.1ii) for design requirements.
- iii)* See 3.D.2.1iii) for alternatives to recognized codes and/or standards.

2.3 Pumps

All pumps for process support service are to comply with a recognized industrial standard such as ANSI, UL, ASME, etc., and may be accepted on the basis of manufacturer's affidavit of compliance with a recognized industrial standard.

2.4 Compressors

Compressors, such as those used with air or refrigeration systems, are to be designed to a recognized industrial standard, and may be accepted on the basis of manufacturer's affidavit of compliance with a recognized industrial standard.

2.5 Prime Movers (Internal Combustion Engines and Turbines)

2.5.1 General

- i)* Engines and turbines are to be designed and constructed in accordance with a recognized industry standard or code of practice, and be suitable for the full range of possible operating conditions, including angles of heel and trim, and accelerations due to floating structure roll, pitch and yaw.
- ii)* Additionally, prime movers for emergency services on floating structures are to be shown suitable for extended periods of operation at the maximum angles of heel, trim, pitch, and roll.
- iii)* Gas turbines are to comply with API Std. 616, as applicable.
- iv)* Manufacturer's affidavit verifying compliance with recognized standards are to be submitted.
- v)* For engines and turbines of less than 100 kW (134 hp), manufacturer's affidavit may be presented and accepted by the attending Surveyor.

2.5.2 Installation

The installation of internal combustion engines and gas turbines is to be approved by BKI, and is to comply with a recognized standard such as NFPA Std. No. 37, as applicable.

2.5.3 Engines in Classified Areas

- i)* Combustion engines are not to be installed in Class 1, Division 1 areas, unless they are installed in an enclosure of fire resistive construction with adequate ventilation from a non-classified area.
- ii)* Spark ignition engines may not be installed in Class 1, Division 2 areas, except when natural gas fuel is utilized, in accordance with the provisions of NFPA Standard 37. See 3.F.8 for hazardous areas.

2.5.4 Exhaust Manifolds

- i)* Exhaust manifolds and piping are to be shielded for ignition prevention and personnel protection.
- ii)* Explosion relief valves or other appropriate protection against explosion are to be provided in the exhaust and scavenge manifolds.
- iii)* The explosion relief valves are to be of the return-seating type.
- iv)* The arrangement and location of the valves is to minimize the dangers from emission of flame.
- v)* Exhaust piping from internal combustion engines and turbines is to be equipped with spark arresters, and discharge into non-hazardous areas. See 3.F.8 for hazardous areas.

2.5.5 Air Intakes

- i)* Air intakes to internal combustion engines and gas turbines are to be not less than 3 m (10 ft) from hazardous areas.
- ii)* An explosion relief valve or other appropriate protection against explosion is to be provided in the air inlet manifold.

2.5.6 Starting Air

- i)* Means are to be provided to exclude gas from starting air if the engine is air-started.

- ii)* Starting air branch pipes to each cylinder are also to be provided with flame arresters.

2.5.7 Protection of Crankcase and Piston Underside Space

2.5.7.(a) Ventilation and Monitoring

- i)* For a trunk piston type engine, the following are to be provided:
 - a) Ventilation is to be provided for the crankcase to prevent accumulation of gas.
 - b) Arrangements are to be made so that any blow-by gas may readily reach the vent.
 - c) The crankcase vent is to be led to a safe location in the atmosphere through a flame arrester.
 - d) The crankcase is also to be protected by an oil mist detector and gas detecting or equivalent equipment.
- ii)* For a cross-head type engine, the following are to be provided:
 - a) The crankcase is to be protected by an oil mist detector or bearing temperature detector.
 - b) Gas detection or equivalent equipment is to be provided for the piston underside space.

2.5.7.(b) Explosion Relief Valves.

- i)* Where explosion relief valves are fitted, the valves are to be sized based on the expected detonation pressure resulting from the ignition of fuel oil, fuel gas, and lubricating oil vapors.
- ii)* Since the detonation pressure depends on the length of flame travel, it may be necessary to increase the relief areas, or provide more than one (1) relief valve for each crankthrow.

2.5.7.(c) Warning Notice.

- i)* To caution against opening a hot crankcase, suitable warning notices are to be fitted, preferably on a crankcase door on each side of the engine, or on the engine/turbine control stand.
- ii)* The notices are to specify a period of time for cooling after shutdown, (based on the size of the engine, but not less than 10 minutes in any case) before safely opening the door.
- iii)* The notices are to include a caution that the crankcase is not to be opened until adequate precautions have been taken to insure that no gas remains trapped in the crankcase.
- iv)* The notice is also to warn against restarting an overheating engine/turbine until the cause of overheating has been remedied.

2.5.8 Regulators

- i)* When the gas pressure on the upstream side of a regulator exceeds 350 mm (14 in) of H₂O, a relief valve is to be installed on the downstream side.
- ii)* This relief valve is to discharge to a safe location in the atmosphere through a flame arrester.
- iii)* The capacity of the relief valve is to be adequate in venting the volume of gas that would pass through the regulator if that device should fail.

2.6. Cranes (Optional)

Cranes and hoists are to comply with API Spec 2C, API RP 2D, or BKI Guidelines for Construction and Survey for Lifting Appliances, when requested by the Owner.

3. System Requirements

Process support piping design, selection of valves, fittings, and flanges are to be in accordance with, API RP 14E, ASME B31.3 or other recognized standards.

For plastic piping, the requirements of Appendix 1 are applicable.

3.1 Utility/Instrument Air System

3.1.1 Arrangement

- i)* Utility and instrument air may be supplied by a single air compressor or by a separate compressor for each service.
- ii)* When using a single compressor for both services, controls are to be provided to give priority to instrument air requirements.

3.1.2 Air Quality

Instrument air is to be oil-free and dried to prevent liquids and dirt from entering pneumatic instruments.

3.1.3 Piping

- i)* Air compressor suctions are to be at least 3 m (10 ft) from hazardous areas.
- ii)* Air outlets from compressors are to be fitted with non-return valves and discharged into air receivers/scrubbers for oil and water removal.
- iii)* Instrument piping is to be installed to minimize low points, and provisions are to be included in the piping to allow removal of condensation.
- iv)* Crossovers where air and combustible fluids could be intermixed are not permitted anywhere in the system.

3.2 Fuel/Instrument Gas System

- i)* Gas used for fuel or instrument systems is to be passed through a gas scrubber to remove entrained liquid.
- ii)* The instrument gas may also have to be dried to meet requirements of the specific equipment that will use the gas.
- iii)* Gas containing hydrogen sulfide is not to be used as instrument gas.
- iv)* Where gas is used for instrument systems, the area classification in way of these instruments is to be in accordance with API RP 500 or 505.

3.3 Segregation of Piping Systems

- i)* Piping systems carrying non-hazardous fluids are to be segregated from piping systems that may contain hazardous fluids.
- ii)* Cross connection of the piping systems may be made where means are provided for avoiding possible contamination of the non-hazardous fluid system by the hazardous medium.

3.4 Use of Produced Gas as Fuel

- i)* Enclosed spaces located on the production deck having boilers, inert gas generators, and combustion engines using produced gas as fuel, are to have ventilation systems providing at least 30 air changes per hour.
- ii)* These spaces are to be fitted with gas detection systems to alarm at 20% L.E.L., and to activate automatic shutdown of the gas supply at 60% L.E.L.
- iii)* The automatic shutdown valve is to be located outside the space.
- iv)* This valve is also to be activated upon loss of the required ventilation in the enclosed space, and upon detection of abnormal pressure in the gas supply line.
- v)* For produced gas containing hydrogen sulfide, provisions are to be made for gas sweetening, unless the equipment manufacturer has certified the equipment's suitability for sour gas application, and the equipment is located in a freely ventilated, open space.
- vi)* To bring fuel gas containing H₂S to equipment located in an enclosed machinery space, the sour gas must be sweetened. Additionally, the machinery space is to be equipped with H₂S gas detectors. The detectors are to be set to alarm at 10 ppm, and to activate the shutdown valve at 50 ppm.
- vii)* Burner control systems are to be in accordance with NFPA 8501.

3.5 Purging System for Process Equipment

3.5.1 Purging

- i)* Process equipment and systems are to be purged prior to initial startup.
- ii)* They are also to be purged when being put back into service after shutdown, if there is a possibility of oxygen entering the system during shutdown.
- iii)* Facilities not equipped for storage of liquid hydrocarbon may only require temporary inert gas storage containers. (For facilities equipped for storage, refer to 3.E.3.3 for floating installations, and 4.D.4 for fixed installations).

3.5.2 Oxygen Content and Monitor

- i)* The oxygen content of the inert gas used is not to exceed 5% by volume.
- ii)* Oxygen monitoring equipment is to be provided to monitor oxygen levels in the inert gas supply.

3.5.3 Isolating Valves

Shut off valves are to be fitted at the inlet and outlet of the final pressure regulator in a stored purging gas system.

3.6 Fuel Oil System

This section of this Rule is applicable to all fuel oil systems located on the production deck that supply fuel to the process equipment.

For fuel oil systems serving marine support functions such as the fuel oil system for the vessel/unit service generator or for the helicopter deck refueling facility, see the BKI Part 1 – Seagoing Ship or Guidelines of Helicopter Decks and Facilities for applicable requirements.

3.6.1 Pumping Arrangements

Fuel oil pumping arrangements are to be completely separate from other pumping systems, and are not to be connected to other piping systems.

3.6.2 Pump Controls

- i)* Fuel oil transfer pumps, fuel oil unit pumps, and other similar fuel pumps are to be fitted with local and remote controls so they may be stopped in case of an emergency.
- ii)* Remote controls are to be located in a space not affected by fire at the pump locations.

3.6.3 Containment

A containment at least 150 mm (6 in.) high is to be provided at unloading and/or offloading stations, pump areas, and overflow/vent line locations, and arranged to direct a possible leak or spill to the open drain system.

3.6.4 Valves on Oil Tanks

- i)* Where pipelines emanate from oil tanks at such a level that they will be subjected to a static head of oil from the tank, they are to be fitted with a positive closing valve located at the tank.
- ii)* Gray cast iron valves are not to be used as shutoff valves for fuel oil tanks.
- iii)* Arrangements are to be provided for closing the tank's valve locally and from a space not affected by fire at the fuel oil tank location. This requirement may be omitted if the tank capacity is less than 132 US gallons (500 liters).

3.6.5 Non-metallic Expansion Joints and Hoses

- i)* Non-metallic expansion joints and hoses for use in fuel oil systems are only allowed at machinery connections, provided they are in an easily accessible position, and pass the API Spec 16C fire test. See Appendix 2 of this Rule for API Spec 16C fire test requirements.
- ii)* Non-metallic expansion joints and hoses are not allowed for connecting runs of pipes for expansion and deflection purposes in fuel oil systems.

3.7 Hydraulic System

This section of this Rule is applicable to all hydraulic oil systems located on the production deck that supply hydraulic fluid to control systems of process related equipment.

For hydraulic systems that are serving both industrial support and marine support functions, see 3.E.3.1 of this Rule.

- i)* High flash point hydraulic fluids are to be used, unless a specific system design requires the use of low flash point fluids.

- ii)* When low flash point fluids are used, precautions are to be taken to minimize fire hazard, by insulating nearby hot surfaces that could ignite a low flash point fluid. See 3.H.9.3 or 4.H.9.3, as applicable.
- iii)* Non-metallic hoses used for oil based hydraulic fluid in all hydraulic control systems, except BOP control system, must pass API Spec 16C fire test or equivalent. See Appendix 2 of this Rule for API Spec 16C fire test requirements.
- iv)* Gray cast iron material is not allowed for supply valves on oil based hydraulic storage tank.

3.8 Lubricating Oil System

3.8.1 Interconnection

The lubricating oil piping is to be entirely separated from other piping systems.

3.8.2 Valves on Lubricating Oil Storage Tanks

Normally opened valves on lubricating oil storage tanks are to comply with the requirements as those for fuel oil tanks given in 3.D.3.6.4.

3.8.3 Turbines

- i)* Automatic Shut-off. Turbines are to be provided with a means of automatically shutting off the steam or gas turbine fuel supply upon failure of the lubricating oil system.
- ii)* Indicators.
 - a) Indicators are to be fitted to allow monitoring of the pressure and temperature of the water inlet and oil outlet of the oil coolers.
 - b) Pressure systems are to be fitted with low-pressure alarm.
 - c) Sump and gravity tanks are to be provided with suitable gauges for determining the level of oil within the tank.
- iii)* Strainers and Filters.
 - a) For auxiliary turbines, a magnetic strainer and fine mesh filter (strainer) are to be provided in the lubricating oil piping to the turbine.
 - b) Strainers are to be so arranged as to prevent, in the event of leakage, spraying oil onto heated surfaces.

3.8.4 Internal Combustion Engines

- i)* Lubricating Oil Pumps. The lubricating oil pump is to be of sufficient capacity for the maximum output of the engine.
- ii)* Filters. Lubrication oil filter is to be provided and so arranged as to prevent, in case of leakage, spraying oil onto heated surfaces.
- iii)* Low Oil Pressure Alarm. An alarm device with audible and visual signals for failure of the lubricating oil system is to be fitted.

3.9 Chemical Injection System

3.9.1 Materials

- i)* The chemical storage tank, pumps, and piping are to be suitable for the chemicals being handled.
- ii)* Affidavit from tank manufacturers confirming the tank material is compatible with the chemical

being stored is to be provided.

- iii)* Fiberglass reinforced polyester independent tanks may be considered for non-flammable chemicals only.
- iv)* For metallic tanks containing flammable or combustible fluids, scantling plans and calculations are to be submitted for review.
- v)* Atmospheric and low pressure metallic storage tanks for flammable liquids are to be designed and fabricated in accordance with Section 2 and 3 of the Part 5, Offshore Technology, Volume 6 - Rules for Mobile Offshore Unit, Section 2, 3 and 4 of Volume 7 – Rules for Fixed Installations, Section 3.B.10 of the Part 1 Seagoing Ship, Volume II Rules for Hull Section 24, Volume IX Rules for Ship Carrying Liquefied Gases in Bulk and Volume X Rules for Ship Carrying Dangerous Chemical in Bulk and Part 1- Seagoing Ship, Volume V – Rules for Materials, as applicable.
- vi)* Design and construction of non-metallic tanks for non-flammable liquids are to be in accordance with industry-recognized standards, such as ASME Section X, API Spec. 12P (FRP) or applicable ASTM standards.
- vii)* Alternatively, all tanks may be accepted based on the manufacturer's affidavit of compliance with an applicable standard.

3.9.2 Arrangement and Components

- i)* For multi-chemical systems, a separate tank or tank compartment is to be provided for each chemical used.
- ii)* Chemical storage tanks are to be provided with atmospheric vents and level glasses.
- iii)* Flame arrester is to be provided to flammable or combustible tank vent.
- iv)* The discharge of each pump is to be provided with a pressure relief device to return the chemical to the pump suction or chemical tank.
- v)* Injection lines are to be fitted with non-return valves, and means are to be provided to automatically shutdown the injection pump in the event of process shutdowns.

3.10 Heating and Cooling Systems

The medium used for heating or cooling any hydrocarbon system is to be contained solely within the classified area, unless the return line of the heating or cooling system to a non-classified area is provided with means to detect any hydrocarbon contamination.

3.11 Sodium Hypochlorite Solution Storage

The sodium hypochlorite solution injected into the seawater system to combat the growth of marine organisms and algae that could foul filters and pipelines is considered highly corrosive.

- i)* Stainless steel or GRP storage tank may be considered.
- ii)* The solution also produces hydrogen gas; therefore, the storage tanks are to be located in a well-ventilated open deck area.

3.12 Control of Static Electricity

Refer to 3.F.15.

E. Marine Support Systems

1. General

Marine support systems are to be in accordance with the requirements of the Part 1- Seagoing Ship, except as modified herein and in Section 3, F, G and H.

See 3.B.6 for list of typical marine support systems.

2. Equipment Requirements

2.1. Pressure Vessels

Pressure vessels are to be in accordance with the requirements of the Part 1 Seagoing Ship, Volume III Rules for Machinery Installations ,Section 8.

- i)* Where applicable, the design is also to ensure that stresses due to external nozzle loads and moments, stresses due to acceleration forces arising out of the motion of the floating installation, and stresses due to any other applicable external forces are within the limits allowed by the design code or standard.
- ii)* Consideration will be given to arrangements and details of pressure vessels that can be shown to comply with other recognized codes and/or standards, provided they are of equivalent level of safety.

2.2. Heat Exchangers

Heat exchangers are to be in accordance with the requirements of the Part 1 – Seagoing Ship, Volume III Rules for Machinery Installations ,Section 8.

- i)* See 3.E.2.1i) for design requirements.
- ii)* See 3.E.2.1ii) for alternatives to recognized codes and/or standards

3. System Requirements

3.1 Pipe System Interconnections

- i)* If a system is serving marine support and industrial functions (i.e., hydraulic power to ballast control valves, process shutdown valves, etc.), the design criteria of the system are to meet the Part 1 – Seagoing Ship, Volume IX Rules for Ship Carrying Liquefied Gases in Bulk, Section 3.
- ii)* If portions of the system serve only industrial functions and can be isolated from the part serving marine functions, the less severe industrial criteria can be applied to that part of the system up to, but not including, the isolating valve.
- iii)* For industrial systems design criteria, see 3.C.6.1 and 3.D.1, as applicable.

3.2 Oil Storage Tank Purging and Blanketing Systems

On facilities equipped for storage of liquid hydrocarbons, a permanently installed inert gas system is to be provided for tank purging and blanketing.

- i)* The inert gas system is to be designed and constructed in accordance with Part 1 –Seagoing Ship, Volume III Rules for Machinery Installations ,Section 15.D, except as modified below.
- ii)* Either inert gas or produced gas is to be used to maintain crude oil storage tanks with a positive pressure in relation to the surrounding atmosphere, and with an oxygen content not exceeding 5% by

volume in the inert gas supply main to the storage tanks.

- iii) The system is to be capable of maintaining the atmosphere in any part of any storage tank with an oxygen content not exceeding 8% by volume.
- iv) The storage tanks are to be previously purged with inert gas when produced gas is used for tank blanketing.

3.3 Oil Storage Tanks Venting System

- i) Where pressure/vacuum relief valves are fitted on crude oil storage tanks, pressure relief lines are to be connected to the low-pressure (less than 2.5 psig) flare header, or vented to a safe location.
- ii) The oil storage tanks venting system is to be designed and constructed in accordance with *Part 1 – Seagoing Ship, Volume III Rules for Machinery Installations, Section 15.B.5.*

3.4 Use of Produced Gas as Fuel

- i) Enclosed spaces above decks having boilers, inert gas generators, and combustion engines using produced gas as fuel, are to have ventilation systems providing at least 30 air changes per hour.
- ii) These spaces are to be fitted with gas detection systems to alarm at 20% L.E.L., and to activate automatic shutdown of the gas supply at 60% L.E.L.
- iii) The automatic shutdown valve is to be located outside the space. This valve is also to be activated upon loss of the required ventilation in the enclosed space, and upon detection of abnormal pressure in the gas supply line.
- iv) For produced gas containing hydrogen sulfide (H₂S), provisions are to be made for gas sweetening, unless the equipment manufacturer has certified the suitability of the equipment for sour gas application, and the equipment is located in a freely ventilated open space.
- v) To bring fuel gas containing H₂S to the equipment located in an enclosed machinery space, the sour gas must be sweetened.
- vi) Additionally, the machinery space is to be equipped with H₂S gas detectors.
- vii) The detectors are to be set to alarm at 10 ppm (part per million), and to activate the shutdown valve at 50 ppm.
- viii) Use of produced gas as fuel for boilers, inert gas generators, and combustion engines located within machinery spaces under decks, is to comply with *Part 1- Seagoing Ship, Volume IX Rules for Ship Carrying Liquefied Gases in Bulk, Section 16.*
- ix) For floating installations with no Disconnectable À AMS notation, the dual fuel requirements listed in *Part 1- Seagoing Ship, Volume IX Rules for Ship Carrying Liquefied Gases in Bulk, Section 16.5.* are not applicable.
- x) Burner control systems are to be in accordance with *Part 1- Seagoing Ship, Volume IX Rules for Ship Carrying Liquefied Gases in Bulk, Section 16.*

3.5 Flammable Liquid Storage Facility Arrangement

- i) The storage of flammable liquids having a flash point of 60°C (140°F) or less, such as methanol, in integral hull tanks requires, in many respects, the application of “Tanker” requirements.

- ii) Section *Part 1 –Seagoing Ship, Volume III Rules for Machinery Installations*, Section 15 is applicable for pumping, piping, venting and electrical arrangements.
- iii) With regard to the general arrangement and tank locations, cofferdams may be required to prevent hazardous area delineation in adjacent spaces, and the pumping/piping are to be arranged independently from all other systems.
- iv) Transfer pumps and piping (including fill, discharge, vent and sounding piping) are not to be located in, or pass through, the machinery spaces.

See 3.H/3.3 of this Rule for fire protection requirements.

3.6 Raw Water System for Self –Elevating Units in Elevated Condition (as applicable)

Raw water systems supplying seawater to essential services on a self-elevating unit in elevated condition are to be approved by BKI. Raw water towers, leg well suction and hose reels may be considered an acceptable arrangement for raw water systems.

3.6.1 General

At least two means of supplying water to essential services, such as cooling water system for main power generation or fire main system, are to be provided. Pump capacity, system pressure and piping installation are to be as required for the specific system or systems supplied. The pumps are to be sized to provide their full required water demand with one pump out of service. In general, the use of hoses from the discharge of the submersible pump to the connection to the fixed seawater system on board the unit is permitted, provided that the hose is suitable for the intended service. The hoses are to be fire resistant, except when they are adequately separated such that a single incident (fire, blast, etc) would not damage all the raw water hoses.

3.6.2 Raw Water Tower

The strength of the raw water tower and its components to withstand the maximum design environmental conditions for the unit in elevated condition is to be assessed and calculations in this regard are to be submitted for review.

3.6.3 Leg Well Suction

The raw water system is to be suitably supported to the unit's leg and adequately protected against mechanical damage due to the operation of the legs.

3.6.4 Hose Reel

In lieu of utilizing either raw water towers or leg well suction, submersible pumps installed on a hose reel and lowered into the sea may be considered as an acceptable means of water supply onboard a self-elevating unit, subject to the following conditions:

- i) **Arrangement**
Here are to be at least two hose reels provided. The hose reel units are to be adequately separated by either distance or primary structure such that a single incident (fire, blast, etc.) would not render both pumping systems inoperable.
- ii) **Pump Power**
Each hose reel pump unit is to be powered independently, such that a single failure in the power distribution system would not render both units inoperable.

iii) Design

The design of the hose reel/pump skid is to be submitted for review, including verification of the skid and reel strength and component suitability (piping and electrical). In particular, details of the hoses, including type, standard, material and capability to withstand the maximum design environmental loads, are to be submitted for review. In principle, collapsible type hoses are not considered acceptable for this service.

iv) Isolation

In order to isolate a damaged pump/hose from the rest of the sea water system, a suitable isolation valve is to be provided, capable of being operated during or immediately after the incident (fire, blast, etc.) in such a way that the water supply is not interrupted.

v) Location

The reels are not to be located in a hazardous zone and each reel is to be positioned directly next to the deck edge or opening utilized to lower the pumps overboard.

vi) Operation

All hose reels provided are to be deployed at all times the unit is in the elevated condition. Instructions in this regard are to be included in the Operating Manual.

F. Electrical Systems**1. Applicability**

Electrical systems used solely for hydrocarbon processing on floating installations are to meet the requirements of this rule. Where electrical systems or equipment are used to supply services other than Oil or Gas Production, the equipment is also to comply with the relevant BKI Class Rules for the hull structure.

2. General

Electrical installations are to comply with this rule and API RP 14F.

- i)* Consideration will be given to the use of other recognized industry or international standards, such as IEC, provided they are of equivalent level of safety, and the entire system is designed to such standards.
- ii)* For installations classified by class and zone, the requirements of API RP 14FZ is to be in full compliance.

3. Design Considerations**3.1 Equipment and Enclosures**

Electrical equipment and enclosures subject to the offshore environment are to be provided with a degree of protection suitable to the environment or hazard in which they are located, in accordance with API RP 14F or other recognized standard.

3.2 Selection of Materials

Materials of construction are to be selected that are suitable for their intended service and location.

3.3 Equipment Grounding (Earthing) Arrangements**3.3.1 Permanent Electrical Equipment**

- i)* All electrical equipment with metallic enclosures, whose arrangement and method of installation

does not assure positive grounding to the metal hull or equivalent conducting body, is to be permanently grounded through a separate conductor, and protected against damage.

- ii)* Where separate grounding conductors are required, they are to be in accordance with API RP 14F.
- iii)* Systems designed to other recognized standards are to comply with such standards, but in no case are the separate grounding conductors to be of a cross-sectional area of less than indicated in 3-F/Table 2.

3.3.2 Lightning Protection

Equipment and structure are to be protected against lightning damage in accordance with NFPA 780 or other recognized standard.

3.4 System Grounding (Earthing)

Where electrical systems are used solely for process facilities, system grounding is to comply with API RP 14F.

3.4.1 Vessels with Integral Hull Tanks

If the facility has integral hull tanks containing liquids with a flash point not exceeding 60°C (140°F), a grounded distribution system is not to be used, except for the following:

- i)* Grounded intrinsically safe circuits
- ii)* Power supplied control circuits and instrumentation circuits where technical or safety reasons preclude the use of a system without a grounding connection, provided the current in the hull is limited to 5 Amperes or less in both normal and fault conditions.
- iii)* Limited and locally grounded systems, provided any possible resulting current does not flow directly through any hazardous areas.
- iv)* Alternating current power networks of 1 kV root mean square (r.m.s.) (line to line) and over, provided any possible resulting current does not flow directly through any hazardous areas.

3.4.2 Ground (Earth) Return Paths Through the Hull

The metal structure of an offshore installation is not to be used as a normal current return for the electrical distribution system, except for the following systems:

- i)* Impressed current cathodic protection
- ii)* Limited and locally grounded systems for battery systems for engine starting having a one-wire system and the ground lead connected to the engine
- iii)* Grounded intrinsically safe circuits

3.5 Distribution and Circuit Protection

Electrical installations are to comply with API RP 14F as noted herein.

3.5.1 General

- i)* All ungrounded conductors and the devices and circuits which they serve are to be protected against over-current.
- ii)* Protective devices are to be provided to guard against overload and short circuit currents, and to open

the circuit if the current reaches a value that will cause excessive or dangerous temperatures in the conductor or conductor insulation.

3.5.2 Motor Controllers

Motor starting and control installations, including overload protection and short circuit protection, are to be in accordance with API RP 14F.

4. Rotating Electrical Machinery

4.1 General

Motors and generators are to be designed, manufactured and tested to NEMA Standard MG-1 or IEC 60034 for performance, manufacture, protection, and construction.

4.2 Temperature Rating

- i)* Equipment is to be selected for the rated temperature higher than the specified ambient temperature. If equipment is intended to be used in a space where the equipment's rated temperature is below the specified ambient temperature of the space, it is to be used at a derated load.
- ii)* The assumed ambient temperature of the space plus the machine's actual temperature rise at its derated load is not to exceed the machine's total rated temperature (rated temperature of the machine plus rated temperature rise).

4.3 Moisture Condensation Protection

- i)* All generators and motors 50 hp or more are to be equipped with space heaters, to prevent accumulation of moisture and condensation when they are idle for appreciable periods.
- ii)* The space heaters are to be capable of being electrically isolated.

4.4 Temperature Detection

Generators larger than 500 kVA are to be provided with at least one (1) embedded temperature detector per phase, at the hot end of the stationary winding, with temperature indication at a manned location.

5. Transformers

5.1 General

- i)* Each power transformer is to be provided with a corrosion resistant nameplate indicating the name of the manufacturer and all pertinent electrical characteristics.
- ii)* They are to be constructed and tested to ANSI C57 or equivalent.
- iii)* Transformers are to be protected in accordance with API RP 14F Section 8.

5.2 Transformer Supplying Services Other than Oil or Gas Production

In addition to the above, transformers supplying services other than oil or gas production are to be selected, installed, and protected in accordance with their environmental conditions and *Part 1 – Seagoing Ship, Volume IV Rules for Electrical Installations, Section 4.D.*

6. Switchgear

6.1 Application

Main and emergency switchboards, power and lighting distribution boards, motor control centers and motor controllers, and battery charging panels, are to be designed, constructed, and tested in accordance with the provisions of this Subsection.

6.2 Construction, Assembly and Components

6.2.1 Enclosures

- i)* Each power transformer is to be provided with a corrosion resistant nameplate indicating the name. Enclosures and assemblies are to be constructed of steel or other suitable incombustible, moisture-resistant materials, and reinforced as necessary to withstand the mechanical, electro-magnetic and thermal stresses which may be encountered under both normal and short circuit fault conditions.
- ii)* Each power transformer is to be provided with a corrosion resistant nameplate indicating the name. Enclosures are to be of the closed type.
- iii)* Each power transformer is to be provided with a corrosion resistant nameplate indicating the name. The degree of the protection is to be appropriate for the intended location. See also 3.F.3.1.
- iv)* Each power transformer is to be provided with a corrosion resistant nameplate indicating the name. All wearing parts are to be accessible for inspection and be readily renewable.

6.2.2 Bus Bars

6.2.2(a) General.

Bus bars are to be sized and arranged so that the temperature rise under the most severe loading conditions will not affect the normal operation of electrical devices mounted in the switchboard.

6.2.2(b) Bracing of Bus Bars

Bus bars and circuit breakers are to be mounted, braced, and located to withstand thermal effects and magnetic forces resulting from the maximum prospective short circuit current.

6.2.2(c) Bolted Connections

- i)* Bolted bus bar connections are to be suitably treated (e.g., silver plating) to avoid deterioration of electrical conductivity over time.
- ii)* Nuts are to be fitted with means to prevent loosening.

6.2.2(d) Cable connections

- i)* Soldered connections are not to be used for connecting or terminating any cable of 2.5 mm² or greater.
- ii)* These connections are to be made with of soldered lugs or equivalent.

6.2.2(e) Clearance and creepage

Minimum clearances and creepage distances between live parts of different potential (i.e., between phases and between phase and ground) are to be in accordance with API RP 14F or 3.F/Table 3, as appropriate.

6.2.3 Circuit Breakers

6.2.3(a) Compliance with a Standard

- i)* Circuit breakers are to be designed, constructed, and tested to ANSI C37, NEMA AB-1, IEC 60947-2, or other recognized standard.
- ii)* The certificates of tests are to be submitted upon request by BKI.

6.2.3(b) Short Circuit Capacity

Circuit breakers are to have sufficient breaking and making capacities as specified in the short circuit calculation. See 3.F.14.

6.2.3(c) Isolation

- i)* Circuit breakers are to be mounted or arranged in such a manner that the breakers may be removed from the front of the switchboard, without first de-energizing the bus bars to which the breakers are connected.
- ii)* Draw-out or plug-in type circuit breakers that are arranged in such a manner that the breaker may be removed from the front without disconnecting the copper bus or cable connections, are acceptable for this purpose.
- iii)* Alternatively, an isolation switch may be fitted upstream (line or supply side) of the breaker.

6.2.4 Fuses

- i)* Fuses are to be designed, constructed, and tested in accordance with UL 248 or IEC 60269 or other recognized standard.
- ii)* The certificates of tests are to be submitted upon request from BKI.
- iii)* The requirements of 3.F.6.2.3ii) and 3.F.6.2.3iii) above are applicable.
- iv)* Where disconnecting means are fitted, they are to be on the supply side.
- v)* If the switch is not rated to interrupt the circuit under load, it is to be provided with interlock to prevent opening until the load is de-energized.

6.2.5 Internal Wiring

6.2.5(a) Wires

Internal instrumentation and control wiring is to be of the stranded type and is to have flame-retarding insulation. They are to be in compliance with a recognized standard.

6.2.5(b) Protection

In general, internal instrumentation and control wiring is to be protected (by fuse or circuit breaker) against short circuit and overload, with the following exceptions:

- i)* Generator voltage regulator circuits
- ii)* Generator circuit breaker tripping control circuits, and
- iii)* Secondary circuit of current transformer
These circuits, however, except that of the current transformer, may be fitted with short circuit protection only.

6.2.5(c) Terminals.

- i)* Terminals or terminal rows for systems of different voltages are to be clearly separated from each other, and the rated voltage is to be clearly marked.
- ii)* Each terminal is to have a nameplate indicating the circuit designation.

6.2.6 Circuit Identification

Identification plates for feeders and branch circuits are to be provided, and are to indicate the circuit designation and the rating or settings of the fuse or circuit breaker of the circuit.

6.3 Switchboards

In addition to the preceding requirements, main and emergency switchboards are to comply with 3.F.6.3.1 and 3.F.6.3.2.

6.3.1 Bus Bars

Bus bars for switchboards supplied by generators are to comply with API RP 14F.

6.3.2 Power Generation Switchboards

At minimum, the following equipment and instrumentation are to be provided for switchboards associated with power generation:

- i)* Voltage Regulators
- ii)* Synchronizing Controls
- iii)* Synchronizing Relay
- iv)* Ground Fault Detection
- v)* Prime Mover Speed Control
- vi)* Ammeter - with selector switch arranged to measure each phase
- vii)* Voltmeter - with a selector switch
- viii)* Frequency Meter
- ix)* Watt Meter/Power Factor Meter.
- x)* Space Heater Pilot Lamp - where required
- xi)* Stator Winding Temperature Indicator (500 kVA and larger Generators)

6.4. Motor Controllers

In addition to the applicable requirements in 3.F.6.2 above, motor controllers are to comply with the following:

6.4.1 Overload and Under-voltage Protection

Overload protection and low-voltage protection, if provided in the motor controllers, are to be in accordance with API RP 14F, or other appropriate standard.

6.4.2 Disconnecting Means

- i)* A circuit-disconnecting device is to be provided for each motor branch circuit so that the motor and the controller may be isolated from the power supply for maintenance purposes.
- ii)* The circuit-disconnecting device is to be operable externally.

6.5 Battery Charging Panels

In addition to the applicable requirements in 3.F.6.2 above, battery chargers are to comply with the following:

6.5.1 Battery Charger

Except when a different charging rate is necessary and is specified for a particular application, the charging facilities are to be such that the completely discharged battery can be recharged to 80 % capacity in not more than 10 hours.

6.5.2 Reversal of Charging Current

An acceptable means is to be installed, such as reverse current protection, to prevent the battery charger component failure from discharging the battery.

6.5.3 Instrumentation

The following are to be provided:

- i) Disconnect switch for power supply to the charge
- ii) Indicator light connected to the downstream side of the disconnect switch in i)
- iii) Means for adjusting the voltage for charging
- iv) Voltmeter to indicate the charging voltage, and
- v) Ammeter to indicate the charging current.

6.6. Switchgear Supplying Services Other than Oil and Gas Production

Main and emergency switchboards, power and lighting distribution boards, motor control centers and motor controllers, and battery charging panels that are used to supply services other than Oil and Gas Production, are to comply with *Part 1 – Seagoing Ship, Volume IV Rules for Electrical Installations, Section 5* in addition to the above mentioned sections.

7. Wire and Cable Construction

7.1 General

All wires, cables, conduit fittings and wiring devices are to be constructed in accordance with IEEE, ICEA, IEC, or other recognized standards.

7.2 Conductor Type

Conductors are to be of copper, and stranded in all sizes, and are to be in accordance with API RP 14F or other recognized standards, but in no case are they to be less than the following in cross sectional size:

- i) 1.5 mm² (2,960 circ. mils) for motor feeder and branch circuit cables
- ii) 1.0 mm² (1,973 circ. mils) for power lighting and control cables
- iii) 0.5 mm² (786.5 circ. mils) for essential or emergency signaling and communications cables, except for those assembled by the equipment manufacturer, and
- iv) 0.375 mm² (739.3 circ. mils) for telephone cables for non-essential communications services, except for those assembled by the equipment manufacturer.

7.3 Insulation

- i) Conductor insulation is to be rated suitable for a minimum operating temperature of 75°C (167°F) in wet environments.

- ii)* In addition, insulation rating is to be at least 10°C (50°F) higher than the maximum ambient temperature that the conductor can encounter at its service location.

7.4. Cable Flame Retardancy

7.4.1 Standards

All electric cables are to be at least of a flame-retardant type complying with the following:

- i)* Cables constructed in accordance with IEEE, ICEA, IEC, or other recognized standards, are to comply with the flammability criteria of IEEE Std. 45 or IEC 60332.3 Category A where installed in trays, bunches, or similar groupings.
- ii)* Cables constructed to IEEE Std. 45 are to comply with the flammability criteria of that standard.
- iii)* Cables constructed to IEC Publication 60092 standards are to comply with the flammability criteria of IEC Publication 60332-3, Category A.

Consideration will be given to special types of cables, such as radio frequency cables, which do not comply with the above requirements.

7.5 Fire Resistant Property

When electric cables are required to be fire-resistant, they are to comply with the requirements of IEC Publication 60331.

8. Hazardous Areas

8.1 General

Areas and spaces in which flammable vapors or gases are handled, processed, or stored, are to be classified in accordance with the following sections and/or API RP 500. Where installations are classified by zone, API RP 505 may be used in lieu of API RP 500.

8.2. Electrical Installations in Hazardous Areas

Electrical installations in classified areas are to be limited to those systems needed to carry out necessary control, monitoring and power distribution functions, and are to be in accordance with API RP 14F.

8.3. Area Classifications and Electrical Installations

Electrical installations and delineation of classified areas for offshore installations having storage tanks for liquids with a flash point not exceeding 60°C (140°F), and that are integral with the hull structure, need not comply with Classification Rules with regard to the hull classification, provided they comply with applicable requirements as follows:

8.3.1. Area Classification

Delineation of classified areas is to be as follows:

- i)* Open Decks Over Crude Storage Tanks. Freely ventilated, open and gas tight deck spaces to the full breadth of the ship and 3 m (10 ft) fore and aft of cargo block to a height of 2.4 m (8 ft), or to the height of the production deck, are to be considered Class I, Division 2 areas (Zone 2).
- ii)* Enclosed Spaces Adjacent to Crude Storage Tanks. Semi-enclosed or enclosed spaces immediately adjacent to crude oil storage tanks are to be considered Class I, Division 1 areas (Zone 1).
- iii)* Pump Room. A continuously ventilated (20 air changes per hour) crude oil pump room is to be

considered a Class I, Division 1 (Zone 1) area, provided the failure of ventilation is alarmed in a manned location.

- iv)* Cofferdam. Spaces which are separated by a single bulkhead from crude oil storage tanks are to be considered Class I, Division 1 (Zone 1) areas.
- v)* Crude Storage Tank Vents. Areas of unrestricted ventilation around cargo tank vents are to be considered Class I Division 1 (Zone 1) areas with a spherical radius of 3 m (10 ft), and Class I Division 2 (Zone 2) for an additional 7 m (23 ft).

8.3.2. Electrical Interconnections

- i)* Where marine service systems are interconnected with hydrocarbon production systems, a point in the system 2.4 m (8 ft) above the oil storage tank deck is to be designated as an electrical system design code demarcation point.
- ii)* Above this point, electrical system design is to be in accordance with this section; below this point, in accordance with applicable sections of the Part 1 –Seagoing Ship ,Volume IV Rules for Electrical Installations or Part 5 – Offshore Technology ,Volume 5 Rules for Electrical Installations

8.4. Wiring Methods in Hazardous Areas

8.4.1. General

- i)* Threaded metal conduit, armored cable, metallic sheathed cable, or other approved methods or cable types, may be installed in Class I, Division 1 (Zone 1) areas.
- ii)* Cables with moisture resistant jacket (impervious sheathed) may be installed in Class I, Division 2 (Zone 2) areas, provided they are protected from mechanical damage.

8.4.2. Splicing

No splices are allowed in classified locations, except in intrinsically safe circuits.

8.4.3. Conduit Installations

Conduit wiring systems in classified areas are to be in accordance with API RP 14F.

9. Ventilation

9.1. General

- i)* Attention is to be given to ventilation inlet and outlet locations and air flow directions in order to minimize the possibility of cross contamination.
- ii)* Ventilation inlets are to be located in non-classified areas.
- iii)* Ventilation for classified spaces is to be completely separate from that for non-classified spaces.
- iv)* For engine and turbine air intakes, see 3.D.2.5.

9.2. Ventilation of Enclosed Classified Spaces

- i)* Ventilation of enclosed classified spaces is to be made with under-pressure in relation to adjacent, less hazardous areas.
- ii)* The arrangement of ventilation inlet and outlet openings for the enclosed classified space is to be such

that the entire space is efficiently ventilated, giving special considerations to locations of equipment which may release gas, and to spaces where gas may accumulate.

- iii) Ventilation inlets are to be from non-classified areas.
- iv) Ventilation outlets are to be led to outdoor locations that are of the same or a less hazardous classification than the ventilated space.
- v) Ventilating fans are to be of non-sparking construction.
- vi) The capacity of the fan is to be such that the space is adequately ventilated, as defined by API RP 500.

9.3. Ventilation of Non-classified Spaces

- i) Ventilation inlets and outlets for non-classified spaces are to be located in non-classified areas.
- ii) Where passing through classified spaces, ducts are to have overpressure in relation to the classified spaces.
- iii) Enclosed non-hazardous working spaces opening into hazardous locations do not need to be considered hazardous, provided the arrangements required by *Part 5 – Offshore Technology, Volume 4 Rules for Machinery Installations*, Section 2.3.(6.3.1 of the 1989 IMO MODU Code) or NFPA 496 or IEC 60079-2, are complied with.

9.4. Emergency Shutdown

Means are to be provided for shutdown of ventilation fans and closing external openings from outside the spaces served, in the event of fire or detection of combustible or hydrogen or sulfide gas.

10. Cable Support and Installation

The cable installation is to be in accordance with the “standard details” submitted in accordance with 3.B.7.8 of this Rule.

10.1. Mechanical Protection

For cables which are not equipped with metal armor or metal sheathing, installation in rigid conduit or similar structural protection is to be utilized if such cable is employed near walkways, at deck level, near hoist or crane laydown or work areas, or where equipment maintenance work must be accomplished in a constrained area.

10.2. Splicing

10.2.1. General

- i) Electrical cables are to be installed in continuous lengths between terminations. However, approved splices will be permitted for cables of exceptional length, to facilitate their installation.
- ii) The location and particulars of the splices are to be submitted for review.

10.2.2. Construction

- i) Cable splice is to be made of fire-resistant replacement insulation equivalent in electrical and thermal properties to the original insulation.

- ii) The replacement jacket is to be at least equivalent to the original impervious sheath, and is to assure a watertight splice.
- iii) Splices are to be made with an approved splice procedure addressing the following components:
 - a) Connector of correct size and number
 - b) Replacement insulation
 - c) Replacement jacket
 - d) Instructions for use

10.2.3. Hazardous Areas

See 3-F/8.

11. Power Source Requirements

This Subsection provides minimum electrical power generation sources for main and emergency modes of operation.

- i) It should be noted that the governmental regulations might require reserve main power or an emergency power source in excess of these requirements.
- ii) Where the main power source is used to supply services other than oil or gas production, the main power source is to comply with *Part 1 – Seagoing Ship, Volume IV Rules for Electrical Installations, Section 2*
- iii) Where the Flag Administration permits, the minimum number of required main power sources may be reduced to one (1) source.

11.1. Unmanned Facilities

11.1.1. Main Power

The main power source(s) is to be sufficient to maintain the maximum intended operational loads of the facility, without need to use the emergency source of power.

11.1.2.. Emergency Power

An emergency power source, independent of the facility's main power, is to be sufficient to supply services for navigational aids as required by the Flag Administration, but not for less than four (4) days.

11.2. Manned Facilities

11.2.1. Main Power

The main power source(s) is to be sufficient to maintain the maximum intended operational load of the facility.

11.2.2. Emergency Power

- i) An emergency source of power for systems vital to safety, fire fighting, and protection of personnel, is to be provided to supply the services as listed herein.
- ii) Where an emergency power supply has been provided for classification/flag state purposes, this source may also be used to provide emergency loads in production areas, provided the emergency source of power is adequately sized to supply all of the connected loads.

- iii) Provision for emergency power supply, less than those listed herein, will be considered, provided adequate technical justification is submitted.
- iv) Loads to be supplied by the emergency source of power are listed in 3.F.11.2.3 and 3.F.11.2.4 below.

11.2.3. Fire Pump

- i) If both fire pumps required by 3.H.3.1.2 of this rule are electric motor driven, one of these pumps is to be powered by the emergency source of power.
- ii) The emergency source of power is to have sufficient fuel for at least 18 hours of fire pump operation.

11.2.4. Other Loads

The following loads are to be powered by the designated emergency source of power:

- | | |
|--|---|
| i) Fire detection | 18 hours |
| ii) Gas detection | 18 hours |
| iii) Communication | 18 hours |
| iv) ESD system (if electric) | 18 hours |
| v) Paging and alarm system | 18 hours |
| vi) Emergency lighting from all spaces to all alternative egress point | 18 hours |
| vii) Electric blowout preventer control system | 18 hours |
| viii) Navigational aids | As required by the applicable Coastal Authority, but not less than 4 days |

12. Emergency Source of Power

An emergency source of power as required by 3.F.11 may be supplied by an emergency generator or batteries, in accordance with API RP 14F.

Installations supplying services other than oil or gas production are to be in accordance with *Part 1 – Seagoing Ship, Volume IV Rules for Electrical Installations, Section 2.B.3 and Section 3.C.1 – 3.C.5.*

13. Battery Systems

Battery installations are to comply with API RP 14F, except that equipment inside a battery room needs to be certified for use in Division 1 or Division 2 only if the battery room is classified Division 1 or 2, respectively, in accordance with API RP 500.

Ventilation of battery rooms is to be separate from all other ventilation. Arrangements of equivalent safety will be given special consideration.

14. Short Circuit Current Calculations and Coordination Study

14.1. General

The protection and coordination of power systems are to be in accordance with the BKI *Part 1 – Seagoing Ship, Volume IV Rules for Electrical Installations Section 4.A.2.2*, IEC, IEEE 242, or equivalent standard.

14.2. Short Circuit Capacity

The maximum calculated short circuit current available at the main bus bars and at each point in the distribution system, is to be used to determine the adequacy of the short circuit capacities of the protective devices and bus bar bracing, as per 3.F.6.2.2ii).

14.3. Coordination

The power system coordination study is to show that the protective devices and their settings are properly selected to minimize damage to switchgear, transformers, generators, motors, conductors, conductor shielding and other equipment, as well as undesirable shutdowns.

15. Protection from Ignition by Static Charges

Any ignition hazard due to a difference in electrical potential to ground is to be effectively controlled. This may require the use of conductive belts, grounding of combustible fluid loading or discharge equipment and hose, and the grounding of helicopters prior to refueling.

All precautions against ignition due to static electric discharge are to be in accordance with NFPA 77, or other suitable standard.

**Table 1A. Degree of Protection
(Indicated by the First Characteristic Numeral)**

<i>Degree of Protection</i>		
<i>First Characteristic Numeral</i>	<i>Short Description</i>	<i>Definition</i>
0	Non-protected	No special protection
1	Protected against solid objects greater than 50 mm (2 in.)	A large surface of the body, such as a hand (but no protection against deliberate access). Solid object exceeding 50 mm (2 in.) in diameter
2	Protected against solid objects greater than 12 mm (0.5 in.)	Fingers or similar objects not exceeding 80 mm (3.15 in.) in length. Solid objects exceeding 12 mm (0.5 in.) in diameter
3	Protected against solid objects greater than 2.5 mm (0.1 in.)	Tools, wires, etc. of diameter or thickness greater than 2.5 mm (0.1 in.). Solid objects exceeding 2.5 mm (0.1 in.) in diameter
4	Protected against solid objects greater than 1 mm (0.04 in.)	Wires or strips of thickness greater than 1 mm (0.04 in.). Solid objects exceeding 1 mm (0.04 in.) in diameter
5	Dust protected	Ingress of dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with satisfactory operation of the equipment
6	Dust-tight	No ingress of dust

Designation

The degree of protection is designated as shown in the following examples:

When it is required to indicate the degree of protection by only one characteristic numeral, which shows either degree of protection against foreign bodies and electrical shock or against liquid, the omitted numeral is to be replaced by the letter X.

Examples

- | | | |
|---|------|---|
| 1 | IP56 | The first characteristic numeral of “5” |
| 2 | | The second characteristic numeral of “6” |
| 3 | IPX5 | Degree of protection against only liquid |
| 4 | IP2X | Degree of protection against only foreign bodies and electrical shock |

**Table 1B. Degree of Protection
(Indicated by the Second Characteristic Numeral)**

<i>Degree of Protection</i>		
<i>First Characteristic Numeral</i>	<i>Short Description</i>	<i>Definition</i>
0	Non-protected	No special protection
1	Protected against dripping water	Dripping water (vertically falling drops) is to have no harmful effect
2	Protected against dripping water when tilted up to 15 degrees	Vertically dripping water is to have no harmful effect when the enclosure is tilted at any angle up to 15 degrees from its normal position
3	Protected against spraying water	Water falling as spray at an angle up to 60 degrees from the vertical is to have no harmful effect
4	Protected against splashing water	Water splashed against the enclosure from any direction is to have no harmful effect
5	Protected against water jets	Water projected by a nozzle against the enclosure from any direction is to have no harmful effect
6	Protected against heavy seas	Water from heavy seas, or water projected in powerful jets, is not to enter the enclosure in harmful quantities
7	Protected against the effects of immersion	Ingress of water in a harmful quantity is not to be possible when the enclosure is immersed in water under defined conditions of pressure and time
8	Protected against submersion	The equipment is suitable for continuous submersion in water, under conditions that are to be specified by the manufacturer <i>Note:</i> - Normally this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that it produces no harmful effects

See Designation and examples in 3.F/Table 1A “First Characteristic Numeral”.

Table 1C. NEMA Enclosures

<i>NEMA Type No.</i>	<i>Type of Enclosure</i>	<i>Characteristics</i>	<i>Intended Use</i>	<i>Typical Offshore Applications</i>
1	General Purpose, Surface Mounting	A general-purpose (NEMA Type 1) enclosure is designed to meet the latest general specifications for enclosures of Underwriter' Laboratories. This enclosure is intended primarily to prevent accidental contact with enclosed electrical apparatus. A NEMA Type 1 enclosure is suitable for general-purpose application indoors where atmospheric conditions are normal. It is not dust-tight or watertight.	To prevent accidental contact with live parts, indoors, where normal atmospheric conditions prevail.	Lighting panels, motor control centers, disconnect switches, etc., in unclassified locations inside buildings
1-A	Semi-Dust-tight	A semi-dust-tight enclosure (NEMA type 1-A) is similar to the Type 1 enclosure, but with addition of a gasket around the cover. A NEMA Type 1-A enclosure is suitable for general purpose application indoors and provides additional protection against dust, although it is not dust-tight.	Same as NEMA Type 1, but in locations where a small amount of dust is prevalent.	Same as NEMA Type 1.
1-B	General Purpose, Flush Mounting	A flush-type enclosure (NEMA Type 1.B) is similar to the Type 1 enclosure, but is designed for mounting in a wall and is provided with a cover that also serves as a flush plate.	Same as NEMA Type 1, but for flush-type mounting applications	Same as NEMA Type 1 where flush (versus surface) mounting is desired.
2	Drip-tight	A drip-tight enclosure (NEMA Type 2), also referred to as "Drip-proof", is similar to the Type 1 general-purpose enclosure, but with the addition of drip shields or their equivalent. A Type 2 enclosure is suitable for application where condensation may be severe. <i>Note:</i> Drip-tight apparatus may be semi-enclosed apparatus if it is provided with suitable protection integral with the apparatus, or enclosed in such a manner as to exclude effectively falling solid or liquid material.	Locations where condensation may be severe.	No typical offshore applications
3	Weather-tight	A weather-tight enclosure (NEMA Type 3) is designed for use outdoors to provide protection against weather hazards such as rain and sleet. A NEMA Type 3 enclosure is suitable for application outdoors.	Outdoors where it is necessary to provide protection against weather hazards, such as rain and sleet.	Refer to NEMA Type 12 applications
3R	Weather-resistant	A weather-resistant enclosure (NEMA Type 3R) is designed for use outdoors to provide protection against rain. Rain will not readily interfere with operation of internal components. NEMA Type 3R provides less protection than Type 3.	Same as NEMA Type 3, but in less severe application	Same as NEMA Type 3.
4	Watertight	A watertight enclosure (NEMA Type 4) is designed for outdoor use and is required to meet the hose test as follows: NEMA Type 4 Enclosures shall be tested by subjection to a stream of water. A hose with a 1-in. nozzle shall be used and shall deliver at least 65gal/min. The water shall be directed on the enclosure from a distance of not less than 10ft and for a 5-minute period. During this period, it may be directed in one or more directions as desired. There shall be no leakage of water into the enclosure under these conditions.	Outdoor or indoor locations where enclosed equipment might be subjected to splashing or dripping water. Not suitable for submersion in water.	Equipment enclosures and junction boxes subject to wind-driven rain or hose wash-down.
4X	Watertight	A watertight corrosion-resistant (NEMA Type 4X) enclosure is similar to Type 4 enclosure but is manufactured from corrosion-resistant materials, such as glass polyester or stainless steel.	Same as NEMA Type 4, but designed for a more corrosive environment.	Same as NEMA Type 4.

Table 1C. NEMA Enclosures (continued)

<i>NEMA Type No.</i>	<i>Type of Enclosure</i>	<i>Characteristics</i>	<i>Intended Use</i>	<i>Typical Offshore Applications</i>
5	Dust-tight	A dust-tight (NEMA Type 5) enclosure is provided with gaskets and is suitable for application in locations where it is desirable to exclude dirt.	In locations where it is necessary to protect the enclosed equipment against injurious accumulation of dust or lint.	No typical offshore applications.
6, 6P	Submersible	A submersible enclosure is suitable for applications where the equipment may be subject to occasional temporary submersion (NEMA Type 6) and prolonged submersion (NEMA Type 6P) in water. The design of the enclosure will depend upon the specified conditions of pressure and time.	Locations where the equipment is subject to submersion in water.	Junction boxes installed in the splash zone.
7	Explosion proof, Class 1	An explosion proof enclosure (NEMA Type 7) is designed to meet the application requirements in NEC Art. 500 for Class I locations and is designed in accordance with the latest specifications of Underwriters' laboratories for particular groups of gases. Certain NEMA 7 enclosures are approved for several groups (such as Groups B, C, and D). NEMA 7 enclosures are not necessarily suitable for outdoor use.	Locations classified as Class I, Division 1 or 2 hazardous locations.	Widely used in classified locations when arcing or high temperature devices are utilized.
8		Explosion, oil-filled, Class I. An explosion proof, oil-filled enclosure (NEMA Type 8) is designed to meet the application requirements in NEC Art. 500 for Class I locations and is designed in accordance with the latest specifications of Underwriters' laboratories for specific gases. The apparatus is immersed in oil.	Same as NEMA Type 7	Not widely utilized offshore, but suitable for same areas as NEMA Type.7.
9	Dust-ignition Proof, Class II	A dust-ignition-proof enclosure (NEMA Type 9) is designed to meet the application requirements in NEC Art. 500 for Class II locations and is designed in accordance with the latest specifications of Underwriters' Laboratories for particular dusts.	Locations classified as Class II hazardous Locations (containing combustible dust).	No typical offshore applications.
10		A Type 10 enclosure is designed to meet the latest requirements of the Bureau of Mines and is suitable for applications in coal mines.	Locations required to meet the latest requirements of the Bureau of Mines.	No typical offshore applications.
11	Acid-and fume resistant, oil-immersed	An acid-and fume-resistant (NEMA Type 11) enclosure is suitable for applications indoors where the equipment may be subject to corrosive acid or fumes. The apparatus is immersed in oil.	Locations where acid or fumes are present.	No typical offshore applications.
12	Dust-tight and Drip-tight	A dust-tight and drip-tight (NEMA Type 12) enclosure is provided with an oil-resistant synthetic gasket between the case and the cover. To avoid loss, any fastener parts are held in place when the door is opened. There are no holes through the enclosures for mounting or for mounting controls within the enclosure and no conduit knockouts or conduit openings. Mounting feet or other suitable means for mounting are provided. A NEMA Type 12 enclosure is suitable for industrial application in locations where oil or coolant might enter the enclosure. NEMA Type 12 enclosures are not suitable for outdoor use, but may be modified to meet Type 3 requirements with the addition of a drip shield. Enclosures carrying a NEMA 3.12 rating area superior to those carrying only a NEMA 3 rating.	Indoor locations where oil or coolant might enter the enclosure.	Indoors in areas protected from the environment, or outdoors when modified, to meet NEMA Type 3 requirements.

Table 1C. NEMA Enclosures (continued)

<i>NEMA Type No.</i>	<i>Type of Enclosure</i>	<i>Characteristics</i>	<i>Intended Use</i>	<i>Typical Offshore Applications</i>
13	Oil-tight and Dust-tight	An oil-tight and dust-tight (NEMA 13) enclosure is intended for use indoors primarily to house pilot devices such as limit switches, push buttons, selector switches pilot, lights, etc., and to protect these devices against lint and dust, seepage, external condensation, and spraying of water, oil or coolant. They have oil-resistant gaskets and, when intended for mounting on the wall or on machines, have mounting means external to the equipment cavity. They have no conduit knockouts or unsealed openings providing access into the equipment cavity. All conduit openings have provision for oil-tight conduit entry.	Indoor locations where spraying oil or coolant might enter the enclosure.	Indoors in areas protected from the environment for control panels.

Table 2. Size of Ground (Earth)-continuity Conductors and Grounding (Earthing) Connections

<i>Type of Grounding Connection</i>		<i>Cross-sectional Area of Associated Current Carrying Conductor (A)</i>	<i>Minimum Cross-sectional Area of Copper Grounding Connection</i>
Ground-continuity conductor in flexible cable or flexible cord	A1	$A \leq 16 \text{ mm}^2$	A
	A2	$16 \text{ mm}^2 < A \leq 32 \text{ mm}^2$	16 mm^2
	A3	$A > 32 \text{ mm}^2$	$A/2$
Ground-continuity conductor incorporated in fixed cable	<i>For cables having an insulated ground-continuity conductor</i>		
	B1a	$A \leq 1.5 \text{ mm}^2$	1.5 mm^2
	B1b	$1.5 \text{ mm}^2 < A \leq 16 \text{ mm}^2$	A
	B1c	$16 \text{ mm}^2 < A \leq 32 \text{ mm}^2$	16 mm^2
	B1d	$A > 32 \text{ mm}^2$	$A/2$
	<i>For cables with bare ground wire in direct contact with the lead sheath</i>		
	B2	$A \leq 2.5 \text{ mm}^2$	1 mm^2
B2b	$2.5 \text{ mm}^2 < A \leq 6 \text{ mm}^2$	1.5 mm^2	
Separate fixed grounding conductor	C1a	$A \leq 2.5 \text{ mm}^2$	Stranded grounding connection: $1.5 \text{ mm}^2 < A \leq 1.5 \text{ mm}^2$ A for $A > 1.5 \text{ mm}^2$
	C1b		Unstranded grounding connection: 2.5 mm^2
	C2	$2.5 \text{ mm}^2 < A \leq 8 \text{ mm}^2$	4 mm^2
	C3	$8 \text{ mm}^2 < A \leq 120 \text{ mm}^2$	$A/2$
	C4	$A > 120 \text{ mm}^2$	70 mm^2 (See note 1)

Note: For grounded distribution systems, the size of grounding conductor need not exceed A/2.

Conversion Table for mm^2 to circular mils:

mm^2	<i>Circ. mils</i>	mm^2	<i>Circ. mils</i>	mm^2	<i>Circ. mils</i>	mm^2	<i>Circ. mils</i>
1	1.973	2.5	4.933	6	11.841	70	138.147
1.5	2.960	4	7.894	16	31.576	120	236.823

Table 3. Clearance and Creepage Distance for Switchboards, Distribution Boards, Chargers, Motor Control Centers and Controllers ⁽¹⁾

<i>Rate Insulation Voltage (V)</i>	<i>Minimum Clearances, mm (in.)</i>	<i>Minimum Creepage Distances, mm (in.)</i>
Up to 250	15 (19/32)	20 (25/32)
From 251 to 660	20 (25/32)	30 (13/16)
Above 660	25 (1)	35 (13/8)

Notes :

- 1 The values in this table apply to clearances and creepage distances between live parts as well as between live parts and exposed conductive parts, including grounding.

G. Instrumentation and Control Systems

1. Applicability

This Section defines criteria for the instrumentation and control systems for offshore facilities. The design of these systems is to comply with API RP I4C or other acceptable standards and the additional criteria contained in this Section.

Statutory governmental regulation or guidance, which may be applicable, is to be taken into consideration.

The documentation pertaining to instrumentation and control systems required for submittal is listed in 3.B.8.

1.1. General

This Section defines criteria for the instrumentation and control systems for offshore facilities. The design of these systems is to comply with API RP I4C or other acceptable standards and the additional criteria contained in this Section

- i)* The control and instrumentation systems are to provide an effective means for monitoring and controlling pressures, temperatures, flow rates, liquid levels and other process variables for the safe and continuous operation of the facilities.
- ii)* Where control over the electrical power generation and distribution is required for the operation of the facilities then the control system should also be arranged to cover this.
- iii)* Control and instrumentation systems for process, process support, utility and electrical systems are to be suitable for the intended application.
- iv)* All control and safety shutdown, systems are to be designed for safe operation of the equipment during start-up, shutdown and normal operational conditions.
- v)* It is the intention of this Section to identify systems (either through experience or the application of the FMEAs) on which safety relies and then to incorporate requirements commensurate with this the importance of that function.
- vi)* The technical requirements included are considered to be consistent and complimentary to the associated API standards.
- vii)* Should the designer wish to apply other techniques (e.g., the Safety Integrity Levels (SILs) incorporated in IEC 61508), this equivalent approach will be considered.

1.2. Installation

1.2.1 Electrical Installations

Electrical installations for instrumentation and control systems are to be in accordance with Section 3.F and Section 4.F as applicable.

1.2.2 Hydraulic and Pneumatic Control Systems

Piping systems for hydraulic and pneumatic controls are to be in accordance with 3.D.3.7 and Section 4.D as applicable.

2. Components

2.1. Environmental Considerations

All instrumentation control and safety system components, including alarm and indicator devices, are to be designed for use in a marine environment, resistant to corrosion, and capable of operating under all anticipated environmental conditions.

Each component is to be designed and tested for the extremes of pressure and temperature that it can encounter in service.

2.2. Suitability of Computer Based Equipment

Where safety related functions are performed by computer based equipment then the equipment is to be tested in accordance with the requirements of IACS Req. 1991/Rev.5 2006 E.10

2.3. Electrical Variations

Electrical and electronic components in AC systems are to be capable of operating satisfactorily under normally occurring variations in voltage and frequency.

DC system devices are to be capable of operating satisfactorily at minus 15% voltage.

Unless otherwise stated, the variations from the rated value may be taken from 3.G/Table 1.

Table 1. Electrical Variations

<i>Quantity in Operations</i>	<i>Permanent variation</i>	<i>Transient Variation</i>
Frequency	±5%	±10% (5 s)
Voltage	+6%, -10%	±20% (1.5 s)

2.4. Loss of Power

- i) Loss of control power (pneumatic, hydraulic or electric) to any device is not to cause the system to go into an unsafe condition.
- ii) Cause and effect matrices are to demonstrate loss of control power effects.

3. Instruments

3.1. Temperature

All temperature-sensing elements or devices are to be installed in separable socket type thermowells, so that they can be removed without danger of pressure or fluid release.

3.2. Pressure

- i)* Pressure switches supplied as safety devices are to be equipped with test connections to enable application of an external pressure source without disturbing the switch installation.
- ii)* Pressure gauges and sensors are to be provided with an isolation valve to permit the safe removal of the gauge without the need to reduce the pressure in the system.
- iii)* The open or closed position of the valve is to be readily identifiable from the position of the handle or stem.

3.3 Level

- i)* Liquid or interface level gauges are to be installed to cover the operating range and set points of level controllers or level switches.
- ii)* Direct viewing level gauges in processing or combustible fluid service are to be of the heavy-duty flat glass type and are to be equipped with self-closing valves at their ends. An equivalent type of level gauge may also be acceptable.

4. Alarm Systems

4.1. Characteristics

- i)* Alarm systems are to be of the self-monitoring type and designed so that a fault in the alarm system is self-revealing or will cause it to fail to the alarmed condition.
- ii)* Additionally, alarms are not to react to normal transient conditions or false signals.

4.2. Independence

Alarm systems are to be independent of control and safety systems, except that common sensors will be acceptable for non-shutdown related systems.

4.3. Visual and Audible Alarms

- i)* Alarms are to be both audible and visual, and are to be provided at the control stations, as required in this Section.
- ii)* Alarms are to clearly identify the system and service of the faulted system or process components.
- iii)* Visual alarms are to be displayed in a distinguishable manner such that alarms for similar process components or systems are grouped together, and the colors representing a particular function or condition remain uniform.
- iv)* Visual alarms are to flash when first activated.
- v)* Audible alarms associated with the process plant are to be of distinctive tone from other alarms such as fire alarm, general alarm, gas detection, etc., and they are to be of sufficient loudness to attract the attention of personnel on duty;
- vi)* For spaces of unusual high noise levels, a beacon light or similar device, installed in a conspicuous place is to supplement any of the audible alarms in such spaces; however, red light beacons are only to be used for fire alarms.
- vii)* A fault in the visual alarm circuits is not to affect the operation of the audible alarm circuits.

viii) For computer-based systems, see 3.G.8.

4.4. Acknowledgement of Alarms

- i) Alarms are to be acknowledged by manually changing the flashing display of the incoming alarm to a steady display and by silencing the audible signal; the steady state light display is to remain activated until the fault condition is rectified.
- ii) Alarming of other faults that may occur during the acknowledgement process is not to be suppressed by such action, and is to be alarmed and displayed accordingly.
- iii) Where a centralized control and monitoring station is provided, the silencing of the audible alarm from an associated remote control station is not to lead automatically to the silencing of the original alarm at the centralized control and monitoring station.

4.5. Disconnection and Resumption of Alarm Functions

Alarm circuits may be temporarily disabled for maintenance purposes or during initial plant start-up, provided such action is clearly indicated at the associated station in control and, where such station is provided, at the centralized control and monitoring station. However, such alarm is to be automatically re-activated after a preset time period.

4.6. Summary Alarms

When individual alarms are displayed and alarmed at a centralized control and monitoring station, the visual alarms may be displayed and alarmed at other associated remote control stations as summary alarms.

4.7. Built-in Testing

Alarm systems are to be provided with effective means for testing all audible and visual alarms and indicating lamps without disrupting the normal machinery or system operation. Such means are to be fitted in the associated remote stations

4.8. Adjustable Set-points

Where means are provided to field adjustable set-points, either locally or remotely, positive indication of the value of the set-point is to be clearly identified at the control location.

5. Control and Monitoring

5.1. General

Display systems are to comply with 3.G.4.1, 3.G.4.3, 3.G.4.7 and 3.G.4.8

5.2. Loss of Signal

Loss of control signal from a field sensing device required to comply with this rule is to initiate an alarm or cause a shutdown.

5.3. Display of Parameters

- i) Operating parameter displays are to be clear, concise, consistent and grouped logically.
- ii) Operating parameter displays are to be included in control stations as required in this Section.

5.4. Logic Circuit Features

- i)* When logic circuits are used for sequential start-up or for operating individual process components, indicators are to be provided at the control console to show the successful completion of the sequence of operations by the logic-circuit and start-up and operation of the process component.
- ii)* If some particular step is not carried out during the sequence, the sequence is to stop at this point, and such condition is to be alarmed at the control console or, where provided, at the centralized control and monitoring station.
- iii)* Feedback devices are to be employed in order to sense steps carried out during the start-up sequence. Sequence operation is to stop upon lack of feedback signal.
- iv)* Where valves are employed in any start-up sequence, valve condition is to be sensed as valve stem position and not as a function of control or power signal to the valve.

5.5. Overrides

- i)* No condition of operation within normal ranges is to require the override of a required protective device or function.
- ii)* Where shutdown functions are bypassed during special operational modes described below, sensing devices are to be arranged to continue to indicate the condition of each process variable.
- iii)* In addition, an indicator for each function is to alert the operator that the shutdown function is being “bypassed”.
- iv)* Provisions to override shutdown functions may include the following:
 - a) Calibration. To periodically test or calibrate field sensing device.
 - b) Out of Service. To take the vessel or other process component out of service.
 - c) Start-up
 - 1) To allow process conditions to stabilize, automatic bypass of shutdown functions on start-up may be installed, provided the process variable condition is indicated, and an automated device is fitted which will return the shutdown function to operation once the normal process condition has been attained.
 - 2) The use of timers in association with this required automatic function will be considered.

6. Safety Systems

6.1. General

- i)* Safety systems are to be of the fail-safe type and are to respond automatically to fault conditions that may endanger the plant or safety of the crew.
- ii)* Unless otherwise required in this Section or specially approved, this automatic action is to cause the plant to take the least drastic action first, as appropriate, by reducing its normal operating output or switching to a stand-by process component, and last, by stopping it.
- iii)* Actuation is to result in audible and visual alarm.
- iv)* See also 3.C.7.2 for number of safety levels required.

6.2. Independence

Safety systems are to be completely independent of the control and alarm systems so that a failure in one of these systems will not prevent the safety system from operating.

6.3. Activation

- i)* Each safety action is to be alarmed at the associated remote station.
- ii)* Where a centralized control and monitoring station is fitted, individual alarms are to be provided at that station; in which case, a summary alarm for the specific safety system will be acceptable at other associated remote stations.
- iii)* When both an alarm and a safety action are required for a specific failure condition the operating points are to be arranged such that alarm is activated earlier.

6.4. Resumption of Operation

Process components that are stopped as a result of a safety action are to be manually reset before their operation is resumed.

6.5. Override of Safety Provisions

- i)* Remote overrides are not to be provided for those safety actions specified in other Sections of this Rule.
- ii)* For safety actions specified in 3.G.5.5, any overrides of safety provisions are to be so arranged that they cannot go unnoticed, and their activation and condition are to be alarmed and indicated at the associated remote station.
- iii)* The override is to be arranged to preclude inadvertent operation and is not to deactivate alarms associated with safety provisions.
- iv)* The override mechanism to disconnect safety provisions is to be fitted at the associated remote station, except that where a centralized control and monitoring station is fitted, the override mechanism may be fitted at the centralized station instead.

6.6. Adjustable Set-points

Where means are provided to the field adjustable set points, either locally or remotely, positive indication of the value of the set point is to be clearly identified at the control location.

7. Shutdown Systems

7.1. General

- i)* Shutdown systems are to comply with the requirements of safety systems given in 3.G.6, except that systems supplied in accordance with 3.H.3.6 or 4.H.3.5, as applicable, are not to be automatically actuated and need not be fail safe.
- ii)* Additionally, computer-based systems are to comply with the requirements of 3.G.8.

7.2. Safety Analysis

Where alarm and shutdown functions are required, a Safety Analysis Function Evaluation (SAFE) Chart is to be provided for equipment packages with their own control/shutdown panels, as well as for individual process equipment protected by a common safety shutdown system.

7.3 Emergency Shutdown

7.3.1 General

- i)* Shutdown is to take place within 45 seconds or less as may be considered necessary for the safety of the plant after activation of the ESD system at a manual ESD station, or after detection of a trouble condition by an automatic shutdown device.
- ii)* Electric circuits essential to ESD that rely on the continued operation of the cable for correct operation of the system are to be of the fire resisting type (e.g., mineral insulated cable or complying with IEC 60331).

7.3.2 Emergency Shutdown - Automatic

See 3.C.7.2.

7.3.3 Emergency Shutdown - Manual

- i)* See 3.C.3.3.
- ii)* All electrical circuits used in the manual ESD system are to be dedicated to this purpose and hard wired.

8. Computer-based Systems for Alarm, Control and Safety Systems

8.1 General

- i)* Computer-based systems are to be designed so that failure of any of the system's process components will not cause unsafe operation of the system.
- ii)* Hardware and software serving vital and non-vital systems are to be arranged to give priority to vital systems.

8.2. Independence

Control, alarm and safety shutdown system functions are to be arranged such that a single failure or malfunction of the electronic computer equipment will not affect more than one of these system functions.

This is to be achieved by dedicated equipment for each of these functions within a single system, or by the provision of back-up equipment, or by other suitable means considered equal or more effective.

8.3. Failure Mode and Effect Analysis (FMEA)/Failure Mode, Effect and Criticality Analysis (FMECA)

Where computer-based systems include safety functions (i.e., safety functions are not backed-up by hardwired safety systems) an FMEA or FMECA is to be performed and submitted for review.

8.4. Visual Display of Alarms

8.4.1. Incoming Signals

- i)* In addition to the requirements contained in 3.G.4, alarms are to be presented in an identifiable manner when displayed by way of a computer monitor (video display unit), and are to appear in the sequence the incoming signals are received.

- ii)* Alarming of incoming fault signals are to automatically appear on the screen to alert the on-duty personnel, regardless of whether the computer and monitor (video display unit) are in a mode other than the monitoring mode (i.e., computing or displaying other system's mimic or schematic diagrams).

8.4.2. Unrectified Alarms

Alarms associated with faults which have not been rectified may be displayed in a summarized fashion until all the faults have been dealt with.

8.4.3. Computer Monitor (Video Display Unit)

- i)* Displays on the computer monitor (video display unit) are to be clearly visible under ambient lighting conditions.
- ii)* Data displayed on computer monitors are to be readable by the operator from normal operating position.

8.5. Memory Capacity and Response Time

- i)* Computer system's memory is to be of sufficient capacity to handle the operation of all computer programs (software) as configured in the computer system.
- ii)* The time response for processing and transmitting data is to be such that an undesirable chain of events may not arise as a result of unacceptable data delay or response time during the computer system's worst data overload operating condition (multi-tasking mode).

8.6. Data Loss and Corruption

To preclude the possible loss or corruption of data as a result of power disruption, programs and data considered to be essential to the operation of a specific system are to be stored in non-volatile memory, or in volatile memory with a secure un-interruptible power supply (UPS).

8.7. Local Area Network (LAN)

For safety systems where an automatic or remote control and monitoring system for specific process components is arranged to operate in a local area network (LAN), the following is to be complied with:

- i)* The network topology is to be configured so that in the case of a failure between nodes, or at a node, the system on the network remains operational.
- ii)* In case of failure of the network controller, the network is to be arranged to automatically switch to a standby controller. A network controller failure is to be alarmed at the associated remote control station.
- iii)* Safeguards are to be provided to prevent unacceptable data transmission delays (overloading of network). An alarm is to be activated at the associated remote control stations prior to a critical network data overload condition. See 3.G.8.5.
- iv)* The communication data highway is to be provided in duplicate and is to be arranged so that upon failure of the on-line highway, the standby data highway is automatically connected to the system. The standby data highway is not to be used to reduce traffic in the on-line highway.

8.8. Power Supply Disruption

The system's software and hardware is to be designed so that upon restoration of power supply after power failure, automatic or remote control and monitoring capabilities can immediately be available after the

preestablished computer control access (sign-in) procedure has been completed.

8.9. Parameters and Program Changes

Alteration of parameters that may affect the system's performance is to be limited to authorized personnel by means of keyswitch, keycard, password, or other approved methods.

8.10. Multiple Points of Control

Systems with multiple control stations are to be provided with clear indication at each location to identify the station in control, and are to be provided with procedures to ensure proper transfer of control.

9. Relief Valves

9.1. General

- i)* Where spare relief valves are provided, the upstream block valve is to be locked closed and the downstream block valve is to be locked open to prevent the relief valve from being over-pressurized due to the leakage of the upstream block valve.
- ii)* The practice of using check valves in lieu of downstream block valves is not permitted.
- iii)* The upstream block valve is to have a full bore area equal to or greater than the pressure relief valve inlet.
- iv)* Similarly, the downstream block valve is to have a full bore area equal to or greater than the pressure relief valve outlet.

9.2. Provisions for Testing

- i)* Provision is to be made for periodic testing of each relief valve without removing it from the line or vessel.
- ii)* Where necessary, relief valves are to be individually equipped with an inlet block or check valve and test connection so that an external pressure source can be applied.

9.3. Block Valve Locking Devices

Any block valve upstream or downstream of a relief valve or rupture disc is to be equipped with a carseal or locking device to prevent the relief valve from being isolated while in service.

10. Shutdown Valves, Blowdown Valves and Diverter Valves

Automatically actuated shutdown, blowdown or diverter valves are to be equipped with position indicators at the valve operating station, or be of a type that valve position (open or closed) is externally obvious.

H. Fire Protection and Personnel Safety

1. Applicability

Fire protection and personnel safety features for hydrocarbon processing systems on a floating installation are to meet the requirements described in this Section.

Fire protection systems for vessel service functions on installations are to be in accordance with the Part 1 – Seagoing Ship.

2. General

2.1 Scope

The fire protection and personnel safety features are to comply with this Section and other applicable industrial standards, as referenced herein. Due to the varying configurations of offshore production facilities, fire protection requirements will vary accordingly. The documentation requirements for Design Review are given in 3.B.9 of this Rule.

2.2 Governmental Authority

In addition to BKI Class requirements, depending on the unit's flag of registry and the unit's intended area of operation, the flag state and coastal state may have additional requirements/regulations which are to be met; therefore, the appropriate governmental authorities are to be consulted for each installation.

3. Fire Fighting Systems

3.1 Firewater Systems

Fixed water fire fighting systems are to be provided as follows:

3.1.1 Piping

3.1.1(a) General

- i)* Water fire fighting systems are to be capable of maintaining a continuous supply in the event of damage to water piping.
- ii)* Piping is to be arranged so that the supply of water could be from two (2) different sources.
- iii)* Isolation valves are to be provided such that damage to any part of the system would result in the loss in use of the least possible number of hydrants, water spray branches, or foam water supplies. In most facility arrangements, this will require a loop type fire main.
- iv)* Connections of the primary and standby pump supplies are to be as remote from each other as possible.

3.1.1(b) Materials

- i)* Materials rendered ineffective by heat are not to be used in firewater piping systems.
- ii)* Resilient seated valves may be considered for use in firewater systems, provided the proposed valves are capable of passing an appropriate fire test acceptable to BKI (e.g., API Std. 607, ISO 10497).
- iii)* Additionally, the valves must be capable of being effectively closed even with the resilient seat damaged or destroyed, such that leakage through the closed valve is insignificant.
- iv)* The leakage rate at the firewater pressure through the closed damaged-seated valves still permits the firewater to deliver at least two (2) jets of water at the required pressure.
- v)* Non-metallic expansion joints may be considered for use in firewater system, provided the proposed joints are capable of passing a recognized fire test such as ISO 19921/19922:2005.
- vi)* Similarly, flexible hoses may be considered for use in firewater systems, provided the proposed hoses are capable of passing a recognized fire test such as ISO 15540/15541.
- vii)* All plastic piping materials are to meet Appendix 1 of this rule.
- viii)* Generally, plastic (GRP/FRP) materials used in firewater systems are to pass Level 1 fire endurance test. However, a plastic piping material that passes Level 3 fire endurance requirements in lieu of Level 1 requirements may be considered when conditions listed in 3.H.3.1.1(e) below are fully met and accepted by the Flag Administration.

3.1.1(c) Charging

- i) The firewater distribution system may be maintained in a charged or dry condition.
- ii) Where a system is maintained dry, relief devices and additional pipe bracing is to be considered to prevent damage to the piping system due to water hammer when the system is charged.
- iii) When plastic pipe that passes only Level 3 fire endurance test is used, the firewater system design is to be pressurized (wet main) or be permanently in a charged condition.

3.1.1(d) Piping Maintenance

- i) The distribution system is to be maintained such that internal and external corrosion of the piping is minimized.
- ii) In areas where the system is subject to freezing, steps are to be taken to prevent freezing. For instance, drains, circulation loops or other means may be provided for cold water protection.
- iii) If drains are provided, they are to be located at the lowest points in the system.

3.1.1(e) Additional System Requirements for Level 3 Plastic Pipe

The following additional requirements are applicable to the plastic material piping that passes Level 3 in lieu of Level 1 fire endurance tests and is used in the fire main system:

- i) Plastic piping must be located on the exterior perimeter of the vessels/units and shielded by primary structural members from potential sources of fire that may occur on or emanate from the vessels/units.
- ii) Plastic piping must be located so that pooling of flammable liquids below the piping is not possible. A properly designed drainage system may be provided to mitigate the pooling of flammable liquid below the piping system.
- iii) The firewater system design is to be such that the plastic sections are continuously maintained in the wet condition.
- iv) The firewater system is to be equipped with an adequate number of isolation and cut-off valves such that, if a section of the system were to fail, it could be isolated and the remainder of the system would still be capable of supplying firewater.

3.1.2 Fire Pumps**3.1.2(a) General**

- i) There are to be at least two (2) independently driven and self-priming fire pumps.
- ii) The fire pumps, together with their respective source of power, fuel supply, electric cables, lighting, ventilation, piping and control valves, are to be located such that a fire in any one (1) location will not render both fire pumps inoperable.
- iii) One of the two (2) pumps is to be designated as the primary fire pump, and the other as the standby fire pump.
- iv) At least one of the pumps is to be diesel engine driven, unless the emergency power supply can supply the load for an electric motor driven pump (see 3.F.11.2.3). *See Part 1 – Seagoing Ship, Volume III, Section 12.E.1 or Part 5 – Offshore Technology, Volume 4, Section 10.D.1/1 and Section 3.E.3.6 of this Rule* for applicable fire protection requirements for fire pumps.

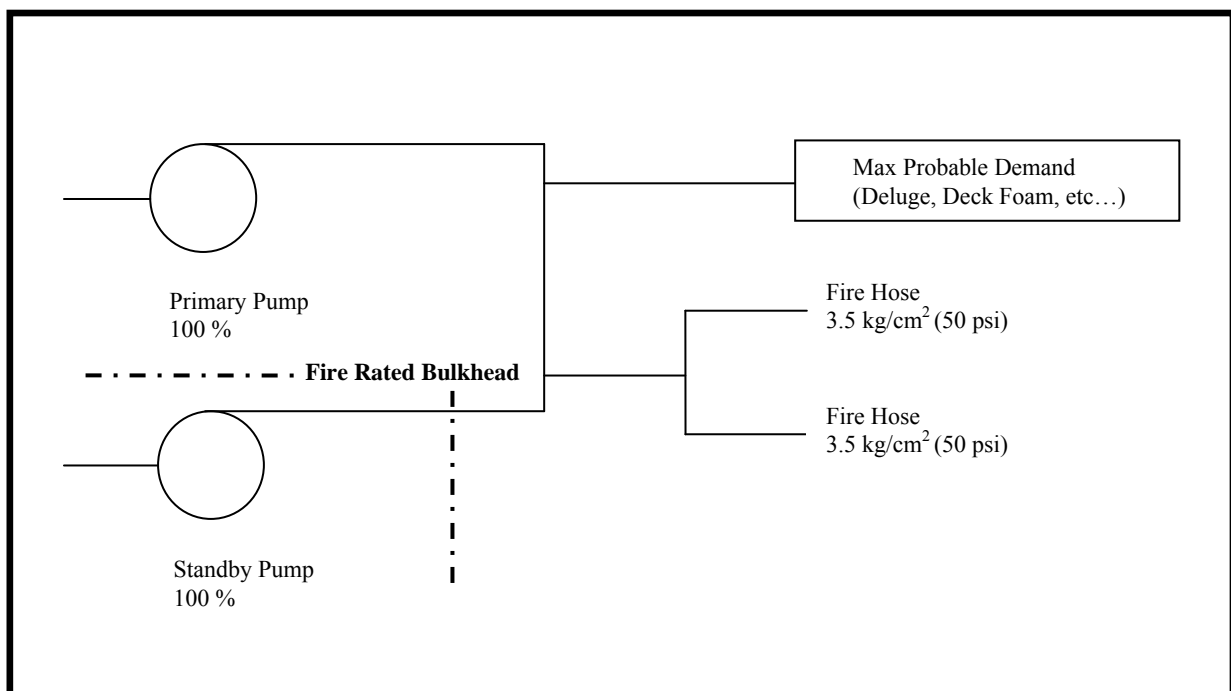
3.1.2(b) Capacity

- i) The primary and standby fire pumps are each to be capable of supplying the maximum probable water demand for the facility.
- ii) The maximum probable water demand is the total water requirement for protection of the largest single fire area plus two (2) jets of firewater at a pressure of at least 3.5 kg/cm² (50 psi).
- iii) Multiple-pump installations will be considered in lieu of a single primary and standby pump installation, provided they are arranged in such a manner that a fire in one (1) area would not reduce

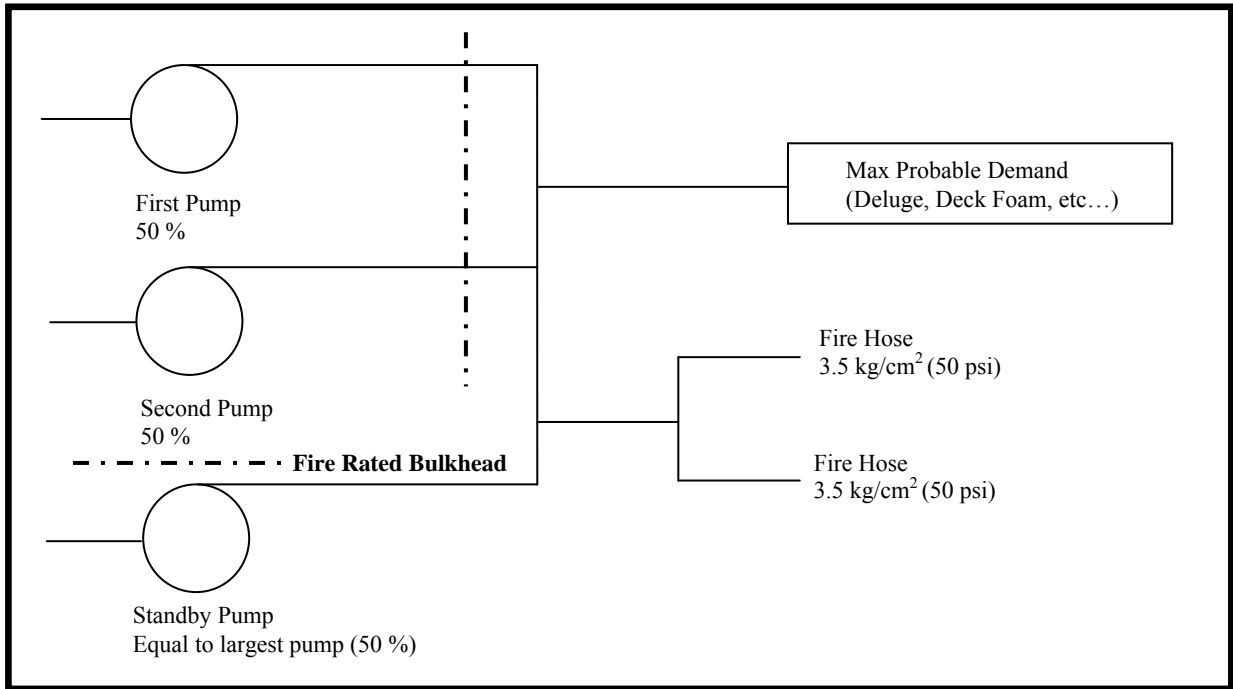
the available supply of firewater required to handle that fire, or such that if the largest pump is out of service for maintenance, the available supply of water would not be reduced below the maximum probable water demand.

- iv) A means is to be provided for periodic testing of each fire pump. See 3.H/Fig. 1 through 3.H/Fig. 3 for typical arrangement of fire pumps on newly constructed floating installations.
- v) For a FPSO conversion from an existing tanker based or a FPS conversion from an existing MODU (built prior to 1996) based, the capacity of the primary and standby fire pumps is to be in accordance with this section of the Rules, except that the pressure at the nozzles for the two (2) jets of firewater is to be at least 2.7 kg/cm^2 (40 psi). See 3.H/Fig. 4.
- vi) For a typical FPSO arrangement, the maximum probable water demand includes the water supply to the water spray system for a single fire on the production deck as discussed above, the water supply to the foam system on the tanker deck below, plus two (2) jets of firewater.
- vii) For detailed requirements of the water spray system, see 3.H/3.1.4.
- viii) To determine the maximum probable water demand, the fire risk areas on the production deck may be divided into fire zones.
 - a) If a fire is being considered in a single zone, the water supply for the water spray system is to be sufficient for that zone and adjacent zones.
 - b) The water spray system requirement may be ignored for adjacent zones if these zones are separated by a firewall (no less than A-60) or by an adequate distance between process components to justify such zoning. See 3.H/Fig. 5A for reference.
- ix) Note that the system emergency shutdown and the equipment blowdown may be considered a safe alternative to the water spray for low hydrocarbon liquid inventory equipment such as the gas compressor units. See 3.H/Fig. 5B for reference.

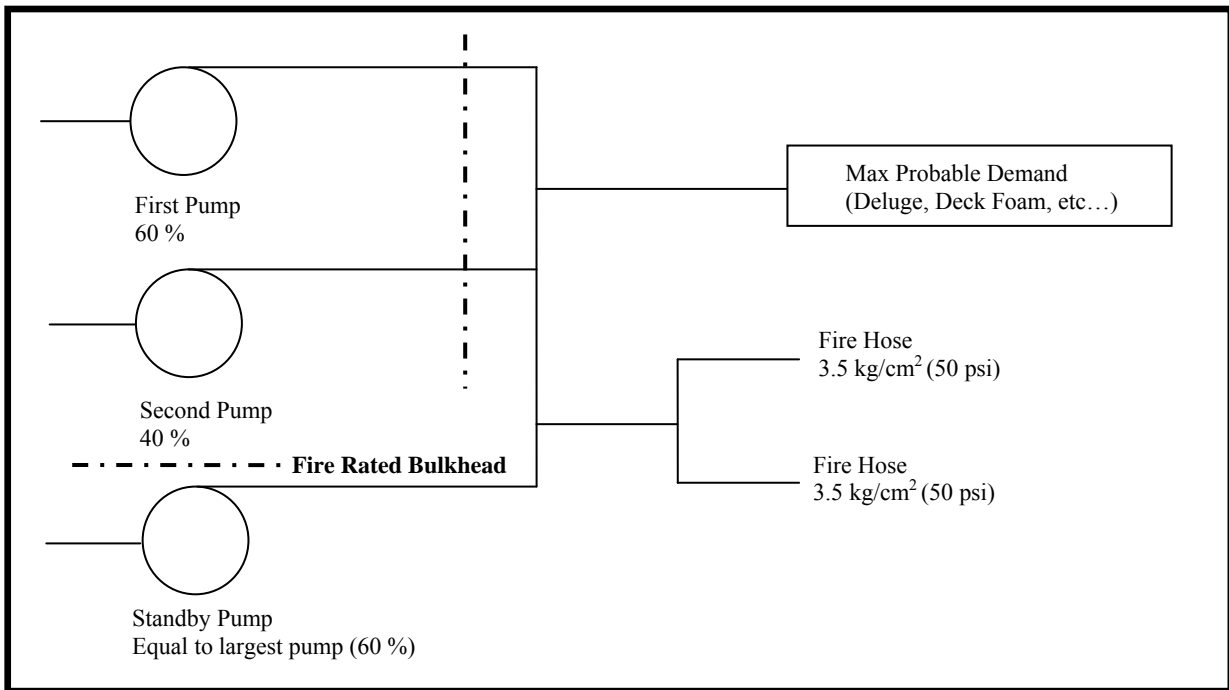
**Fig. 1. Floating Installation Fire Pump Arrangement
Two-Pump Scenario**



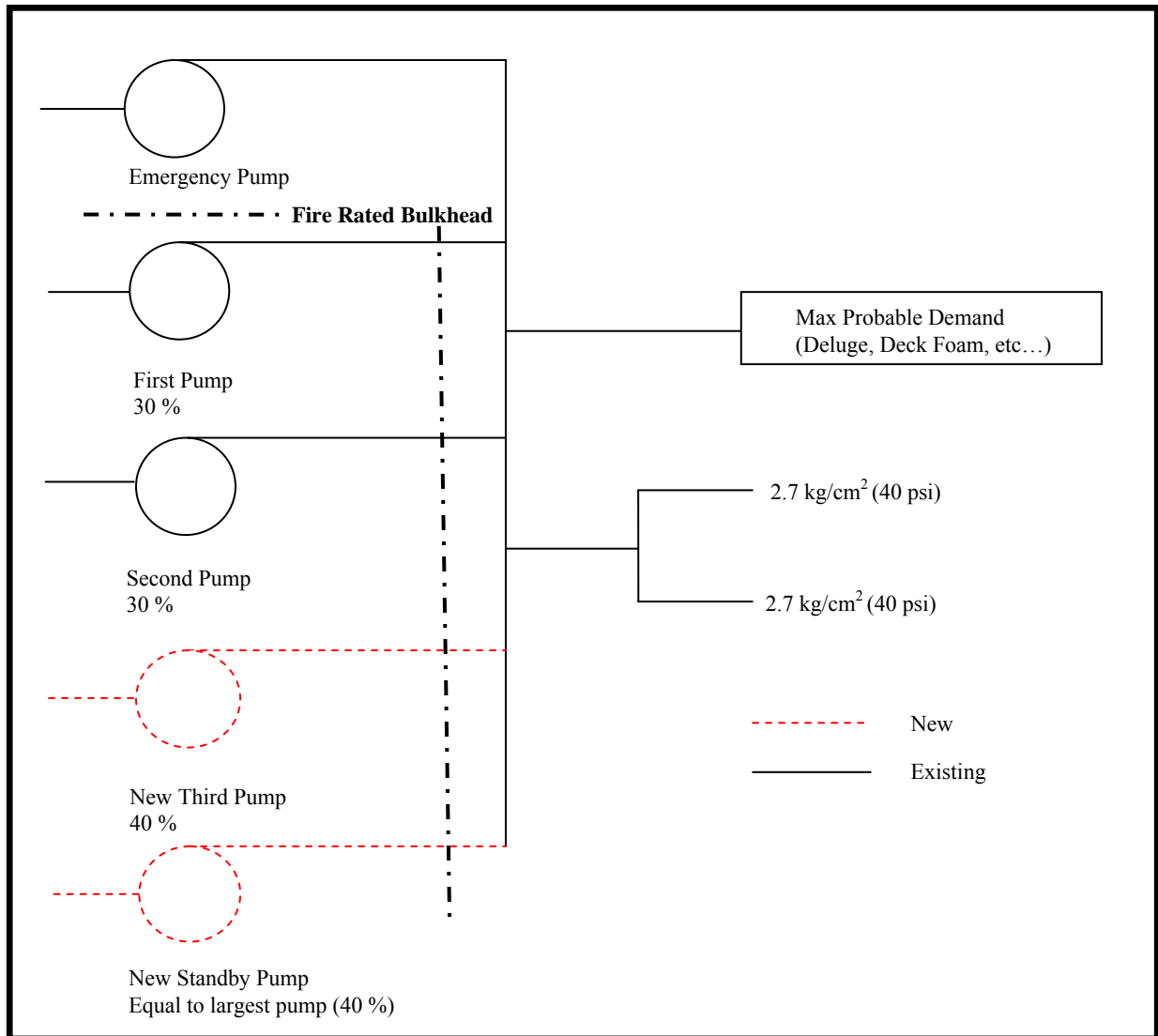
**Fig. 2. Floating Installation Fire Pump Arrangement
Multiple-pump (Even Power) Scenario**



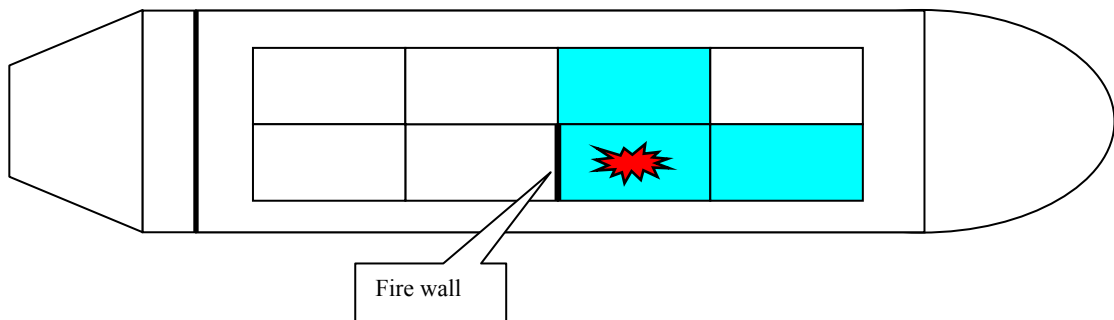
**Fig. 3. Floating Installation Fire Pump Arrangement
Multiple-pump (Uneven Power) Scenario**



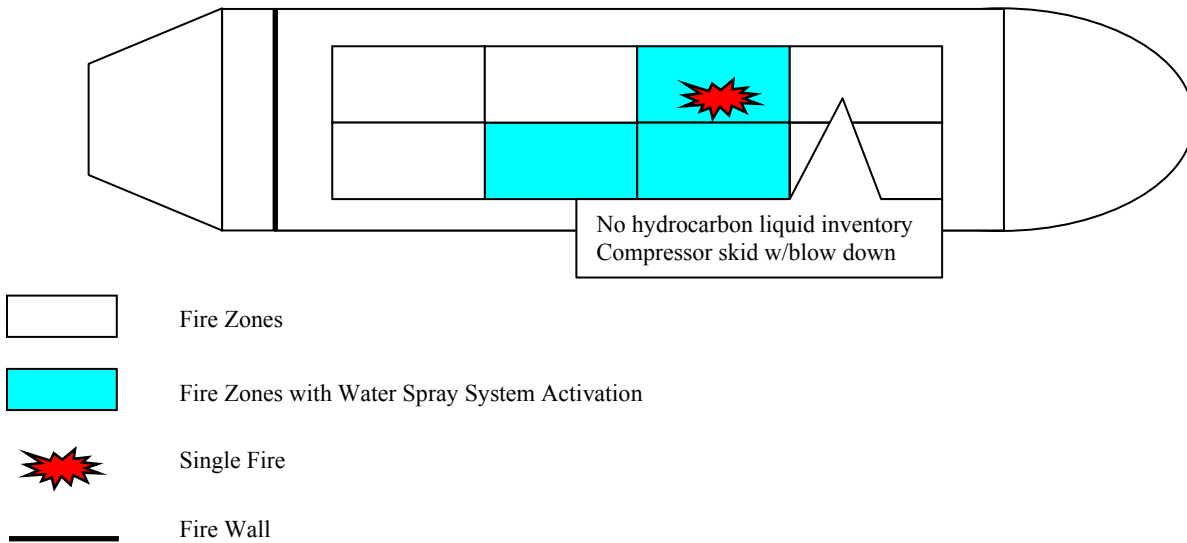
**Fig. 4. Floating Installation Fire Pump Arrangement
Multiple-pump Scenario for Oil Carrier Converted to Offshore Installation**



**Fig. 5A. Typical Fire Zones Arrangement on a Production Deck of a FPSO
Single Fire with A-60 Fire Wall**



**Fig. 5B. Typical Fire Zones Arrangement on a Production Deck of a FPSO
Single Fire with an Adjacent Zone that has no Liquid Inventory**



3.1.2(c) Operability and Control

- i) Pump(s) with sufficient capacity for process water spray systems is (are) to be provided with automatic starting.
- ii) In addition to the pump automatic starting requirement, pump driver starters are to be provided with means for local and remote operation from a permanently manned station or a fire control station.
- iii) Pump discharge control valves, used to separate the section of the firewater service system and the fire pump(s), are to be fitted in an easily accessible location outside of the pump space.
- iv) Diesel-driven fire pumps may be provided with electrical or pneumatic starting and control systems.
- v) Diesel drives using electrical starting and control systems are to be maintained in a weather-protected enclosure.
- vi) Alternative means of protecting electrical starting and control systems will be considered.

3.1.2(d) Pump Drivers

- i) Pump drivers may include diesel engines, natural gas engines, or electric motors.
- ii) The pump drivers are to be in general accordance with API RP 14G with respect to their types and installation requirements.
- iii) Fuel tanks, fuel lines to engines, and power cables and starters for electric motors, are to *be protected against fire and mechanical damage*.
- iv) Where diesel and natural gas engine fire pumps are considered, the arrangements are to comply with requirements of 3.D.2.5, 3.F.11.2.3, and 3.F.12.
- v) For electrical motor-driven fire pumps, see 3.F.4 and 3.F.10.2.3 for applicable requirements.

3.1.2(e) Fuel Systems

- i) Fuel systems are to comply with the requirements of 3.D.5.11.
- ii) Fuel supply for diesel engines is to be sufficient for 18 hours operation.

3.1.2(f) Lift Columns

- i) Water lift columns are to be encased in pipe for protection against wave action and mechanical damage, and the protective pipes are to be securely attached to the structure in order to lessen wave action damage.

- ii*) Corrosion allowance is to be considered when the water lift column is designed.
- iii*) Where pipes for lift columns pass through floating structures, penetrations are to be made by approved methods to maintain the watertight integrity of the structure.
- iv*) Intake strainers constructed of corrosion-resistant materials are to be fitted at the suction end of the fire pump's water lift column.

3.1.3 Firewater Stations

3.1.3(a) General

- i*) Firewater stations are to be located so that each station will be readily accessible in the event of a fire.
- ii*) All materials that comprise the firewater station and the access to firewater stations are to be of steel or equivalent material which would not be rendered ineffective by heat.
- iii*) Fiber Reinforced Plastic (FRP) grating may be considered, provided all conditions listed in Appendix 3 are fully met and are accepted by the Flag Administration.

3.1.3(b) Arrangement

- i*) Firewater stations are to be located on the perimeter of process areas.
- ii*) The stations and their arrangements are to provide at least two (2) jets of water not emanating from the same fire station to reach any part of the production facility that may be exposed to fire.
- iii*) The firewater stations are also to be arranged to provide protection against fire damage or mechanical damage, operation free from interference by other emergency activities, and effective co-ordination with other stations.

3.1.3(c) Monitors and Nozzles

- i*) Monitors are to be sized for a minimum flow of 1,892 liters/min. at 7.3 kg/cm² (500 gpm at 100 psig).
- ii*) Nozzles are to be adjustable from straight stream to full fog and to have a nozzle diameter of at least 12 mm (0.5 in.).
- iii*) Monitors and nozzles are to be of corrosion-resistant materials and/or be protected with a suitable coating to protect the equipment from the offshore environment.
- iv*) All nozzles are to incorporate means for a shut-off.

3.1.3(d) Hoses.

- i*) Fire hoses located on the production deck are to be of a non-collapsible type mounted on reels, and are to be certified by a competent independent testing laboratory as being constructed of non-perishable material to recognized standards.
- ii*) The hoses are to be of material resistant to oil and chemical deterioration, mildew and rot, and exposure to the offshore environment.
- iii*) Hoses are to be sufficient in length to project a jet of water to any location in the areas where they may be required to be used.
- iv*) Each hose is to be provided with a nozzle and the necessary couplings.
- v*) Unlike collapsible hoses, which require more space for handling, the maximum length of hose reels used on the production deck may be as long as 30 m (100 ft).

- vi*) All indoor fire stations (i.e., quarters areas, machinery spaces, office spaces, etc.), where required, are to be provided with collapsible hoses.
- vii*) The maximum length of collapsible hoses is not to exceed 23 m (75 ft).

3.1.4 Water Spray (Deluge) Systems for Process Equipment

3.1.4(a) General

- i*) A fixed water spray system is to be installed for the process equipment.

- ii)* The intent of the water spray system is to keep the process equipment cool and reduce the risk of escalation of a fire.
- iii)* Water spray systems are to be capable of being actuated both automatically by a fire detection system and manually.
- iv)* Installations are generally to be in accordance with NFPA Standard 15, or other equivalent standard such as API RP 2030.
- v)* Deluge isolation valves are to be located in a safe area and outside the fire zone they protect.
- vi)* Consideration will be given to the use of manual actuation alone, provided that the combined volume of process and storage vessels is less than 15 m³ (530 ft³), and the installation is manned on a 24-hour basis and the manual actuation station is readily accessible.

3.1.4(b) Materials

- i)* All requirements in 3-H/5.1.1(b) are applicable, except the requirements for plastic piping materials, which are modified and listed below.
- ii)* Plastic piping materials are to meet Appendix 1 of this rule.
- iii)* Generally, plastic (GRP/FRP) materials used in water spray systems are to pass Level 1 fire endurance test.
- iv)* However, a plastic piping material that passes Level 3 Modified Test - Level 3 WD fire endurance requirements in lieu of Level 1 requirements may be considered when the following design conditions are fully met and accepted by the Flag Administration:
 - a)* Plastic piping is installed in open deck or semi-enclosed locations.
 - b)* The water spray piping system must meet the Level 3 fire endurance requirements as specified in Appendix 1.
 - c)* In addition to meeting the Level 3 fire endurance requirements, the water spray piping system must meet the requirements of the wet/dry fire endurance testing specified in Appendix 1.H
 - d)* Other wet/dry fire endurance test methods that may be equivalent to or more severe than the methods described in Appendix 1.H, will be considered on a case-by-case basis.
 - e)* An automatic fire detection system is to be installed in areas protected by the water spray system.
 - f)* The water spray system is to be designed to activate automatically upon detection by the automatic fire detection system.
 - g)* Each section or area served by a water spray system is to be capable of being isolated by one (1) water supply valve only. The stop valve in each section is to be readily accessible, and its location clearly and permanently indicated.
 - h)* The design of the water spray system is to be such that upon fire detection, the time required to have water flowing through the hydraulically most remote nozzle is less than one (1) minute. This requirement will be verified by system testing at the time of installation and at subsequent annual inspections.
 - i)* The water spray system piping is to be located downstream of the water supply valve.
 - j)* All piping upstream of the water supply valve is to meet the requirements for fire main and water spray systems as specified in Appendix 1, or be of metallic material.

3.1.4(c) Process Equipment

- i)* Process equipment, including hydrocarbon vessels, heat exchangers, fired heaters and other hydrocarbon handling systems, are to be protected with a water spray system.
- ii)* The system is to be designed to provide a water density of 10.2 liters/min/m² (0.25 gpm/ft²) of exposed surface area for uninsulated vessels, or 6.1 liters/min/m² (0.15 gpm/ft²) of exposed surface area for insulated vessels.
- iii)* Process equipment support structure, including saddles, skirt, legs, but not secondary deck structure members, is to be protected with a water spray system designed to provide a water density of 4.1 liters/min/m² (0.10 gpm/ft²).
- iv)* Alternatively, the use of intumescent coatings may be acceptable in protecting the support structure, provided the selection of the fire rating of the coating is based on the results from a risk analysis and/or fire load calculation which must be reviewed and accepted by BKI.
- v)* The condition (intactness) of the coatings will be the subject of surveyor inspection during attendance of the unit following normal survey intervals.

- vi) For gas-handling equipment, such as gas compressor skids, where the hydrocarbon liquid inventory is kept minimal, a water spray system is not required if the equipment is provided with an automatic blowdown upon the process shutdown.

3.1.4(d) Wellhead Areas

- i) Wellheads with maximum shut-in tubing pressures exceeding 42 kg/cm² (600 psi) are to be protected with a water spray system.
- ii) The water spray system is to be designed to provide a minimum water density of 20.4 liters/min/m² (0.50 gpm/ft²) based on the protection of wellheads, ESD valves, and critical structural components including the firewall.

3.1.4(e) Turret Areas (Internal Turret)

- i) Internal turrets with swivel pressure ratings exceeding 42 kg/cm² (600 psi) are to be protected with a water spray system.
- ii) Turret areas, including the swivel and its associated equipment, are to be protected by a water spray system designed to provide a minimum water density of 20.4 liters/min/m² (0.50 gpm/ft²).

3.1.5 Foam Systems for Crude Storage Tanks

- i) Deck foam systems are to be provided for all facilities storing crude oil in integral storage tanks, in accordance with 3.D.1.3.2.1 and *Part 1 – Seagoing Ship, Volume III Rules for Machinery Installations, Section 12 K. and Volume X, Section 11.3*.
- ii) Where process equipment is located or supported above crude storage areas such that deck foam system application might be obstructed by steel supporting members, foam applicators or fixed systems may be considered as an alternative.
- iii) Deck foam system coverage in way of process equipment supports is to be no less effective than for other cargo deck areas.

3.2 Dry Chemical Systems

For production facilities with no liquid hydrocarbon storage capabilities and limited hydrocarbon liquid retention in processing equipment, dry chemical hose reel units may be used for fire fighting in lieu of firewater station required by 3.H.3.1.3.

Design of the dry chemical systems is to be in accordance with NFPA Standard 17.

3.3 Fixed Fire Extinguishing Systems

A fixed fire fighting system complying with 3.H.3.3.1, 3.H.3.3.2 or 3.H.3.3.3 is to be provided in each enclosed space and enclosed skid module containing the following equipment:

- i) Internal combustion machinery, including diesel and gas engines, having a total power output of not less than 750 kW (1000 hp).
- ii) Oil or gas-fired boilers and other processes such as incinerators and inert gas generators.
- iii) Oil fuel units. An oil fuel unit is defined as any equipment such as pumps, filters and heaters, used for the preparation and delivery of fuel oil to oil-fired boilers (including incinerators and inert gas generators), internal combustion engines or gas turbines at a pressure of more than 1.8 bar (26 psi).
- iv) Settling tanks for boilers.
- v) Gas compressors
- vi) Transfer pumps for crude oil and flammable liquid with low flash point (below 60°C~140°F) such as methanol. See Part 1 Seagoing Ship, Volume III Rules for Machinery Installations, Section 12 and Volume X, Section 11.2 for reference.

If a fixed foam system is to be used for the methanol pump room and methanol tank space, the type of foam selected is to be suitable for use with methane (alcohol-resistant foams).

3.3.1 Gas Smothering Systems

3.3.1(a) General

- i)* Storage
 - a) Smothering medium storage location is to be outside of protected space.
 - b) If gas bottles are kept in an enclosed compartment, the storage space is not to be used for purposes other than storing the bottles.
 - c) The storage space is also to be situated in a safe and readily accessible position, and be effectively ventilated by a ventilation system independent of other spaces, including the protected space.
- ii)* Controls.
 - a) Automatic release of fire-extinguishing medium for total flooding systems is not permitted.
 - b) Two (2) separate controls are to be provided for releasing the fire-extinguishing medium into a protected space and to ensure the activities of the alarm.
 - c) One (1) control is to be used to discharge the gas from its storage containers.
 - d) A second control is to be used for opening the valve of the piping, which conveys the gas into the protected space. This requirement is not applicable if the system is provided for a single space and the protected space is relatively small [under 170 m³ (6000 ft³)].
 - e) Controls are to be grouped together to provide complete actuation of the system from their location.
 - f) The number of release stations is to be limited to as few as possible, typically two (2), one (1) at the gas storage location and another outside of the protected space.
 - g) For the one outside of the protected space, it is to be located in proximity and along the main escape route of the space.
- iii)* Alarms
 - a) Means are to be provided for automatically giving audible warning of the release of fire-extinguishing gas into any space to which personnel normally have access.
 - b) The alarm is to operate for at least a 20-second period before the gas is released.
 - c) Alarms may be pneumatically (by the extinguishing medium or by air) or electrically operated.
 - d) If electrically operated, the alarms are to be supplied with power from the main and an emergency source of electrical power.
 - e) If pneumatically operated by air, the air supply is to be dry and clean and the supply reservoir is to be atomically kept charged at all times, and is to be fitted with a low-pressure alarm.
 - f) The air supply may be taken from the starting air receivers.
 - g) Any stop valve fitted in the air supply line is to be locked or sealed in the open position.
 - h) Any electrical components associated with the pneumatic system are to be powered from the main and an emergency source of electrical power.

3.3.1(b) Carbon Dioxide Systems

- i)* In addition to the above general requirements, the design philosophy of CO₂ fire extinguishing systems is to be in compliance with a single standard/code (i.e., Chapter 5 of the International Code for Fire Safety Systems (FSS Code), NFPA 12, or other recognized fire code).
- ii)* Once a standard is chosen for a design basis, the standard is to be used throughout the design, and criteria from other standards may not be used.

3.3.1(c) Halon and Halon Alternative Systems

- i)* Halon is not permitted in new installations.
- ii)* Halon alternative systems are to meet IMO MSC Circ. 848 general requirements, and above.
- iii)* Halon alternative agents are to be accepted by the governmental authorities.

3.3.2 Foam Systems

3.3.2(a) Fixed High Expansion Foam Systems.

Fixed high expansion foam systems are to be in accordance with Chapter 6 of the FSS Code or other recognized fire code such as NFPA 11A. Note reference is made to the IMO MSC/Circular 670.

33.2(b) Fixed Low Expansion Foam Systems

- i) Fixed low expansion foam systems may be installed in machinery spaces in addition to the required fixed fire extinguishing system.
- ii) Fixed low expansion foam systems are to be in accordance with Chapter 6 of the FSS Code or other recognized fire code such as NFPA 11. Note reference is made to the IMO MSC/Circular 582.

3.3.3 Fixed Water Spray Systems

Fixed water spray systems are to be in accordance with Chapter 7 of the FSS Code or other recognized fire code such as NFPA 15.

3.4 Paint Lockers and Flammable Materials Storerooms

Paint lockers and flammable material storerooms located on the production decks with deck area in excess of 4 m² (43 ft²) are to be protected by a fixed fire extinguishing system. One of the following systems is to be provided:

- i) CO₂ system designed for 40% of the gross volume of the space
- ii) Dry powder system designed for at least 0.5 kg/m³ (0.03 lb/ft³)
- iii) Water spray system designed for 5 liters/min/m² (0.12 gpm/ft²). The water spraying systems may be connected to the unit's fire main system.
- iv) Systems other than those mentioned above may also be considered.

For paint lockers and flammable material storerooms located on the installation but not on the production deck, see the *Part 1 – Seagoing Ship, Volume III Rules for Machinery Installations, Section 12 M.* for applicable comments.

3.5 Helicopter Facilities

For fire fighting requirements of helicopter facilities, refer to the *Part 5 – Offshore Technology, Volume 2 Rules for Structure, Section 9. D.* and *Guidelines for Helicopter Decks and Facilities* for applicable comments.

3.6 Emergency Control Station

- i) At least two (2) emergency control stations are to be provided.
- ii) One of the stations is to be located in a normally manned space such as the process control room, or near the drilling console if the facility is fitted with drilling and workover systems.
- iii) The other is to be at a suitable location outside of the hazardous area.
- iv) The emergency control stations are to be provided with the following:
 - a) Manually operated switches for actuating the general alarm system
 - b) An efficient means of communication with locations vital to the safety of the installation
 - c) Manual activation of all well and process system shutdowns (3.C.7.2.4 and 3.C.3.3)
 - d) Means for shutdown, either selectively or simultaneously, of the following equipment, except for electrical equipment listed in 3.H.3.7:
 - (1) ventilating systems, except for prime movers,
 - (2) main generator prime movers, (3) emergency generator prime movers.

3.7. Operation after Facility Total Shutdown

The following services are to be operable after total shutdown of a facility:

- i) Emergency lighting required for evacuation from service/accommodation spaces and machinery spaces to embarkation stations. This includes lighting at all control stations, stowage positions for

firemen's outfits, helicopter landing deck, alleyways, stairways and exits, embarkation station deck, launching appliances, and the area of water where they are to be launched, etc. The lighting is to be provided for thirty minutes.

- ii) General alarm
- iii) Blowout preventer control system if fitted on the installations
- iv) Public address system
- v) Distress and safety radio communications
- vi) All equipment in exterior locations that is capable of operation after activation of the prime mover/ventilation shutdown system, is to be suitable for installation in Class I, Division 2 (Zone 2) locations.

3.8 Portable and Semi-portable Extinguishers

- i) Locations, types and quantities of fire extinguishers provided for the production deck area are to be in accordance with 3.H/Table 1 and 3.H/Table 2.
- ii) For areas not specifically addressed in these tables, NFPA Standard 10 is to be followed.

Table 1. Portable and Semi-portable Extinguishers

<i>Classification Type & Size</i>	<i>Water Liters (Gallons)</i>	<i>Foam Liters (Gallons)</i>	<i>Carbon Dioxide Kilograms (Pounds)</i>	<i>Dry Chemical Kilograms (Pounds)</i>
A – II	9 (2.5)	9 (2.5)		5 (11) ⁽¹⁾
B – II		9 (2.5)	5 (11)	5 (11)
B – III		45 (12)	15.8 (35)	9.0 (20)
B – IV		76 (20)	22.5 (50) ⁽²⁾	22.5 (50)
B – V		152 (40)	45 (100) ⁽²⁾	22.5 (50) ⁽²⁾
C – II			5 (11)	5 (11)
C – III			15.8 (35)	9.0 (20)
C – IV			22.5 (50) ⁽²⁾	13.5 (30)

Notes:

1. Must be approved as a Type A, B, and C extinguisher
2. For outside use only, double the quantity of agent that must be carried.

Classification of Portable and Semi-portable Extinguishers

Fire extinguishers are designated by types as follows:

- A. For fires in combustible materials, such as wood
- B. For fires in flammable liquids and greases
- C. For fires in electrical equipment

Size of Portable and Semi-portable Extinguishers

- Fire extinguishers are designated by size, where size II is the smallest and size V is the largest.
- Size II is a portable extinguisher.
- Sizes III, IV and V are semi-portable extinguishers.

Table 2. Classification and Placement of Portable and Semi-portable Extinguishers

<i>SPACE</i>	<i>CLASSIFICATION</i>	<i>QUANTITY & LOCATION</i>
<i>SAFETY AREAS</i>		
Main control room	C - II	2 near the exit (See Note 1 on the next page)
Stairway and elevator enclosure	B - II	Within 3 m (10 ft) of each stairway on each deck level 1 in
Corridors	A - II	each main corridor, not more than 45 m (150 ft.) apart
Lifeboat embarkation & lowering stations	--	None required
Radio room	C - II	2 near the exit (See Note 1)
Paint store rooms	B - II	1 outside each room in vicinity of exit (See Note 2 on the next page)
Store rooms	A - II	1 for every 232 m ² (2500 ft ²) or fraction thereof, located in vicinity of exits, either inside or outside of spaces (See Note 2)
Workshop and similar spaces	C - II	1 outside each space in vicinity of an exit (See Note 2)
<i>ENCLOSED MACHINERY SPACES</i>		
Gas/oil-fired boilers : spaces containing gas/oil-fired boilers, either main or auxiliary, or their fuel oil units	B - II	2 required in each space
	B - V	1 required in each space
Internal combustion or gas turbine Machinery spaces	B - II	1 for every 745 kW (1,000 brake horsepower) but not less than 2 nor more than 6 in each space
	B - III	1 required in each space
<i>ENCLOSED AUXILIARY SPACES</i>		
Internal combustion engines or gas turbines	B - II	1 outside the space containing engines or turbines in vicinity of exit (See Note 2)
Electric emergency motors or gas turbines	C - II	1 outside the space containing motors or generators in vicinity of exit (See Note 2)
Steam drive auxiliary	--	None required
Fuel tanks	--	None required

Table 2. Classification and Placement of Portable and Semi-portable Extinguishers (continued)

<i>SPACE</i>	<i>CLASSIFICATION</i>	<i>QUANTITY & LOCATION</i>
<i>MISCELLANEOUS AREAS</i>		
Crane with internal combustion engines	B - II	1 required in vicinity of crane cab exit
Production areas	B - III or B - IV	(See Note 3)
Drilling areas	B - III or B - IV	(See Note 3)
Open Areas	B - II C - II	1 for every 3 internal combustion or gas turbine engines 1 for every 2 electric generators and motors of 3.7 kW (5 hp) or greater
Turret areas for internal turret	B - III or B - IV	One for each level of turret area
<i>CHEMICAL and FUELS with FLASH POINT BELOW 60°C ~ 140°F</i>		
Pump room	B - II	1 required in vicinity of exit (See Note 4)
Storage tank area	B - V	1 required on open deck capable of reaching the storage tanks, tank vents, and transfer connections (See Note 4 and Note 5)

Notes:

1. One of which must be placed inside (dry chemical extinguishers not recommended for these applications).
2. Vicinity is intended to mean within 1 m (3 ft).
3. One B-III or B-IV extinguisher is to be provided at every entrance to any escape route, under no circumstances are two (2) extinguishers to be placed more than 15.24 m (50 ft) apart.
4. For methanol, foam extinguishers may be considered if the extinguishers are of the polar solvent type foam (alcohol-resistant type)
5. Not applicable to integral crude oil tanks protected by a deck foam system as per 3.H.3.1.5.

4. Fire and Gas Detection and Alarm Systems**4.1. Fire Detectors**

- i)* Open or enclosed areas are to be provided with automatic fire detection such that all potential fire outbreak points are monitored.
- ii)* The automatic fire detection system will sound an alarm and initiate necessary shutdown functions for the facility.
- iii)* Guidelines for the selection and use of fire detectors are contained in API RP 14C, API RP 14F and API RP 14G.

4.2. Gas Detectors

4.2.1 Combustible Gases

- i)* In all enclosed and semi-enclosed areas that might accumulate combustible gases, gas sensors of an explosion (flame)-proof type are to be installed and operated in accordance with API RP 14C and API RP 14F, as applicable.
- ii)* Consideration is to be given to providing combustible gas sensors near points of a possible leak at process equipment and piping systems located in open areas.
- iii)* Sensors are also to be provided at fresh air inlets to non-classified areas.

4.2.2. Hydrogen Sulfide

Where hydrogen sulfide gas may be present in the well fluid in excess of 20 ppm, hydrogen sulfide gas detection systems are to be installed in accordance with API RP 55, as applicable.

4.2.3. Detector Set Points

- i)* The low and high gas alarm set points are to be at 20% L.E.L. and 60% L.E.L. for combustible gases, and 10 ppm and 50 ppm for hydrogen sulfide.
- ii)* Process safety shutdown functions are to be initiated upon high gas detection.

4.3. Smoke Detectors

A smoke detection and alarm system is to be provided for control rooms, switchgear rooms, and other areas where slow-developing fires might be expected.

4.4. Alarm Panel

- i)* A master fire and gas panel is to be provided to receive and process all fire and gas detection signals.
- ii)* The panel is to be located in the central control room or other normally manned non-classified area.
- iii)* The panel arrangement is to comply with Section 3.G.

4.5. Fire and Gas Detection Wiring

Wiring arrangement is to comply with Section 3.F.

4.6. General Alarm

- i)* Means are to be provided for manually activating a general alarm system capable of producing a distinctive audible sound in all areas of the facility.
- ii)* Alarm-actuating devices are to be located at points of egress from accommodation areas, process areas, and machinery spaces.
- iii)* Power for the general alarm system is to comply with Section 3.F.

5. Structural Fire Protection

5.1. General

The term “structural fire protection” refers to the passive method of providing fire protection to the spaces/compartments of the unit through the usage of fire divisions and the limitation of combustibles in the construction materials.

- i)* Maintaining the adequacy of the fire division includes proper protection of penetrations in those divisions, which includes electrical, piping, or ventilation systems penetrations.
- ii)* The structural fire protection requirements of this section are intended to address the need for fire protection of boundaries separating new and/or existing areas/spaces onboard the installation from the process facility equipment.
- iii)* For ship shape FPSOs, SOLAS requirements will be followed along with any additional or more

- stringent items in the IMO MODU Code.
- iv) Existing spaces that do not share common boundaries with the process facility equipment are to be treated based on the requirements that were in effect at the time of construction.
- v) Newly built spaces that do not share common boundaries with the process facility equipment and all portable/temporary living quarters are to comply with the latest Rule requirements.

5.2 Structural Fire Protection Requirements

- i) The minimum fire integrity of bulkheads and decks is to be as prescribed in 3.H/Table 3A and 3.H/Table 3B.
- ii) Windows and sidescuttles that face the production facilities are to possess a fire rating equivalent to the bulkheads in which they are fitted.

Table 3A. Fire Integrity of Bulkheads Separating Adjacent Spaces/Areas

<i>Spaces</i>		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Control Stations including Central Process Control Rooms	(1)	A-0	A-0	A-60	A-0	A-15	A-60	A-15	H-60 (d)	A-60	A-60	*	A-0	
Corridors	(2)		C	B-0	B-0 A-0 (b)	B-0	A-60	A-0	H-60 (d)	A-0	A-0	*	B-0	
Accommodation Spaces	(3)			C	B-0 A-0 (b)	B-0	A-60	A-0	H-60 (d)	A-0	A-0	*	C	
Stairways	(4)				B-0 A-0 (b)	B-0 A-0 (b)	A-60	A-0	H-60 (d)	A-0	A-0 *	*	B-0 A-0 (b)	
Service Spaces (low risk)	(5)					C	A-60	A-0	H-60 (d)	A-0	A-0	*	B-0	
Machinery Spaces of Category A	(6)						*	A-0 (a)	H-60 (d)	A-60	A-60	*	A-0	
Other Machinery Spaces	(7)							A-0 (a) (c)	H-0 (d)	A-0	A-0	*	A-0	
Process Areas, Storage Tank Areas, Wellhead/manifold Areas	(8)		Symmetrical							----	H-60 (d)	H-60 (d)	*	H-60 (d)
Hazardous Areas	(9)									----	A-0	*	A-0	
Service Spaces (high risk)	(10)										A-0 (c)	*	A-0	
Open Decks	(11)											----	*	
Sanitary and Similar Spaces	(12)												C	

Please see the notes under 3-H/Table 3B for further interpretations.

Table 3B. Fire Integrity of Decks Separating Adjacent Spaces/Areas

<i>Space Below ↓</i>	<i>Space → Above</i>		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Control Stations including Central Process Control Rooms	(1)	A-0	A-0	A-0	A-0	A-0	A-0	A-60	A-0	H-60 (d)	A-0	A-0	*	A-0
Corridors	(2)	A-0	*	*	A-0	*	A-60	A-0	H-60 (d)	A-0	A-0	*	*	
Accommodation Spaces	(3)	A-60	A-0	*	A-0	*	A-60	A-0	X	A-0	A-0	*	*	
Stairways	(4)	A-0	A-0	A-0	*	A-0	A-60	A-0	H-60 (d)	A-0	A-0	*	A-0	
Service Spaces (low risk)	(5)	A-15	A-0	A-0	A-0	*	A-60	A-0	H-60 (d)	A-0	A-0	*	A-0	
Machinery Spaces of Category A	(6)	A-60	A-60	A-60	A-60	A-60	* (a)	A-60	H-60 (d)	A-60	A-60	*	A-0	
Other Machinery Spaces	(7)	A-15	A-0	A-0	A-0	A-0	A-0 (a)	* (a)	H-0 (d)	A-0	A-0	*	A-0	
Process Areas, Storage Tank Areas, Wellhead/manifold Areas	(8)	H-60 (d)	H-60 (d)	X	H-60 (d)	H-60 (d)	H-60 (d)	H-60 (d)	----	----	H-60 (d)	----	H-60 (d)	
Hazardous Areas	(9)	A-60	A-0	A-0	A-0	A-0	A-60	A-0	----	----	A-0	----	A-0	
Service Spaces (high risk)	(10)	A-60	A-0	A-0	A-0	A-0	A-0	A-0	H-60 (d)	A-0	A-0 (c)	*	A-0	
Open Decks	(11)	*	*	*	*	*	*	*	----	----	*	----	*	
Sanitary and Similar Spaces	(12)	A-0	A-0	*	A-0	*	A-0	A-0	H-60 (c)	A-0	*		*	

Notes:

- If a space contains an emergency power source or components of an emergency power source, and adjoins a space containing a unit's service generator or components of a unit's service generator, the boundary bulkhead or deck between those spaces is to be an A-60 class division.
- For clarification as to which note applies, See Part 5. Offshore technology Volume IV section 10.B.4.5 and 4.7
- Where spaces are of the same numerical category and subscript (c) appears in the tables, a bulkhead or deck of the rating shown is only required when the adjacent spaces are for a different purpose. For example, in category (10), a galley next to another galley does not require a bulkhead, but a galley next to a paint room requires an A-0 bulkhead.
- If the results of a Risk Analysis or Fire Load Analysis (reviewed and accepted by BKI) justify such, an "A-60" fire division may be used in lieu of an "H-60" bulkhead. An "A-0" wall used in conjunction with a water curtain system designed to provide a density of at least 6.1 liters/min/m² (0.15 gpm/ft²) of exposed surface area may be used as an equivalent means of meeting the "A-60" class division.
- Intumescent coatings may be acceptable in providing the "H" rating. The intumescent coating used is to have limited flame spread properties, low smoke development and low heat generation. In addition, an assessment is to be made of the toxicity of gases emitted in the event of a fire. The condition (intactness) of the coatings will be the subject of surveyor inspection during attendance of the unit following normal survey intervals.

*Where an asterisk appears in the tables, the division is to be of steel or equivalent material, but is not required to be of an A-class standard. However, where a deck is penetrated for the passage of electric cables, pipes, and vent ducts, such penetrations are to be made tight to prevent the passage of flame and smoke.

Where an X appears in the table, the configuration is not allowed.

5.3 Wellhead Areas

- i)* “A-0” firewalls are to be used to provide protection from potential uncontrolled flare front wellheads with shut-in pressure exceeding 42 kg/cm² (600 psi).
- ii)* These firewalls are independent of the requirements for structural fire protection of spaces.
- iii)* The intent of these firewalls is to provide protection for escape routes, temporary refuges, lifeboat embarkation stations, fire pumps and potential fire hazards.
- iv)* The dimensions of the firewall and distance from the wellhead are to be determined based on the results from fire load calculations or other recognized method. See 3.C.3.4.

5.4 Fired Vessels

- i)* “A-0” firewalls are to be used to provide protection from potential fire hazard of fired vessels.
- ii)* These firewalls are independent of the requirements for structural fire protection of spaces.
- iii)* The intent of these firewalls is to provide protection for escape routes, temporary refuges, lifeboat embarkation stations, fire pumps and potential fire hazards.
- iv)* The dimensions of the firewall and distance from the direct-fired heaters are to be determined based on the results from fire load calculations or other recognized method. See 3.C.5.11.

5.5 Helideck

- i)* All helidecks are to be constructed of steel or other material which provides equivalent structural and fire integrity properties to that of steel.
- ii)* Helidecks which form the deckhead (roof) of the accommodations are to be insulated to an “A-60” class standard.
- iii)* If the helideck is located less than one (1) meter above the deckhouse top, the helideck is to be constructed to an “A” class standard.
- iv)* Deckhouse roofs (below the helideck) are to have no openings.

5.6. Ventilation

Standards for ventilation are to be in accordance with the requirements for ventilation as contained in the Part 5 Offshore Technology Volume IV Section 2.C, with the following additional requirements:

Non-ducted HVAC systems (i.e., those that use the plenum for return air) are discouraged. The use of a non-ducted system will need prior review of the design philosophy, taking into consideration the movement of smoke between spaces and the maintenance of “smoke free” escape routes. Prior design approval by BKI is mandatory before construction of such a system.

5.7. Penetrations

All penetrations through bulkheads and decks are to have the same fire integrity as the bulkhead and deck through which they penetrate. This is to be accomplished using BKI-established procedures with materials that have been approved by a major governmental maritime administration, or by approved procedures that have been tested.

5.8. Materials/Certification

All materials used in the construction of structural fire divisions and protection of the penetrations are to be certified for the fire rating in which they are fitted. This includes both structural fire protection and thermal insulation, joiner bulkheads, doors, HVAC ducts, flooring materials, windows, fire dampers, etc.

6. Muster Areas

6.1 General

All units are to have a designated muster station(s) where personnel can gather prior to entering the lifeboats.

6.2 Materials

- i) All materials that comprise the muster stations routes are to be of steel or equivalent material.
- ii) Fiber Reinforced Plastic (FRP) grating may be considered, provided all conditions listed in Appendix 3 are fully met and are accepted by the Flag Administration.

6.3 Muster Stations

- i) The muster station is to be of sufficient area to accommodate the number of personnel to be gathered.
- ii) The muster station is to be located in a safe location with respect to the processing equipment.
- iii) The muster station may be a meeting room inside the accommodations or may be part of the lifeboat *embarkation station*.

7. Means of Escape

7.1 General

- i) The escape route requirements of the applicable Rules and/or Regulations are to apply along with the requirements of 3.H.7.2, 3.H.7.4 and 3.H.7.5.
- ii) In the absence of escape route requirements by the applicable Rules and/or Regulations, the requirements of 3.H.7.2 through 3.H.7.5 apply.

7.2 Materials

- i) All materials that comprise the escape routes are to be of steel or equivalent material.
- ii) Fiber Reinforced Plastic (FRP) grating may be considered, provided all conditions listed in Appendix 3 are fully met and are accepted by the Flag Administration.

7.3 Escape Routes

- i) At least two (2) means of escape are to be provided for all continuously manned areas, and areas that are used on a regular working basis.
- ii) The two (2) means of escape must be through routes that minimize the possibility of having both routes blocked in an emergency situation.
- iii) Escape routes are to have a minimum width of 0.71 m (28 in.).
- iv) Dead-end corridors exceeding 7 m (23 ft) in length are not permitted.
- v) Dead-end corridors are defined as a pathway which (when used during an escape) has no exit.

7.4 Marking and Lighting of Escape Routes

Escape route paths are to be properly identified and provided with adequate lighting.

7.5 Escape Route Plan

- i) An escape route plan is to be prominently displayed at various points in/of the facility.
- ii) Alternatively, this information may be included in the Fire Control or Fire/Safety Plan.

8. Lifesaving Requirements

8.1. General

- i) The lifesaving appliance requirements of the applicable governmental regulations are to apply along with the requirements of 3.H.8.3.5 and 3.H.8.3.6.
- ii) In the absence of lifesaving appliance requirements by the applicable Regulations, or if no

Regulations exist, the requirements of 3.H.8.2 and 3.H.8.3 apply.

- iii)* Where the words “of an approved type” are indicated, the equipment is to meet the requirements of SOLAS or equivalent standard.
- iv)* Launching appliances for lifeboats and liferafts are also to meet the requirements of SOLAS or equivalent standard.

8.2. Lifeboat Embarkation Areas

- i)* All materials that comprise the lifeboat embarkation platform are to be of steel or equivalent material.
- ii)* Fiber Reinforced Plastic (FRP) grating may be considered, provided all conditions listed in Appendix 3 are fully met and are accepted by the Flag Administration.

8.3. Lifesaving Appliances and Equipment

8.3.1. Lifeboats

- i)* Lifeboats of an approved type are to be provided, with a total capacity to accommodate twice the total number of people onboard the subject unit.
- ii)* They are required to be installed on at least two (2) sides of the installation, in safe areas in which there will be accommodation for 100%, in case one of the stations becomes inoperable.

8.3.2. Liferafts

- i)* Inflatable liferafts of an approved type are to be provided onboard such that their total capacity is sufficient to accommodate the total number of people expected to be onboard the facility.
- ii)* Liferafts are to be placed in or next to areas where personnel may be working, in sufficient quantity to hold the maximum number of people that might be present in the area at any one (1) time.

8.3.3. Life Buoys

- i)* At least four (4) life buoys of an approved type, with floating water lights, are to be provided.
- ii)* One (1) ring life buoy is to be placed in a suitable rack on each side of the structure in an acceptable location.
- iii)* Multi-level structures may require the placement of additional life buoys.

8.3.4. Life Jackets

- i)* At least one (1) life jacket of an approved type, is to be provided for each person on a manned facility.
- ii)* Life preservers/work vests are to be stored in readily accessible locations.
- iii)* Life jackets numbering the same quantity as the maximum aggregate capacity of each life boat station must be stored next to the lifeboat station.

8.3.5. Work Vests

When personnel baskets are used to transfer personnel from the facility to work boats, or vice versa, a work vest is to be provided and kept with the personnel basket for each person riding in the basket.

8.3.6. Breathing Apparatus

- i)* For operations involving hydrogen sulfide, each person expected on the facility is to be provided with a self-contained breathing apparatus of an approved type for escape purposes.
- ii)* The breathing apparatus for maintenance personnel is to have a minimum of thirty (30) minutes air supply.
- iii)* A designated safe area with proper supply of air is also to be provided and shown on the fire control/safety plan.

8.4 Means of Embarkation

8.4.1 General

- i)* The means of embarkation requirements of the applicable Rules and/or Regulations are to apply.
- ii)* In the absence of means of embarkation requirements by the applicable Rules and/or Regulations, the requirements of 3.H.8.4.2 below apply.

8.4.2 Means of Embarkation

- i)* Each facility is to have means of embarkation to allow personnel to leave the facility in an emergency. These are in addition to the equipment described in 3.H.8.
- ii)* The means of embarkation are to consist of at least two (2) fixed ladders or stairways, widely separated, and extending from the main and cellar decks to the water line.
- iii)* The ladders or stairways will preferably be located near lifeboat-launching stations.
- iv)* Ladder construction is to be in accordance with the appropriate governmental authority, or other recognized standard.

9. Personnel Safety Equipment and Safety Measures

9.1 Fireman's Outfits

All fireman's outfits and equipment are to be of an approved type (i.e., equipment is to meet the requirements of SOLAS or equivalent standard).

The requirements below are in addition to those required by the applicable Rules and/or Regulations.

9.1.1 Fireman's Outfit

- i)* A minimum of two (2) sets of fire-fighting outfits and equipment is to be provided and stowed in a suitable container.
- ii)* The protective clothing is to be made of a material that will protect the skin from radiant heat of a fire, and be water-resistant.
- iii)* Boots and gloves are to be made of rubber or other electrically non-conducting material.
- iv)* The protective helmet is to be of rigid construction to resist impact, and be equipped with a face shield.
- v)* The fireman's outfits or sets of personal equipment are to be stored as to be easily accessible and ready for use, and where more than one (1) fireman's outfit or more than one (1) set of personal equipment is carried, they are to be stored in widely separated positions.
- vi)* One of the outfits should be readily accessible from the helicopter deck.

9.1.2 Breathing Apparatus

- i)* A minimum of two (2) self-contained breathing apparatus, of an approved type is to be provided and stowed with the fireman's outfits.
- ii)* There is to be an adequate number of spare compressed air charges.
- iii)* The breathing apparatus is to have a minimum of thirty (30) minutes air supply.

9.2 Guard Rails

- i)* The perimeter of all open deck areas, walkways around accommodation spaces, catwalks and openings, are to be protected with guardrails.
- ii)* The height of the guard rails is to be at least 1 m (39.5 in.) above the deck, except where this height would interfere with normal operation, in which case, a lesser height may be considered if adequate protection is provided.
- iii)* The opening below the lowest course of the guardrails is not to exceed 230 mm (9 in.).
- iv)* The other courses are not to have more than 380 mm (15 in.) of clear opening.

- v) Toe plates are to be provided at the base of all guardrails.

9.3 Insulation of Hot Surfaces

9.3.1 Personal Protection

All exposed surfaces with which personnel are likely to come in contact are to have temperatures that do not exceed 71°C (160°F). If this can not be achieved, then the exposed surfaces are to be insulated or shielded.

9.3.2 Spillage Protection

Surfaces with temperatures in excess of 204°C (400°F) are to be protected from contact with liquid hydrocarbon spillage and mist.

9.3.3 Combustible Gases

Surfaces in excess of 482°C (900°F) are to be protected from contact with combustible gases.

9.3.4. Protection of Insulation

Insulation is to be protected from weather, oil spillage, mechanical wear, and physical damage.

Section 4

Fixed Installation

A. General

1. Scope

This Section defines the minimum criteria for BKI Class applicable to hydrocarbon production and processing systems, subsystems and equipment on fixed installations. See 1.B.1 of this Rules for Scope and Conditions of Classification.

In the case of existing units (i.e., SEU - Self-elevating Units) built to meet the Rules for Mobile Offshore Unit (Part 5 – Offshore Technology, Volume 6), consideration may be given for marine systems on such units to continue to meet the Rules for Mobile Offshore Unit (Part 5 – Offshore Technology, Volume 6), when these units are converted to a fixed platform.

Terms, definitions, references, abbreviations and acronyms, used in this Section are defined in Section 2.

2. Applicability

The requirements described in this Section are applicable to facilities on fixed installations of various configurations that provide hydrocarbon production and processing services. These services may include:

- Well fluid de-pressurization
- Phase separation
- Fluid cleaning, treatment and stabilization
- Dehydration
- Compression
- Reinjection
- Transfer
- Storage
- Metering
- Off-loading of processed hydrocarbon

3. Conditions of Classification

Refer to the BKI Rules for Classification and Survey (Part 5 – Offshore Technology, Volume 1) and Section 1 of this Rules for information on Classification.

4. Design Considerations

4.1 Recognized Standards

The submitted design is to be in accordance with the requirements of these Rules and the specified codes and/or standards as referenced herein.

- i) Designs complying with other international or national standards not listed in Appendix 4 will be subject to special consideration in accordance with Section 1.D of this Rules.
- ii) BKI advises the designer/manufacturer to contact the BKI Head Office early in the design phase for acceptance of alternate design codes and/or standards.
- iii) When alternate design codes and/or standards are proposed, justifications can be achieved through equivalency, gap analysis or appropriate risk analysis/philosophy to demonstrate that the proposed alternate design code and/or standard will provide an equivalent level of safety to the recognized standards as listed in this Rule and are required to be performed in accordance with Section 1.D of this Rule.

4.2 Alternative Basis of Design

Designs based on manufacturer's standards may also be accepted. In such cases, complete details of the manufacturer's standard and engineering justification are to be submitted for review.

- i) The manufacturer will be required to demonstrate by way of testing or analysis that the design criteria employed results in a level of safety consistent with that of a recognized standard or code of practice.
- ii) Where strain gauge testing, fracture analysis, proof testing or similar procedures form a part of the manufacturer's design criteria, the procedure and results are to be submitted for BKI review.
- iii) Historical performance data for production or process systems, subsystems, equipment or components is to be submitted for justification of designs based on manufacturer's standards.
- iv) BKI will consider the application of risk evaluations for alternative or novel features for the basis of design in accordance with Section 1.D of this Rule, as applicable.

4.3 Design Conditions

The production and process systems, subsystems, equipment, and/or components are to be designed to account for all applicable environmental, operational, and test loads, or combination thereof. These include, but are not limited to, the following:

- i) Environmental Conditions, as applicable
 - Earthquake
 - Wind
 - Temperature
 - 1, 10, 50, 100 year storm event, as applicable
- ii) Operational
 - Static pressure
 - Transient pressure excursion
 - Temperature excursion
 - Fluid static head and properties
 - Tension
 - Bending
 - Vibration
- iii) Transportation
- iv) Installation
- v) Commissioning
- vi) Test Loads

B. Design Plans and Data

1. Submissions of Design Plans and Data

The following sections describe the design plans and data submission requirements for BKI Classing of fixed installations and associated hydrocarbon production and processing systems, subsystems, equipment and/or components.

- i) 4.B/Table 1 and 4.B.2 through 4.B.12, as applicable, identifies the hydrocarbon production and processing systems, subsystems, equipment and/or components that require approval for BKI Classification of the floating installations.
- ii) The submitted design plans and data are to be in accordance with the requirements of this Rule and the latest edition of the specified codes and/or standards, as referenced herein and Appendix 4, from contract date
- iii) The design plans and data, as specified in this Rule, are to be generally submitted electronically to BKI. However, hard copies will also be accepted.
- iv) All plan submissions originating from designers or manufacturers are understood to be made with the knowledge of the main contracting party.
- v) For production and processing systems, subsystems, equipment or components not listed in 4.B/Table 1 or 4.B.2 through 4.B.12, the designers or manufacturers should contact the appropriate BKI Head Office for guidance on technical and survey requirements and completion of the approval process.
- vi) All plan submissions originating from manufacturers are understood to be made with the cognizance of the main contracting party. A fee may be charged for the review of plans that are not covered by the contract of Classification.

It should be noted that due to the varying configurations of offshore production facilities, portions of these requirements may not be applicable to a given installation.

Table 1. Design Plans and Data Submission Requirements

BKI technical documentation requirements for classing facilities on fixed installations:

1. Facility Documentation
1. Project Specifications
2. General Arrangement and Equipment Layout Drawings
3. Area Classification and Ventilation Drawings
2. Hydrocarbon Production and Processing Systems
1. Process Flow Sheets
2. Heat and Mass Balance
3. Piping and Instrument Diagrams (P & ID's) for facility and each system or subsystem
4. Safety Analysis Function Evaluation (SAFE) Charts
5. Packaged Process Units
6. Process Equipment Documentation
7. Process Piping Specifications
8. Pressure Relief and Depressurization Systems
9. Flare and Vent Systems
10. Spill Containment, Closed and Open Drain Systems
11. Sub-sea Production Systems (optional)
3. Process and Platform Support Systems
1. Piping and Instrument Diagrams (P & ID's) for each system or subsystem
2. Equipment Documentation
3. Process Support Piping Specifications
4. Internal-Combustion Engines and Turbines
5. Cranes (Optional)
6. Ballast system (if applicable)
7. Bilge and drainage systems
8. Boiler feed water and condensate systems
9. Compressed air system
10. Cooling water systems
11. Exhaust piping (for boilers, incinerators and engines)
12. Fixed oxygen-acetylene system
13. Fuel oil systems, including storage tanks, drip trays and drains
14. Helicopter refueling system, fuel storage tank and its securing and bonding arrangements
15. Hydraulic and pneumatic systems
16. Lubricating oil systems
17. Sanitary system
18. Sea water systems
19. Vent, overflow and sounding arrangements
20. Steam systems
21. Steam piping analyses (as applicable)
22. Tank venting and overflow systems
23. All Class I and Class II piping systems not covered above

Table 1. Design Plans and Data Submission Requirements (continued)

4. Electrical Installations
1. Electrical One-line Diagrams
2. Short-Circuit Current Calculations
3. Coordination Study
4. Specifications and Data Sheets for Generators and Motors
5. Specifications and Data Sheets for Distribution Transformers
6. Details of Storage Batteries
7. Details of Emergency Power Source
8. Standard Details of Wiring Cable and Conduit Installation Practices
9. Switchboard and Distribution Panel
10. Panelboard
11. Installations in Classified Areas
12. Schematic Drawings - Hydraulic and Pneumatic Systems
13. Programmable Electronic Systems
14. FMEA or FMECA for Computer-Based System
5. Instrumentation and Control Systems
1. General Arrangements
2. Data Sheets
3. Schematic Drawings - Electrical Systems
6. Fire Protection and Personnel Safety
1. Firewater System
2. Water Spray (Deluge) Systems for Process Equipment
3. Foam Systems for Crude Storage Tanks
4. Fixed Fire Extinguishing Systems
5. Paint Lockers and Flammable Material Storerooms
6. Emergency Control Stations
7. Portable and Semi-Portable Extinguishers
8. Fire and Gas Detection and Alarm Systems
9. Fire and Gas Cause and Effect Chart
10. Structural Fire Protection (which indicates classification of all bulkheads for: quarters section, machinery spaces and processing facilities)
11. HVAC plan (including AHU location, duct layout, duct construction and bulkhead penetration details)
12. Joiner detail arrangement and structural fire protection material certification
13. Guard Rails
14. Escape and Egress Routes (may be included on the fire control plan or separate plan)
15. Muster stations
16. Lifesaving Appliances and Equipment Plan (escape routes must be indicated)
17. Insulation of Hot Surfaces
7. Specific Arrangements
1. Arrangements for Storage Tank Venting and Inerting
2. Arrangements for Use of Produced Gas as Fuel
8. Start-up and Commissioning Manual
9. Topside Structure and Structural Arrangements

2. Details

Plans and data for equipment and components are to provide the following, as applicable:

- i) Model and size
- ii) Design specifications, including design codes, standards, and references
- iii) Design parameters: loads, temperature, environmental conditions, etc.
- iv) Design analysis and/or calculations, as applicable
- v) Dimensional details and drawings
- vi) Fabrication details and welding configurations
- vii) Material specifications and material properties

3. Facility Documentation

3.1 Project Specifications

Project specifications are to provide the following, as a minimum:

- i) Brief descriptions of field location
- ii) Environmental conditions
- iii) Well shut-in pressure
- iv) Well fluid properties
- v) Production plans
- vi) Hydrocarbon (oil/gas) transportation arrangements

3.2 General Arrangement and Equipment Layout Drawings

General arrangement and layout drawings are to show:

- i) Arrangements and locations of living quarters, control rooms, and machinery spaces, including all entrances, exits and openings to these spaces.
- ii) Arrangements and locations of machinery, process equipment, cargo storage, etc.

3.3 Area Classifications and Ventilation Drawings

- i) Plans for area classifications and ventilation are to show, as applicable:
 - Extent of all Class I, Division 1 and 2, areas and spaces; or
 - Extent of all Class 1, Zone 0, Zone 1 and Zone 2 areas and spaces
- ii) Arrangements for ventilation of enclosed spaces, and
 - Locations of all ventilation inlets and outlets, with respect to the hazardous areas
 - Locations of all entrances, exits and openings, with respect to the hazardous areas.

3.4 Escape and Egress Route

Plans showing all escape and egress route on the complete facility.

3.5 Muster Locations

Plans showing all muster locations on the complete facility.

4. Hydrocarbon Production and Process Systems

4.1 General

To evaluate the process safety system, the assumptions as made by the designers and as provided in the following documents are to be submitted:

- Project Specification - See 4.B.4.1
- Process Flow Sheets - See 4.B.4.2
- Heat and Mass Balance - See 4.B.4.3

Although these documents will not be approved by BKI, they are critical to approval of the facility, and are to be kept for reference throughout the design review process.

4.2 Process Flow Sheets

Process flow sheets are to identify the following, as a minimum:

- i) Each process stream
- ii) Process equipment
- iii) Planned addition
- iv) Symbols used

4.3 Heat and Mass Balance

Heat and mass balance specification for each process stream under normal operating and upset conditions are to include the following, as a minimum:

- i) Flow rate
- ii) Composition
- iii) Conditions (temperature, pressure, and vapor/liquid ratio)

4.4 Piping and Instrument Diagrams (P & ID's)

P & ID's diagrams showing:

- i) Design, and operating conditions
- ii) Designation and size of all major process equipment
- iii) Piping class specifications (designation and size) for:
 - Piping
 - Valves
 - Pipe fittings and in-line equipment/components such as strainers, filters, etc.
 - Sensing and control instrumentation
- iv) Shutdown and pressure relief devices with set points
- v) Signal circuits
- vi) Set points for controllers
- vii) Continuity of all line pipes
- viii) Boundaries of skid units and process packages.

Safety Analysis Function Evaluation (S.A.F.E.) Charts (see 4.B.4.5) are preferably to be submitted in conjunction with the P & ID's.

4.5 Safety Analysis Function Evaluation (S.A.F.E.) Charts and Cause and Effect Matrix

4.5.1 S.A.F.E. Chart

S.A.F.E. chart is to list all process systems, subsystems, equipment, components and associated emergency support systems with their required instruments, controls, safety devices, and is to list the functions to be performed by each device. See API RP 14C and API RP 14J.

4.5.2 Cause and Effect Matrix

Cause and Effect Matrix establishes the relation between the causes of a hazardous event and the effects of that event. Cause-and-Effect Matrix is to list all causes and the associated resulting effect or event. Cause-and-Effect Matrix can also uncover the interdependencies between the initiating causes and the resultant event or events (effect). Cause and Effect Matrix can be in the form of table, chart, or diagram format.

4.6 Packaged Process Units

Packaged process units include, but are not limited to, the following:

- Dehydration
- Stabilizing
- Separation
- Vapor recovery
- Sweetening
- Gas compression for fuel or re-injection

Documentation requirements for packaged process units include:

- i) Skid arrangements and assembly drawings
- ii) P & ID's - See 4.B.4.4
- iii) S.A.F.E. Charts and Cause and Effect Matrix - See 4.B.4.5
- iv) Process equipment documentation - See 4.B.4.7
- v) Piping system documentation - See 4.B.4.8
- vi) Pressure relief and depressurization systems - See 4.B.4.9
- vii) Electrical one-line diagrams - See 4.B.7.1
- viii) Control schematic - See 4.B.8.3
- ix) Structural design calculations for skid units in dry condition with a center of gravity height of more than 1.5 m (5 ft) or a maximum operating weight in excess of 10 MT (metric ton) or 22.05 Kips.

4.7 Process Equipment Documentation

Complete design specification including, but not limited to, the following documents for verification of compliance to recognized codes and/or standards for equipment as listed in 4.B/Table 2, as applicable:

- i) Equipment technical specifications
- ii) Design data (data sheets) such as pressure, temperature, corrosion allowance, service conditions, external loads etc.
- iii) Design calculations or analysis
- iv) Details of pressure relief arrangement
- v) Dimensional details/drawings covering arrangements and details
- vi) Corrosion allowances
- vii) Material specifications
- viii) Weld details and welding procedure specifications and qualifications
- ix) Extent and method of non-destructive testing
- x) Test pressure
- xi) Factory acceptance test procedures

Table 2. Major Equipment Plans, Calculations and Technical Documentation for Class Requirements

	A	B	C
HYDROCARBON PRODUCTION PROCESS SYSTEMS AND EQUIPMENT			
Production/Process Pressure Vessels	X		
Fired Vessels	X		
Heat Exchangers	X		
Storage Tanks	X		
Meters, Strainers, Filters, And Other Fluid Conditioners			
< 254 mm (10 in.) and 10.54 kg/cm ² (150 psi)		X	
≥ 254 mm (10 in.) or 10.54 kg/cm ² (150 psi)	X		
Pumps			
< 7 kg/cm ² (100 psi) and 757 liters/min (200 gpm)		X	
≥ 7 kg/cm ² (100 psi) or 757 liters/min (200 gpm)	X		
Compressors			
< 7 kg/cm ² (100 psi) and 28.3 m ³ /min (1000 scfm)		X	
≥ 7 kg/cm ² (100 psi) or 28.3 m ³ /min (1000 scfm)	X		
Flowlines And Manifolds	X		
Scraper Launchers/Receivers	X		
Packaged Process Units	X		
Flare Systems	X		
Subsea Systems	X		
PROCESS SUPPORT SYSTEMS AND EQUIPMENT			
Pressure Vessels			
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)		X	
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X		

Heat Exchangers			
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)		X	
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X		
Pumps			X
Air Compressors		X	
Engines And Turbines			
< 100 kW (134 hp)		X	
≥ 100 kW (134 hp)	X		
Packaged Support Systems			
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)		X	
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X		
PLATFORM SUPPORT SYSTEMS and EQUIPMENT			
All systems, subsystems, equipment and components are to comply with Part 1. BKI Rules for Seagoing Ship			
ELECTRICAL SYSTEMS AND EQUIPMENT			
Generators			
< 100 kW (134 hp)			X
≥ 100 kW (134 hp)	X		
Motors			
< 100 kW (134 hp)			X
≥ 100 kW (134 hp)	X		
Distribution Transformers			X
Switchboard, MCC, Panel boards	X		
Storage Batteries	X		
INSTRUMENT AND CONTROL SYSTEMS			
Control Panels	X		
FIRE PROTECTION & SAFETY SYSTEMS and EQUIPMENT			
Fire Pumps		X	
Fire Pump Skid Package	X		
Alarm Panels		X	
Fixed Fire Extinguishing Systems (Nozzles, Controls, Bottles, etc.)	X		
Fire and Gas Detection Systems (Sensors, Panel, Cables, etc.)	X		
EQUIPMENT SKID STRUCTURE			
For modules that require design review, see, 3.C.4, 3.B.3.14, 3.B.7.11 and 4-B/4.6	X		

Index :

- A Technical specifications, data sheets, dimensional details/drawings, design calculations/analysis, including manufacturer's affidavit of compliance are to be submitted for BKI Head Office review.
- B Manufacturer's affidavit of compliance to the applicable codes and/or standards are to be submitted to BKI.
- C Documentations are to be verified by the attending Surveyor at the location of installation

4.8 Process Piping Specifications

Process piping line list to include, but not limited to, the following:

- i) Design specifications, such as pressure rating, temperature rating, service rating, etc.
- ii) Pipe and fitting material lists
- iii) Sizes
- iv) Calculations for pipe wall thickness, etc.

4.9 Pressure Relief and Depressurization Systems

Pressure relief valves and depressurization systems plans and data including, but not limited to:

- i) Design and capacity calculations
- ii) Sizes and arrangements
- iii) Set points
- iv) Materials

4.10 Flare and Vent System

Flare and vent system details including, but not limited to:

- i) Sizing and arrangements
- ii) Gas dispersion analysis including basis of analysis
- iii) Radiant heat intensities
- iv) Design calculations for blow-down rates
- v) Water seals and gas purging systems
- vi) Knockout drum sizing details
- vii) Details of flare tips
- viii) Details of pilots
- ix) Details for ignition system
- x) Details of pressure relief and depressurizations systems

In the case of proprietary flare tips, validation reports to supplement the radiant heat intensity values are to be specified and submitted.

4.11 Spill Containment, Closed and Open Drain Systems

Arrangements for spill containment, details of piping connections to all process equipment, sealing, and slope of drains are to be specified and submitted.

4.12 Sub-sea Production Systems (Optional)

Provide the following for subsea production systems to include, but not limited to, the following:

- i) Stress calculations for structural components
- ii) P & ID's - See 4.B.4.4
- iii) S.A.F.E. charts - See 4.B.4.5
- iv) Equipment technical specifications and data sheets - See 4.B.4.7
- v) Control schematics - See 3.2.15.5
- vi) Assembly drawings
- vii) Installation and operation procedures

5. Process and Platform Support Systems

Process and platform support systems include, but are not limited to, the following:

- i) Utility/Instrument Air System
- ii) Fuel/Instrument Gas System
- iii) Use of produced gas as fuel for process equipment
- iv) Purging System
- v) Fuel Oil System
- vi) Lubricating Oil System
- vii) Crude Oil Storage and Flammable Liquid Facility
- viii) Drainage System
- ix) Hydraulic System
- x) Sewage Treatment System
- xi) Chemical Injection System
- xii) Helicopter Refueling System
- xiii) Vent System
- xiv) Drain System
- xv) Platform Drilling Systems

- xvi) Heating and Cooling System
- xvii) Steam Systems
- xviii) Power Generations
- xix) Fresh Water
- xx) Cargo Handling System
- xxi) Sea Water System
- xxii) Drainage System
- xxiii) Inert Gas Supply
- xxiv) Oil Fired Inert Gas Generator

Plans and data requirements for process support systems are as follows:

5.1 Piping and Instrument Diagrams (P & ID's)

Piping and Instrument Diagrams (P & ID's) for each process support system. See 4.B.4.4.

5.2 Equipment Documentation

Equipment technical specifications, data sheets, drawings and supporting design calculations for each equipment component such as pressure vessels, heat exchangers, pumps and compressors. See 4.B.4.7.

5.3 Piping Specifications

Piping specifications, materials, sizes and pressure ratings for all pipes, valves and fittings, calculations for pipe wall thickness, and line list with design conditions. See 4.B.4.8.

5.4 Internal-Combustion Engines and Turbines

Technical specifications for internal-combustion engines and turbines to include, but not limited to the following:

- i) Types
- ii) Horsepower
- iii) Rated speed / revolutions per minute
- iv) Shutdown arrangements
- v) Manufacturer's affidavit of compliance verifying compliance with recognized standards

5.5 Cranes (Optional)

Technical specifications for cranes to include, but not limited to, the following:

- i) Dimensional details/drawings
- ii) Structural design calculations
- iii) Load rating chart
- iv) Test certificates for wire rope

6. Electrical Systems

6.1 Electrical One-Line Diagrams

Electrical one-line diagrams are to indicate, but not limited to, the following:

- i) Ratings of generators, transformers, motors, and other loads
- ii) Rated load current of each branch circuit
- iii) Type and size and temperature rating of cables
- iv) Rating or settings of circuit breakers, fuses, and switches
- v) Interrupting capacity of switchgear, motor control centers, and distribution panels

6.2 Short-circuit Current Calculations

To establish that the protective devices on the main and emergency switchboards have sufficient short-circuit breaking and making capacities, data are to be submitted giving:

- i) The maximum calculated short-circuit current in symmetrical r.m.s. and asymmetrical peak values available at the main bus bars
- ii) The maximum allowable breaking and making capacities of the protective device
- iii) Similar calculations are to be made at other points in the distribution system where necessary, to determine the adequacy of the interrupting capacities of protective devices.

6.3 Coordination Study

A protective device coordination study is to be submitted to include the following:

- i) The protective device coordination study is to consist of an organized time-current study of all protective devices in series.
- ii) The study is to be from the utilization equipment to the source for all circuit protection devices having different settings or time-current characteristics for long-time delay tripping, short-time delay tripping, and instantaneous tripping, where applicable.
- iii) Where an over-current relay is provided in series and is adjacent to the circuit protection device, the operating and time-current characteristics of the relay are to be considered for coordination.

6.4 Specifications and Data Sheets for Generators and Motors

6.4.1 100 kW and Over

For generators and motors of 100 kW (134 hp) and over, submit the following:

- i) Assembly drawings
- ii) Seating arrangements
- ii) Terminal arrangements
- iv) Designed ambient temperature, temperature rise
- v) Data for complete rating, and class of insulation
- vi) Shafts, coupling, coupling bolts, stator and rotor details
- vii) Weights and speeds for rotating parts

6.4.2 Less than 100 kW

For generators and motors under 100 kW (134 hp), submit nameplate data along with degree of enclosure.

6.5 Specifications and Data Sheets for Transformers

Submit the following documents for transformers:

- i) Rating
- ii) Class of insulation
- iii) Rated ambient temperature
- iv) Rated temperature rise
- v) Details of enclosure and standard to which manufactured

Test reports in accordance with the standard of construction are to be made available upon request.

6.6 Details of Storage Batteries

Details of storage batteries are to include, but not limited, the following:

- i) Arrangement
- ii) Ventilation
- iii) Corrosion protection
- iv) Types and capacities
- v) Conductors and charging facilities
- vi) Over-current protection
- vii) Reverse current protection

6.7 Details of Emergency Power Source

Submit location, arrangement, and services required to maintain the integrity of the facility in the event of primary power loss.

6.8 Standard Details of Wiring Cable and Conduit Installation Practices

Standards and procedures for wiring practices and details are to be submitted, and are to include, but not limited to, the following:

- i) Cable supports
- ii) Earthing details and connections
- iii) Bulkhead and deck penetrations
- iv) Cable joints and sealing
- v) Cable splicing
- vi) Watertight and explosion-proof connections to equipment
- vii) Bonding connections

6.9 Switchboard, Distribution Boards and Motor Control Centers

- i) Complete list and specifications for:
 - Materials
 - Manufacturer's name
 - Model number
 - Rating, size, and type
 - Testing laboratory's listing number (if any), or indication of construction standard for components, such as:
 - Switchboard enclosure
 - Circuit breakers
 - All types of fuses
 - Power and control wiring
 - Bus bars
 - Connectors and terminals
 - Power switches
- ii) An outline and details of the switchboard, to include:
 - Overall dimensions
 - Front view indicating instrumentation
 - Circuit breakers
 - Switches
 - Drip-shields
 - Hand-rail
 - Securing supporting details
- iii) Bracing arrangements and calculations to determine that bus bars and short runs of power cables are adequately braced to withstand the mechanical forces that the switchboard may be subjected to under fault conditions.
- iv) A complete wiring schematic, including type of wiring, size, and setting of protective devices.
- v) One-line schematic of the bus bars, indicating rating for each of the horizontal and vertical buses, the exact connection of circuit breakers to the bus bars, setting of the power circuit breakers and loads ampacities and power cable sizes, if available.
- vi) Actual bus bar arrangement of the horizontal, vertical, and ground buses, including:
 - Bus bar material
 - Size and rating
 - Separation distances between bus bars
 - Separation distances between bus bars and bare metal parts
- vii) Grounding details
- viii) If applicable, details of metal barriers provided to isolate bus bars, wiring, and associated components

6.10 Panelboard

The information as specified in 4.B.6.9i), ii), v) and vii) as applicable.

6.11 Installations in Classified Areas

List of all electrical equipment installed in classified areas, together with documentation issued by an independent accredited testing laboratory certifying suitability for intended services.

7. Instrumentation and Control Systems

7.1 General Arrangements

Submit layout plans for local controllers, central controllers, displays, printers, and other instrumentation and control devices.

7.2 Instrumentation List

Submit a list of instrumentation and control equipment, including monitoring, control, and alarm set points and ranges.

7.3 Schematic Drawings - Electrical Systems

Schematic drawings/details of electrical systems are to include types and sizes of electrical cables and wiring, voltage rating, service voltage and current, overload and short-circuit protection for the following systems:

- i) Process control panels
- ii) Emergency shut-down (ESD) panels
- iii) Intrinsically safe systems
- iv) Fire and gas detection and alarm panels
- v) Fire alarm circuits
- vi) Emergency generator or fire pump drive starting circuit

7.4 Schematic Drawings - Hydraulic and Pneumatic Systems

Submit system description of hydraulic and pneumatic control systems, including pipe sizes and materials, pressure ratings, and relief valve settings.

7.5 Programmable Electronic Systems

Submit the following documentation:

- i) Control philosophy
- ii) Schematic alarm
- iii) Monitoring and control arrangements
- iv) Redundancy arrangements
- v) Failure modes of the system components

See also API RP 14J.

8. Fire Protection and Personnel Safety

8.1 Firewater System

Firewater system plans are to include, but not limited to, the following:

- i) Pump and piping arrangements
- ii) Location of isolation valves
- iii) Locations of firewater stations
- iv) Details of fire pumps including pump drivers, pump capacity and pressure
- v) Hydraulic calculations for sizing of fire pump capacity and fire main.

8.2 Water Spray Systems for Process Equipment

Submit plans showing the arrangement for firewater piping and spraying nozzles, as well as detailed hydraulic calculations.

8.3 Foam Systems for Helicopter Facilities with Refueling Capabilities and for Crude Oil Storage Tanks (if provided)

Foam system plans are to indicate the arrangement for:

- i) Firewater supply

- ii) Foam supply and delivery
- iii) Type of foam and expansion ratio
- iv) Capacity calculations for areas protected

8.4 Fixed Fire Extinguishing Systems

Fixed fire extinguishing plans are to show the following:

- i) Arrangement for piping
- ii) Arrangement for spraying nozzles
- iii) Storage of the extinguishing medium
- iv) Details of control and alarm for release of the extinguishing medium
- v) Capacity calculations and discharge time calculations for areas protected

8.5 Paint Lockers and Flammable Material Storerooms

Submit plans and calculations showing details of fixed fire extinguishing systems for the paint lockers and flammable material storerooms.

8.6 Fire Control and Lifesaving Equipment Plan

Submit a fire control and lifesaving equipment plan. The plan is to include the following:

- i) *Portable and Semi-portable Extinguishers*. The plan is to include type(s), quantities, and locations of portable and semi-portable extinguishers for the platform.
- ii) *Fixed Fire Extinguishing Systems*. The plan is to show locations, controls, protected spaces/areas and types of extinguishing systems.
- iii) *Fire and Gas Detection and Alarm Systems*. The plan is to show:
 - The location and type of fire detectors and gas detectors
 - The location of indicating panel
- iv) *Emergency Control Stations*. The plan is to include location and equipment.
- v) *Lifesaving Appliances and Equipment*. The plan is to show types, capacity, quantity and location.
- vi) *Structural Fire Protection*. The plan is to show arrangements, locations and types of fire walls.
- vii) *Guard Rails and Escape Routes*. The plan is to show arrangement of protective guard rails, toe plates and means of escape from normally manned spaces.

8.7 Fire and Gas Detection and Alarm Systems

Plans are to indicate:

- i) Locations and details of power supplies
- ii) Sensors
- iii) Annunciation and indicating equipment
- iv) Set points of alarm systems
- v) Data sheets for detectors

8.8 Fire and Gas Cause and Effect Chart

Relate all fire and gas sensors to shutdowns, operation of fixed systems and fire control plans.

8.9 Insulation of Hot Surfaces

Submit details of insulation and shielding provided for personnel safety and fire protection.

9. Arrangements for Storage Tank Venting and Inerting

Submit arrangements for storage tank venting and inerting systems if the fixed installation has the crude storage capability.

10. Arrangements for Use of Produced Gas as Fuel

Submit piping and control arrangements for use of produced gas as fuel, showing details of double wall or ducting arrangements for the pipe runs in way of the safe space.

11. Start-up and Commissioning Procedures Manual

The manual outlined in Section 5, Section 1 is to be submitted for review as early as possible, prior to the commissioning of the platform.

12. Maintenance of Class Modifications

Details of modifications to machinery, piping, process equipment, etc., which may affect classification, are to be submitted for approval. Typically, these include the following:

- i) Equipment changes and modifications, including changes in alarms, instrumentation, and control schemes
- ii) Facility throughput changes and changes in feed and product compositions
- iii) Changes in operating conditions, including pressures, temperatures, flow rates, or process conditions different from those in the original process or mechanical design
- iv) Changes in pressure relief requirements due to factors such as increased process throughput, operation at higher temperatures or pressures, increased size of equipment, or addition of equipment
- v) Changes to process support systems, such as changes to chemical injection, gas dehydration, etc.

C. Hydrocarbon Production and Process Systems

1. General

1.1 Scope

The minimum criteria applicable to systems, subsystems, equipment and/or components for handling and processing produced hydrocarbons from completed wells are defined in Section 3. C of this Rule.

These requirements address process equipment such as process vessels, heat exchangers, fired heaters, compressors and pumps, as well as the associated piping, process control, and process safety systems.

The documentation requirements for design review are given in Section 4, B.

D. Process Support Systems

1. General

1.1. Scope

This Section provides requirements for the design and installation of process support systems on fixed installations.

Process support systems are utility and auxiliary systems that complement the hydrocarbon production and process systems. See 4.B.5 for list of typical process support systems.

Process support piping design criteria are to be in accordance with API RP 14E, ASME B31.3 or other recognized codes and/or standards.

General arrangement of these systems is to comply with API RP 14J, or other recognized codes and/or standard. The documentation requirements for design review are given in Section 4.B.

1.2. Applicability

Process support systems for fixed installations are to meet the requirements of Section 3. D, except as modified below.

2. Equipment Requirements

2.1. Pressure Vessels and Heat Exchangers

The designer of a fixed installation may not have to address issues arising from the motion of the floating installation.

The design of pressure vessels and heat exchangers for a fixed installation is to ensure that stresses due to external nozzle loads and moments, and stresses due to any other applicable external forces such as wind or seismic activity are within the limits allowed by the code. (See also 3.D.2.1 and 3.D.2.2.)

3. System Requirements

Platform piping design, selection of valves, fittings, are to be in accordance with API RP 14E, ASME B31.3, or other recognized standards.

3.1. Use of Produced Gas as Fuel

The requirements of 3.D.3.4 are applicable to all enclosed spaces, including spaces located on the production deck, that have boilers, inert gas generators, and combustion engines using produced gas as fuel.

3.2. Fuel Storage for Helicopter Facilities

3.2.1. Location

- i) Fuel storage and transfer facilities are to be remote or suitably isolated from areas that contain a source of vapor ignition, and are not to be located in the approach path of the helicopter.
- ii) The storage and transfer area is to be permanently marked as an area where smoking and open flames are not permitted.

3.2.2. Tank Construction

- i) Fuel storage tanks are to be of approved metal construction.
- ii) For pressurized tanks, the criteria for pressure vessels in 4.D. 2.1 above are to be followed.
- iii) The design and fabrication of atmospheric or low-pressure tanks are to be in accordance with *BKI Rules* or recognized international standard
- iv) Alternatively, the criteria for deep tanks as per the Part 1 – Seagoing Ship, Volume II Rules for Hull, Section 12 may be followed.
- v) Special attention is to be given to the design, mounting, securing arrangement, and electrical bonding of the storage tank and the fuel transfer system.

3.2.3. Tank Vents

- i) Tank vents are to be sized in accordance with API Standard 2000, “Venting Atmospheric and Low-Pressure Storage Tanks”.
- ii) Vent outlets are to be located so that vapors will disperse freely.

3.2.4. Remote Control

- i) Storage tank outlet valves are to be provided with a means of remote closure in case of fire.
- ii) Gray cast iron valves are not to be used as shutoff valves for fuel oil tanks.
- iii) Means are also to be provided for remote shutdown of the fuel transfer unit.

3.2.5. Containment

- i) A containment of at least 150 mm (6 in.) high is to be provided around the fuel storage area, including the pumping unit and associated piping, to contain spillage and retain fire extinguishing agents.
- ii) If the installation is designed with the fuel storage tank(s) cantilevered from the platform and arranged to be jettisoned, containment will be required only around the fuel-pumping unit.

3.2.6. Drain

Drainage is to be provided for the area enclosed by the containment and is to comply with the following:

- i) The area within the containment is to be sloped toward the drain line.
- ii) The drain line is to be led to a holding tank complying with 4.D.3.2.2 and 4.D.3.2.3.
- iii) The drain line cross-sectional area is to be at least twice that of the fuel storage tank outlet connection.

3.2.7. Containment with No Drainage

Containment not provided with drainage arrangements in accordance with the above is to be sized to contain the full volume of the fuel storage tank plus 150 mm (6 in.) of foam.

3.3. Sewage Treatment Systems

Government Authority is to be consulted for requirements of sewage discharge to the sea.

3.4. Vent System

- i) Vent pipes are to be fitted to all tanks and are to be located at the highest part of the tank.
- ii) Vents for fuel oil tanks are to be led to the weather.
- iii) Where tanks are to be filled by pump pressure, the aggregate area of the vents in the tank is to be at least 125% of the effective area of the filling line.
- iv) Vent outlets from fuel oil tanks are to be fitted with corrosion-resistant flame screens having a clear area through the mesh not less than the required area of the vent pipe and are to be located where the possibility of ignition of gases issuing from the vent outlets is remote.

3.5. Drainage System

- i) Efficient means are to be provided for draining water from all enclosed spaces where leakage or accumulation of water may be critical for structural strength or operation of equipment.
- ii) Drains from hazardous and non-hazardous areas are to be separated. See 3.D.3.3 and also 3.C.7.4 for reference.
- iii) Attention is to be directed to Governmental Authority requirements relative to the drain discharge to sea.

4. Crude Oil and Flammable Liquid Storage Facility Arrangement

The requirements of this Subsection apply to fixed installations that have storage capability for crude oil or flammable liquids, such as methanol, with a flash point of 60°C (140°F) or less. See 4.H.3.3 or 4.H.3.4.4 for applicable fire protection requirements.

4.1. Tank Venting Systems

- i) Where pressure/vacuum relief valves are fitted on crude oil storage tanks, pressure relief lines are to be connected to the low-pressure (less than 2.5 psig or 0.17 kg/cm²) flare header, or vented to a safe location.
- ii) The outlets of high velocity vents or free flow vents are to be located not less than 10 m (33 ft) from the air intakes and openings to spaces containing the sources of ignition.
- iii) Free flow vents are to be fitted with flame arresters.

4.2. Storage Tank Purging and Blanketing Systems

4.2.1. Purging and Blanketing

- i) On facilities equipped for storage of liquid hydrocarbons, a permanently installed inert gas system is to be provided for purging and tank blanketing.
- ii) Either inert gas or produced gas is to be used to maintain crude oil storage tanks with a positive

- pressure in relation to the surrounding atmosphere.
- iii) The storage tanks are to be previously purged with inert gas when produced gas is used for tank blanketing.
 - iv) Inert gas and produced gas used for tank blanketing are to be in accordance with 4.D.4.2.2, 4.D.4.2.3, 4.D.4.2.4, below and 4.D.4.3 and 4.D.4.4.

4.2.2. Oxygen Content and Monitor

- i) The oxygen content of the inert gas used is not to exceed 5% by volume.
- ii) Oxygen monitoring equipment is to be provided to monitor oxygen levels in the inert gas supply as well as in the storage facilities.

4.2.3. Capacity and Pressure

- i) The inert gas source is to be capable of supplying gas at a rate not less than 125% of the highest possible oil transfer rate.
- ii) The system is to be designed so that the maximum pressure which can be exerted on the tank(s) does not exceed 0.24 kg/cm² (3.5 psi).

4.2.4. Isolating Valves

Shutoff valves are to be fitted on both the suction and discharge connections for each blower, or at the inlet and outlet of the final pressure regulator in a stored gas system.

4.3. Inert Gas Supply

4.3.1. General

The inert gas may be treated flue gas from boiler(s) or from a separate inert gas generator. In all cases, automatic combustion control suitable for operation under all service conditions is to be fitted. The following specific requirements apply.

4.3.2. Demister

Demisters or equivalent devices are to be provided to minimize carryover of water from the scrubber and the deck water seal.

4.3.3. Gas-regulating Valve

The gas-regulating valve is to be arranged to close automatically when any of the following conditions occur:

- i) Loss of water pressure to deck seal(s)
- ii) Loss of control power

4.3.4. Blowers

When two (2) blowers are provided, the total required capacity of the inert gas system is preferably to be divided equally between the two (2) blowers, and in no case is one (1) blower to have a capacity less than 1/3 of the total capacity required.

4.4. Oil Fired Inert Gas Generators

4.4.1. Fire Protection

The space in which any oil fired inert gas generator is situated is to be protected with a fixed fire extinguishing system. See also 4.H.3.3.

4.4.2. Venting

Arrangements are to be made to vent the inert gas from oil fired inert gas generators to the atmosphere when the inert gas produced is off specification (e.g., during starting-up or in case of equipment failure).

4.4.3. Fuel Oil Shutdown

Automatic shutdown of the fuel oil supply to inert gas generators is to be arranged on predetermined limits being reached with respect to low water pressure or low water flow rate of the cooling and scrubbing arrangement, and with respect to high gas temperature.

E. Platform Support Systems

(See Section 3. E, as applicable)

F. Electrical Systems

1. Applicability

Electrical installations for all fixed installations are to meet the requirements of Section 3. F, except as modified as follows herein. They need not meet the requirements of the *Seagoing Ship Rules*.

2. Transformers

Fixed platforms need not comply with 3.F.5.2.

3. Switchgear

Fixed platforms need not comply with 3.F.6.6.

4. Hazardous Areas

Fixed platforms need not comply with 3.F.8.3.

5. Power Source Requirements

Fixed platforms need not comply with 3.F.11, provided they comply with the requirements listed below. This Subsection details minimum electrical power generation for operation. It is to be noted that governmental regulations may require reserve main power or an emergency power source in excess of these requirements.

5.1 Unmanned Facilities

5.1.1 Main Power

The main power source(s) is to be sufficient to maintain the maximum intended operational loads of the facility without need to use the emergency source of power.

5.1.2 Emergency Power

An emergency power source, independent of the facility's main power, is to be sufficient to supply services for navigational aids as required by the local Coastal Authority, but not for less than four (4).

5.2 Manned Facilities

5.2.1 Main Power

The main power source(s) is to be sufficient to maintain the maximum intended operational load of the facility.

5.3 Manned Facilities in Severe Environments

In areas of severe environment (See 2.A.5.5), sources of power for systems vital to safety, such as firefighting and protection of personnel from severe environmental effects, are to include at least the following:

5.3.1 Main Power

Two (2) main generators, each is to be capable of maintaining the operation of essential equipment on the platform.

5.3.2 Emergency Power

- i) An emergency source of power for systems vital to safety, firefighting and protection of personnel, is to be provided to supply the services as listed herein.
- ii) Provision for emergency power supply less than those listed herein will be considered, provided adequate technical justification is submitted.
- iii) Loads to be supplied by the emergency source of power are listed in 4.F.5.3.3 and 4.F.5.3.4.

5.3.3 Fire Pump

- i) Where both fire pumps, required by 4.H.3.1.2 of this Rules, are electric motor-driven one of these pumps is to be powered by the emergency source of power.
- ii) The emergency source of power is to have sufficient fuel for at least 18 hours of fire pump operation.

5.3.4 Other Loads

The following loads are to be powered by the designated emergency source of power:

- | | |
|---|---|
| i) Fire detection | 18 hours |
| ii) Gas detection | 18 hours |
| iii) Communication | 18 hours |
| iv) ESD system (if electric) | 18 hours |
| v) Paging and alarm system | 18 hours |
| vi) Emergency lighting from all spaces to all alternative egress points | 18 hours |
| vii) Electric blowout preventer control system | 18 hours |
| viii) Navigational aids | As required by the applicable Coastal Authority, but not less than 4 days |

6. Emergency Source of Power

Manned facilities on fixed installations in severe environment need not comply with 3.F.12, provided they comply with the requirements listed below.

6.1 General

An emergency source of power as required by 4.F.5 may be supplied by an emergency generator (3.F.12) or batteries (3.F.13). Installations are to be in accordance with section 5.6 of API RP 14F and the following:

6.2 Location

- i) The emergency power source is to be self-contained on the same platform or structure as the loads it supplies (unless the power source and loads are each on fixed platforms connected by a permanent means such as a bridge).

- ii) The emergency power source is to be installed in a safe space that is to be outside the space containing the main power source and other machinery spaces.

6.3 Operability

- i) Boundaries of spaces containing the emergency source(s) of power are to be insulated to not less than A-60 when these boundaries are common with any machinery space or hazardous area.
- ii) Emergency source of power is to be capable of starting and/or operating independently, whether hydrocarbon production and processing facilities are on stream or shut down.

G. Instrumentation and Control Systems

(See Section 3, Section 7)

H. Fire Protection and Personnel Safety

1. General

1.1 Scope

The fire protection and personnel safety features are to comply with this Section, NFPA Standards and Recommended Practices, and API RP 14G, as referenced herein.

Due to the varying configurations of offshore production facilities, fire protection requirements will vary accordingly.

This Section provides requirements for manned production facilities. The documentation requirements for design review are given in Section 4, B.

1.2 Governmental Authority

In addition to BKI Class requirements, depending on the unit's flag of registry and the unit's intended area of operation, the coastal state may have additional requirements/regulations which may need to be met; therefore, the appropriate governmental authorities are to be consulted for each installation.

1.3 Applicability

Fire protection and personnel safety features for fixed platforms and self-elevating units (SEU) which convert into fixed platforms are to meet this Section of this Rules.

2. Requirements for Fire Fighting Systems

The following are minimum requirements for fire fighting systems on fixed facilities:

2.1 Unmanned Platforms

- i) Portable fire extinguishers per 4.H.3.7
- ii) Fire detection systems per 4.H.4

2.2 Manned Production Platforms

All applicable requirements of Section 4.H of this Rules.

3. Fire Fighting Systems

3.1 Firewater System

Fixed water fire fighting systems are to be provided as follows:

3.1.1 Piping

3.1.1(a) General

- i) Water fire fighting systems are to be capable of maintaining a continuous supply in the event of damage to water piping.
- ii) Piping is to be arranged so that the supply of water could be from two (2) different sources.
- iii) Isolation valves are to be provided such that damage to any part of the system would result in the loss in use of the least possible number of hydrants, water spray branches, or foam water supplies. In most facility arrangements this will require a loop type fire main.
- iv) Connections of the primary and standby pump supplies are to be as remote from each other as possible.

3.1.1(b) Materials

- i) Materials rendered ineffective by heat are not to be used in firewater piping systems.
- ii) Resilient seated valves may be considered for use in firewater systems, provided the proposed valves are capable of passing an appropriate fire test acceptable to BKI (e.g., API 607, ISO 10497).
- iii) Additionally, the valves must be capable of being effectively closed even with the resilient seat damaged or destroyed, such that leakage through the closed valve is insignificant.
- iv) The leakage rate at the firewater pressure through the closed damaged-seated valves still permits the firewater to deliver at least two (2) jets of water at the required pressure.
- v) Non-metallic expansion joints may be considered for use in firewater systems, provided the proposed joints are capable of passing a recognized fire test such as ISO 19921/19922: 2005.
- vi) Similarly, flexible hoses may be considered for use in firewater systems, provided the proposed hoses are capable of passing a recognized fire test such as ISO 15540/ 15541.
- vii) All plastic piping materials are to meet Appendix 1 of this Rules.
- viii) Generally, plastic (GRP/FRP) materials used in firewater systems are to pass Level 1 fire endurance test. However, a plastic piping material that passes Level 3 fire endurance requirements in lieu of Level 1 requirements may be considered when conditions listed in 4.H.3.1.1(e) below are fully met.

3.1.1(c) Charging

- i) The firewater distribution system may be maintained in a charged or dry condition.
- ii) Where a system is maintained dry, relief devices and additional pipe bracing is to be considered to prevent damage to the piping system due to water hammer when the system is charged.
- iii) When plastic pipe that passes only Level 3 fire endurance test is used, the firewater system design is to be pressurized (wet main) and permanently in a charged condition.

3.1.1(d) Piping Maintenance.

- i) The distribution system is to be maintained such that internal and external corrosion of the piping is minimized.
- ii) In areas where the system is subject to freezing, steps are to be taken to prevent freezing. For instance, drains, circulation loops or other means may be provided for cold water protection.
- iii) If drains are provided, they are to be located at the lowest points in the system.

3.1.1(e) Additional System Requirements for Level 3 Plastic Pipe.

The following additional requirements are applicable to the plastic material piping that passes Level 3 in lieu of Level 1 fire endurance tests and is used in the fire main system.

- i) Plastic piping must be located on the exterior perimeter of the platform and shielded by primary structural members from potential sources of fire that may occur on or emanate from the platform.
- ii) Plastic piping must be located so that pooling of flammable liquids below the piping is not possible. A properly designed drainage system may be provided to mitigate the pooling of flammable liquid below the piping system.
- iii) The firewater system design is to be such that the plastic sections are continuously maintained in the wet condition.
- iv) The firewater system is to be equipped with an adequate number of isolation and cut-off valves such that, if a section of the system were to fail, it could be isolated and the remainder of the system would still be capable of supplying firewater.

3.1.2 Fire Pumps

3.1.2(a) General

- i) There are to be a minimum of two (2) independently driven and self-priming fire pumps.
- ii) The fire pumps, together with their respective source of power, fuel supply, electric cables, lighting, ventilation, piping and control valves, are to be located such that a fire in any one (1) location will not render both fire pumps inoperable.
- iii) One of the two (2) pumps is to be designated as the primary fire pump, and the other as the standby fire pump.
- iv) At least one of the pumps is to be diesel engine driven, unless the emergency power supply can supply the load for an electric motor driven pump.
- v) Fire pump installations are to be in accordance with NFPA 20, or an equivalent standard.

3.1.2(b) Capacity.

- i) The primary and standby fire pumps are each to be capable of supplying the maximum probable water demand for the facility.
- ii) The maximum probable water demand is the total water requirement for protection of the largest single fire area plus two (2) jets of firewater at a pressure of at least 5.3 kg/cm² (75 psi).
- iii) Multiple pump installations will be considered in lieu of a single primary and/or standby pump installation, provided they are arranged in such a manner that a fire in one (1) area would not reduce the available supply of firewater required to handle that fire, or such that if the largest pump is out of service for maintenance, the available supply of water would not be reduced below the maximum probable water demand.
- iv) A means is to be provided for periodic testing of each fire pump.
- v) For a typical fixed platform arrangement, the maximum probable water demand includes the water supply to the water spray system for a single fire on the production area as discussed above, plus two (2) jets of firewater. For detailed requirements of the water spray system, see 4.H.3.1.4 below.
- vi) To determine the maximum probable water demand, the fire risk areas on the production deck may be divided into fire zones.
 - a) If a fire is being considered in a single zone, the water supply for the water spray system is to be sufficient for that zone and adjacent zones.
 - b) The water spray system requirement may be ignored for adjacent zones if these zones are separated by a firewall (no less than A-60) or by an adequate distance between process equipment to justify such zoning. See 4.H/Figure 4.A for reference.
- vii) Note that the system emergency shutdown and the equipment blowdown may be considered a safe alternative to the water spray for low hydrocarbon liquid inventory equipment such as compressor units. See 4.H/Figure 4B for reference.
- viii) See 4.H/Figure 1 through 4.H/Figure 3 for typical arrangement of fire pumps on fixed installations.

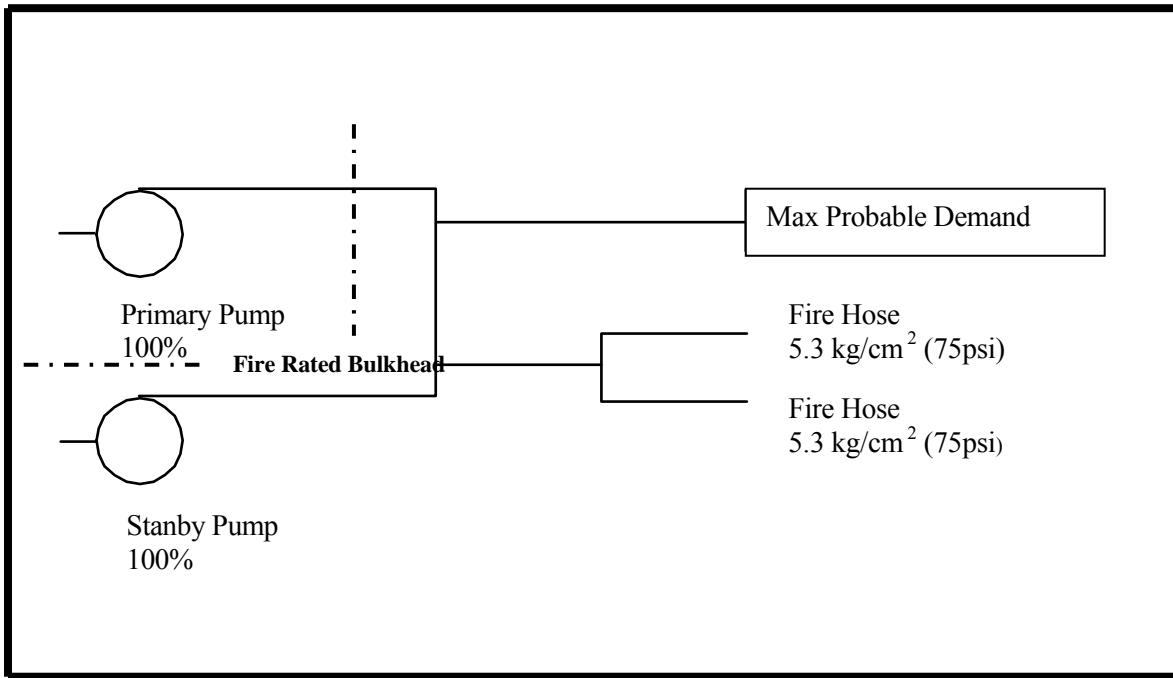


Fig. 1 Fixed Installation Fire Pump Arrangement Two-pump Scenario

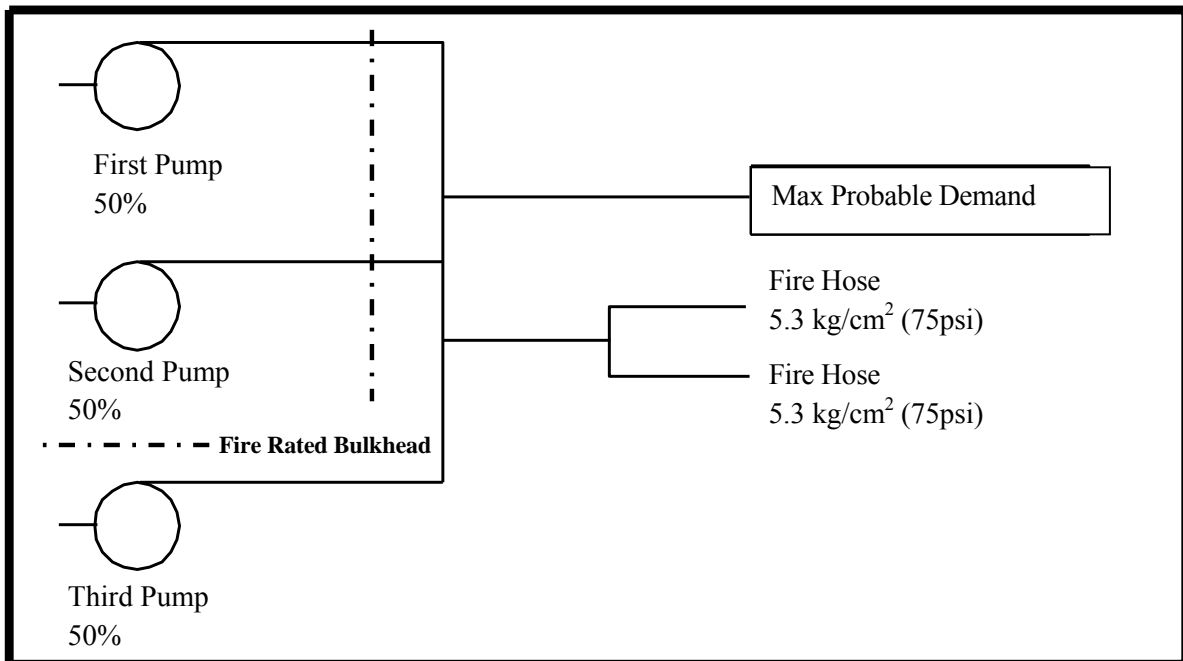


Fig. 2 Fixed Installation Fire Pump Arrangement Multiple-pump (Even Power) Scenario

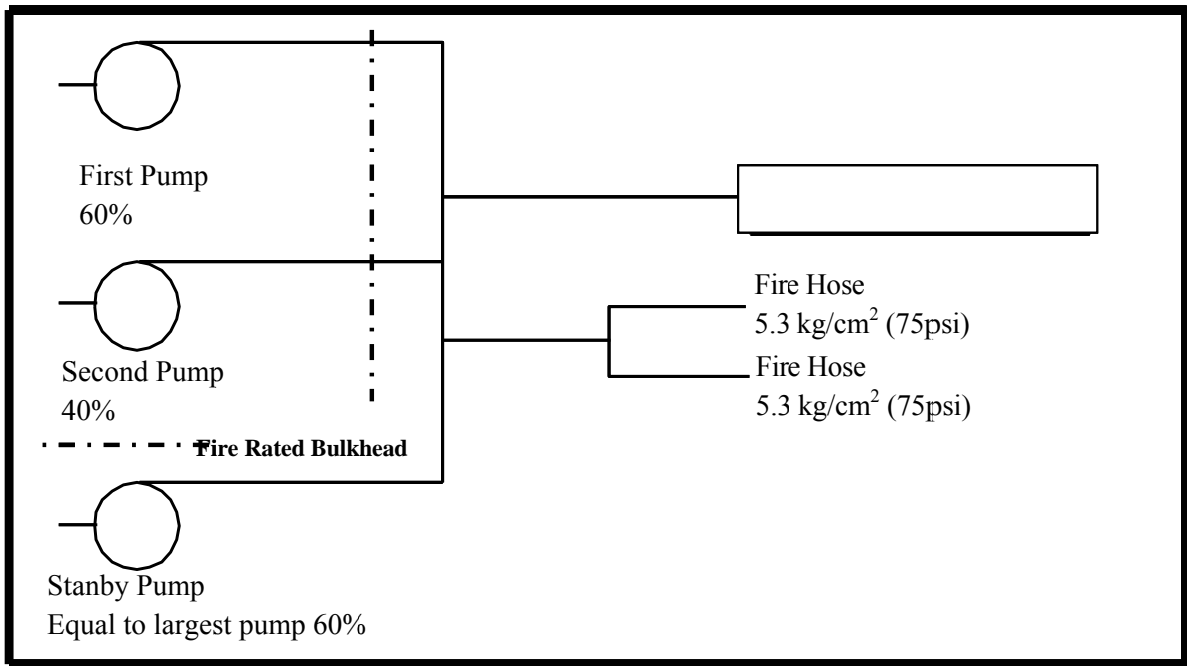


Fig. 3. Fixed Installation Fire Pump Arrangement Multiple-pump (Uneven Power) Scenario

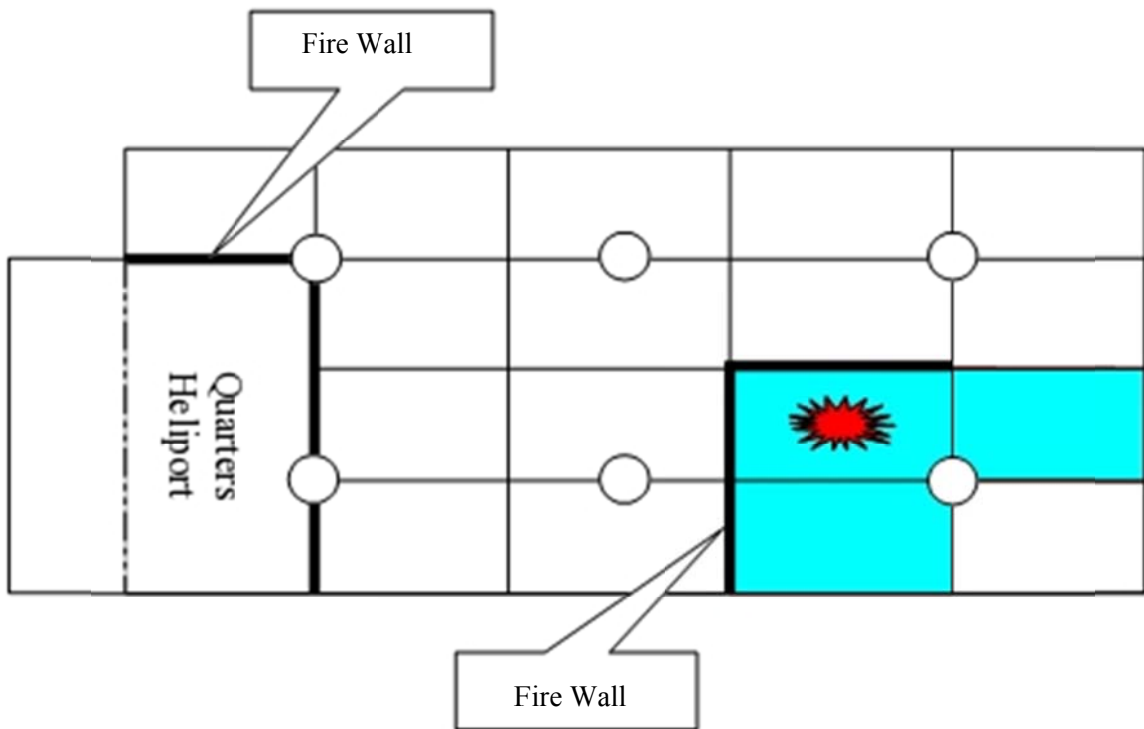
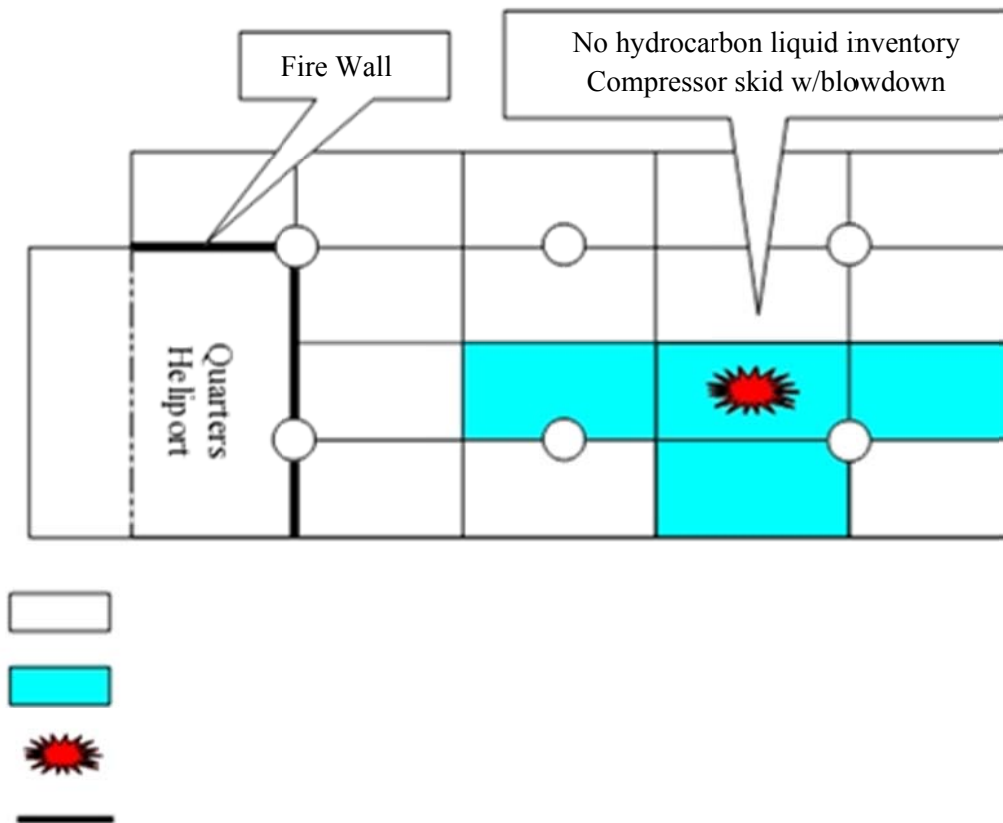


Fig. 4A. Typical Fire Zones Arrangement on Process Area of a Fixed Installation Single Fire with A-0 Fire Wall



**Fig. 4B. Typical Fire Zones Arrangement on Process Area of a Fixed Installation
Single Fire with an Adjacent Zone that has no Liquid Inventory**

3.1.2(c) Operability and Control

- i) Pump(s) with sufficient capacity for process water spray systems is (are) to be provided with automatic starting.
- ii) In addition to the pump automatic starting requirement, pump driver starters are to be provided with means for local and remote operation from a permanently manned station or a fire control station.
- iii) Pump discharge control valves, used to separate the section of the firewater service system and the fire pump(s), are to be fitted in an easily accessible location outside of the pump space.
- iv) Diesel-driven fire pumps may be provided with electrical or pneumatic starting and control systems.
- v) Diesel drives using electrical starting and control systems are to be maintained in a weather-protected enclosure.
- vi) Alternative means of protecting electrical starting and control system will be considered.

3.1.2(d) Pump Drivers

- i) Pump drivers may include diesel engines, natural gas engines, or electric motors.
- ii) The pump drivers are to be in general accordance with API RP 14G with respect to their types and installation requirements.
- iii) Fuel tanks, fuel lines to engines, and power cables and starters for electric motors, are to be protected against fire and mechanical damage.
- iv) Where diesel and natural gas engine fire pumps are considered, the arrangements are to comply with requirements of 3.D.2.5 and Section 4.F.
- v) For electrical motor-driven fire pumps, see Section 4.F for applicable requirements

3.1.2(e) Fuel Systems

- i) Fuel systems are to comply with the requirements of Section 4.D and 3.D.3.6.
- ii) Fuel supplies for diesel engines are to be sufficient for 18 hours operation.

3.1.2(f) Lift Columns

- i) Water lift columns are to be encased in pipe for protection against wave action and mechanical damage, and the protective pipe is to be securely attached to the structure in order to lessen wave action damage.
- ii) Corrosion allowance is to be considered when the water lift column is designed.
- iii) Where pipes for lift columns pass through floating structures, penetrations are to be made by approved methods to maintain the watertight integrity of the structure.
- iv) Intake strainers constructed of corrosion-resistant materials are to be fitted at the suction end of the fire pump's water lift column.

3.1.3 Firewater Stations

3.1.3(a) General

- i) Firewater stations are to be located so that each station will be readily accessible in the event of a fire.
- ii) All materials that comprise the firewater station and the access to firewater stations are to be of steel or equivalent material which would not be rendered ineffective by heat.
- iii) Fiber Reinforced Plastic (FRP) grating may be used if the layout is designed in accordance with Appendix 3, and provided that the FRP grating is approved as meeting the applicable criteria defined in same.

3.1.3(b) Arrangement

- i) Firewater stations are to be located on the perimeter of process areas.
- ii) The stations and their arrangements are to provide at least two (2) jets of water not emanating from the same fire station to reach any part of the production facility that may be exposed to fire.
- iii) The firewater stations are also to be arranged to provide protection against fire damage or mechanical damage, operation free from interference by other emergency activities, and effective coordination with other stations.

3.1.3(c) Monitors and Nozzles

- i) Monitors are to be sized for a minimum flow of 1,892 liters/min. at 7.3 kg/cm² (500 gpm at 100 psig).
- ii) Nozzles are to be adjustable from straight stream to full fog and to have a nozzle diameter of at least 12 mm (0.5 in.).
- iii) Monitors and nozzles are to be of corrosion-resistant materials, and/or be protected with a suitable coating to protect the equipment from the offshore environment.
- iv) All nozzles are to incorporate means for a shut-off.

3.1.3(d) Hoses

- i) Fire hoses located outside, in the production area, are to be of a non-collapsible type mounted on reels, and are to be certified by a competent independent testing laboratory as being constructed of non-perishable material to recognized standards.
- ii) The hoses are to be of material resistant to oil and chemical deterioration, mildew and rot, and exposure to the offshore environment.
- iii) They are to be sufficient in length to project a jet of water to any location in the areas where they may be required to be used.
- iv) Each hose is to be provided with a nozzle and the necessary couplings.
- v) The maximum length of hose is not to exceed 30 m (100 ft).
- vi) For hoses located in the living quarters areas, machinery spaces, or other enclosed areas, consideration is to be given to providing semi-automatic hose racks to permit one-man operation.

3.1.4 Water Spray (Deluge) Systems for Process Equipment

3.1.4(a) General

- i) A fixed water spray system is to be installed for the process equipment.
- ii) The intent of the water spray system is to keep the process equipment cool and reduce the risk of escalation of a fire.
- iii) Water spray systems are to be capable of being actuated both automatically by a fire detection system and manually.
- iv) Installations are generally to be in accordance with NFPA Standard 15, or other equivalent standard such as API Publication 2030.
- v) Deluge isolation valves are to be located in a safe area and outside the fire zone they protect.
- vi) Consideration will be given to the use of manual actuation alone, provided that the combined volume of process and storage vessels is less than 15 m³ (530 ft³), and the installation is manned on a 24-hour basis and the manual actuation station is readily accessible.

3.1.4(b) Materials.

All requirements in 4.H.3.1.1(b) are applicable, except the requirements for plastic piping materials, which are modified and listed below.

Plastic piping materials are to meet Appendix 1 of this Rules. Generally, plastic (GRP/FRP) materials used in water spray systems are to pass Level 1 fire endurance test. However, a plastic piping material that passes Level 3 Modified Test- Level 3 WD fire endurance requirements in lieu of Level 1 requirements may be considered when the following design conditions are fully met.

- i) Plastic piping is installed in open deck or semi-enclosed locations.
- ii) The water spray piping system must meet the Level 3 fire endurance requirements as specified in Appendix 1.
- iii) In addition to meeting the Level 3 fire endurance requirements, the water spray piping system must meet the requirements of the wet/dry fire endurance testing specified in Appendix 1.H. Other wet/dry fire endurance test methods that may be equivalent to or more severe than the methods described in Appendix 1.H will be considered on a case-by-case basis.
- iv) An automatic fire detection system is to be installed in areas protected by the water spray system.
- v) The water spray system is to be designed to activate automatically upon detection by the automatic fire detection system.
- vi) Each section or area served by a water spray system is to be capable of being isolated by one (1) water supply valve only. The stop valve in each section is to be readily accessible, and its location clearly and permanently indicated.
- vii) The design of the water spray system is to be such that upon fire detection, the time required to have water flowing through the hydraulically most remote nozzle is less than one (1) minute. This requirement will be verified by system testing at the time of installation and at subsequent annual inspections.
- viii) The water spray system piping is to be located downstream of the water supply valve. All piping upstream of the water supply valve is to meet the requirements for fire main and water spray systems as specified in Appendix 1, or be of metallic material.

3.1.4(c) Process Equipment.

- i) Process equipment, including hydrocarbon vessels, heat exchangers, fired heaters and other hydrocarbon handling systems, are to be protected with a water spray system.
- ii) The system is to be designed to provide a water density of 10.2 liters/min/m² (0.25 gpm/ft²) of exposed surface area for uninsulated vessels, or 6.1 liters/min/m² (0.15 gpm/ft²) of exposed surface area for insulated vessels.
- iii) Process equipment support structure, including saddles, skirt, legs, but not secondary deck structural members, is to be protected with a water spray system designed to provide a water density of 4.1 liters/min/m² (0.10 gpm/ft²).
- iv) Alternatively, the use of intumescent coatings may be acceptable in protecting the support structure, provided the selection of the fire rating of the coating is based on the results from a risk analysis and/or fire load calculation which must be reviewed and accepted by BKI.
- v) The condition (intactness) of the coatings will be the subject of surveyor inspection during attendance

of the unit following normal survey intervals.

- vi) For gas-handling equipment, such as gas compressor skids, where the hydrocarbon liquid inventory is kept minimal, a water spray system is not required if the equipment is provided with an automatic blowdown upon the process shutdown.

3.1.4(d) Wellhead Areas.

- i) Wellheads with maximum shut-in tubing pressures exceeding 42 kg/cm² (600 psi) are to be protected with a water spray system.
- ii) The water spray system is to be designed to provide a minimum water density of 20.4 liters/min/m² (0.50 gpm/ft²) based on the protection of wellheads, ESD valves, and critical structural components including the firewall.

3.1.5 Accommodation Sprinkler Systems

- i) For existing fixed installations where passive protection requirements are not fully met, the accommodation spaces are to be protected by an automatic wet pipe sprinkler system supplied from the firewater system.
- ii) Design of the system is to be based on NFPA Standard 13 requirements for light hazard occupancies, or other acceptable standards such as Chapter 8 of the International Code for Fire Safety Systems (FSS Code).
- iii) Fresh water is normally to be provided to fill the sprinkler piping. However, the system may be charged with seawater if precautions are taken to eliminate sediment and marine growth in the system.

3.2 Dry Chemical Systems

For production facilities with no liquid hydrocarbon storage capabilities and limited hydrocarbon liquid retention in processing equipment, dry chemical hose reel units may be used for fire fighting in lieu of firewater station required by 4.H.3.1.3 above.

Design of the dry chemical systems is to be in accordance with NFPA Standard 17.

3.3 Fixed Fire Extinguishing Systems

A fixed fire fighting system complying with 4.H.3.3.1, 4.H.3.3.2 or 4.H.3.3.3 is to be provided in each enclosed space and enclosed skid module containing the following equipment:

- i) Internal combustion machinery, including diesel and gas engines, having a total power output of not less than 750 kW (1000 hp)
- ii) Oil- or gas-fired boilers and other processes such as incinerators and inert gas generators
- iii) Oil fuel units. An oil fuel unit is defined as any equipment such as pumps, filters and heaters, used for the preparation and delivery of fuel oil to oil-fired boilers (including incinerators and inert gas generators), internal combustion engines or gas turbines at a pressure of more than 1.8 bar (26 psi).
- iv) Settling tanks for boilers
- v) Gas compressors
- vi) Transfer pumps for crude oil (storage facilities) and flammable liquid with low flash point (below 60°C~140°F) such as methanol.
- vii) If a fixed foam system is to be used for the methanol pump room and methanol tank space, the type of foam selected is to be suitable for use with methane (alcohol-resistant foams).

3.3.1 Gas Smothering Systems

3.3.1(a) General

- i) Storage
 - a) Smothering medium storage location is to be outside of protected space.
 - b) If gas bottles are kept in an enclosed compartment, the storage space is not to be used for purposes other than storing the bottles.
 - c) The storage space is also to be situated in a safe and readily accessible position, and be effectively ventilated by a ventilation system independent of other spaces, including the protected space.
- ii) Controls.
 - a) Automatic release of fire-extinguishing medium for total flooding systems is not permitted.
 - b) Two (2) separate controls are to be provided for releasing the fire-extinguishing medium into a protected space and to ensure the activities of the alarm.
 - c) One (1) control is to be used to discharge the gas from its storage containers.
 - d) A second control is to be used for opening the valve of the piping, which conveys the gas into the protected space. This requirement is not applicable if the system is provided for a single space and the protected space is relatively small (under 170 m³ or 6,000 ft³).
 - e) Controls are to be grouped together to provide complete actuation of the system from their location.
 - f) The number of release stations is to be limited to as few as possible, typically two (2), one (1) at the gas storage location and another outside of the protected space.
 - g) For the one outside of the protected space, it is to be located in proximity and along the main escape route of the space.
- iii) Alarms.
 - a) Means are to be provided for automatically giving audible warning of the release of fire-extinguishing gas into any space to which personnel normally have access.
 - b) The alarm is to operate for at least a 20-second period before the gas is released.
 - c) Alarms may be pneumatically (by the extinguishing medium or by air) or electrically operated.
 - d) If electrically operated, the alarms are to be supplied with power from the main and an emergency source of electrical power.
 - e) If pneumatically operated by air, the air supply is to be dry and clean and the supply reservoir is to be atomically kept charged at all times, and is to be fitted with a low-pressure alarm.
 - f) The air supply may be taken from the starting air receivers.
 - g) Any stop valve fitted in the air supply line is to be locked or sealed in the open position.
 - h) Any electrical components associated with the pneumatic system are to be powered from the main and an emergency source of electrical power.

3.3.1(b) Carbon Dioxide Systems.

- i) In addition to the above general requirements, the design philosophy of CO₂ fire extinguishing systems is to be in compliance with a single standard/code (i.e., Chapter 5 of the FSS Code, NFPA 12, or other recognized fire code).
- ii) Once a standard is chosen for a design basis, the standard is to be used throughout the design, and criteria from other standards may not be used.

3.3.1(c) Halon and Halon Alternative Systems

- i) Halon is not permitted in new installations.
- ii) Halon alternative systems are to meet IMO MSC Circ. 848 and general requirements above.
- iii) Halon alternative agents are to be accepted by the governmental authorities.

3.3.2 Foam Systems

3.3.2(a) Fixed High Expansion Foam Systems.

Fixed high expansion foam systems are to be in accordance with Chapter 6 of the FSS Code or other recognized fire code such as NFPA 11A. Note reference is made to the IMO MSC/Circular 670.

3.3.2(b) Fixed Low Expansion Foam Systems.

- i) Fixed low expansion foam systems may be installed in machinery spaces in addition to the required fixed fire extinguishing system.
- ii) Fixed low expansion foam systems are to be in accordance with Chapter 6 of the FSS Code or other recognized fire code such as NFPA 11. Note reference is made to the IMO MSC/ Circular 582.

3.3.3 Fixed Water Spray Systems

Fixed water spray systems are to be in accordance with Chapter 7 of the FSS Code or other recognized fire code such as NFPA 15.

3.4 Fire Fighting Requirements Pertaining to Specific Locations

3.4.1 Paint Lockers and Flammable Materials Storerooms

Paint lockers and flammable material storerooms are to be protected by a fixed fire extinguishing system. One of the following systems may be considered:

- i) CO₂ system designed for 40% of the gross volume of the space
- ii) Dry powder system designed for at least 0.5 kg /m³ (0.03 lb/ft³)
- iii) Water spray system designed for 5 liters/min/m² (0.12 gpm/ft²). The water spraying systems may be connected to the unit's fire main system.
- iv) Systems other than those mentioned above may also be considered.

3.4.2 Galley Range Hoods

- i) An automatic fire extinguishing system is to be provided for galley range hoods.
- ii) Design and installation of range hood systems are to be in accordance with NFPA Standard 96.

3.4.3 Helicopter Facilities

3.4.3(a) Helicopter Decks with no Refueling Capabilities

- i) Firewater Stations.
 - a) At least two (2) firewater stations are to be provided.
 - b) These fire stations are to be located so that the water supply would come from two (2) different directions.
 - c) Normally, they are located at the access routes to the helicopter deck.
 - d) The firewater stations may consist of hoses with adjustable nozzles and detachable applicators.
 - e) Adjustable nozzles are designed to provide both solid stream and water spray.
 - f) The hose stream discharge from each firewater station is to be sufficient to reach any part of the helicopter deck.
- ii) Extinguishers. The helicopter deck area is to be protected by two (2) approved dry chemical extinguishers of a total capacity of not less than 45 kg (100 lb).
- iii) Back-up System.
 - a) An additional back-up fire fighting system, consisting of CO₂ extinguishers of total capacity of not less than 18 kg (40 lbs) or equivalent, is to be provided.
 - b) One of these extinguishers is to be equipped so as to enable it to reach the engine area of any helicopter using the deck.
 - c) The back-up system is to be located where the equipment would not be vulnerable to the same damage as the equipment required in 4.H.3.4.3(a)i) and 4.H.3.4.3(a)ii) above.

3.4.3(b) Helicopter Decks with Refueling Capabilities

- i) Fire Fighting Equipment.
 - a) A fire fighting system as described in 4.H.3.4.3(a)i) through 4.H.3.4.3(a)iii) above is to be provided for the helideck area.
 - b) An additional dry chemical extinguisher is to be provided for the fuel storage area, having a

- capacity of 13.5 kg (30 lbs).
- ii) Foam System.
 - a) A foam fire extinguishing system is to be provided to protect the helicopter landing area and the fuel storage area.
 - b) The foam system may be an independent system, or be arranged to proportion foam into the firewater stations described in 4.H.3.4.3(a)i) above.
 - c) The helicopter landing area is the area contained within a circle of diameter D, where D is the distance in meters (feet) across the main rotor and tail rotor in the fore and aft line of a helicopter, with a single main rotor, and across both rotors for a tandem rotor helicopter, or the full area of the deck, whichever is less.
 - d) The fuel storage area includes the fuel storage tank and the dispensing hose reel.
 - e) The foam system is to be capable of delivering foam solution at a rate of 6.0 liters/min/m² (0.15 gpm/ft²) for protein foam, or 4.1 liters/min/m² (0.10 gpm/ft²) for Aqueous Film Forming Foam (AFFF) of the areas protected, for at least 5 minutes.
 - iii) Fueling System. The arrangement of the helicopter fueling system is to be in accordance with Section 4.D.

3.4.4 Foam Systems for Crude Storage Tanks

- i) For fixed installations with crude oil storage capabilities, a fixed foam system is to be provided for all crude storage tanks. Chapter 14 of the FSS Code may be used as design guidance.
- ii) If process equipment is located or supported above crude storage areas in such a manner that a deck foam system may be obstructed by steel supporting members, foam applicators or fixed systems may be considered as an alternative.
- iii) Deck foam system coverage in way of process equipment supports is to be no less effective than other tank deck areas.

3.5 Emergency Control Station

- i) At least (2) two emergency control stations are to be provided.
- ii) One of the stations is to be located in a normally manned space such as the process control room, or near the drilling console if the facility is fitted with drilling and work over systems.
- iii) The other is to be at a suitable location outside of the hazardous area.
- iv) The emergency control stations are to be provided with the following:
 - a) Manually operated switches for actuating the general alarm system
 - b) An efficient means of communication with locations vital to the safety of the installation
 - c) Manual activation of all well and process system shutdowns (3.C.4.2.4 and 3.C.5)
 - d) Means for shutdown, either selectively or simultaneously, of the following equipment, except for electrical equipment listed in 4.H.3.6 below:
 - 1) Ventilating systems, except for prime movers
 - 2) Main generator prime movers
 - 3) Emergency generator prime movers

3.6 Operation after Facility Total Shutdown

The following services are to be operable after a facility's total shutdown:

- i) Emergency lighting required for evacuation from service/accommodation spaces and machinery spaces to embarkation stations. This includes lighting at all control stations, stowage positions for firemen's outfits, helicopter landing deck, alleyways, stairways and exits, embarkation station deck, launching appliances, and the area of water where they are to be launched, etc. The lighting is to be provided for thirty minutes.
- ii) General alarm
- iii) Blowout preventer control system if fitted on the installations
- iv) Public address system
- v) Distress and safety radio communications
- vi) All equipment in exterior locations which is capable of operation after activation of the prime mover/ventilation shutdown system, is to be suitable for installation in Class I, Division 2 (Zone 2) locations.

3.7 Portable and Semi-portable Extinguishers

Locations, types, and quantities of fire extinguishers provided for the production deck area are to be in accordance with 4.H/Table 1 and 4.H/Table 2.

For areas not specifically addressed in these tables, NFPA Standard 10 is to be followed.

Table 1 Portable and Semi-portable Extinguishers

CLASSIFICATION TYPE & SIZE	WATER (LITERS)	FOAM (LITERS)	CARBON DIOXIDE (KILOGRAMS)	DRY CHEMICAL (KILOGRAMS)
A-II	9	9		5 ⁽¹⁾
B-II		9	5	5
B-III		45	15.8	9
B-IV		76	22.5 ⁽²⁾	22.5
B-V		152	45 ⁽²⁾	22.5 ⁽²⁾
C-II			5	5
C-III			15.8	9
C-IV			22.5 ⁽²⁾	13.5

Notes:

- 1 Must be approved as a Type A, B, and C extinguisher
- 2 For outside use only, double the quantity of agent that must be carried.

Classification of Portable and Semi-portable Extinguishers

Fire extinguishers are designated by types as follows:

- A For fires in combustible materials, such as wood
- B For fires in flammable liquids and greases
- C For fires in electrical equipment

Size of Portable and Semi-portable Extinguishers

- Fire extinguishers are designated by size, where size II is the smallest and size V is the largest.
- Size II is a portable extinguisher.
- Sizes III, IV and V are semi-portable extinguishers.

Table 2. Classification and Placement of Portable and Semi-portable Extinguishers

<i>SPACE</i>	<i>CLASSIFICATION</i>	<i>QUANTITY & LOCATION</i>
<i>SAFETY AREAS</i>		
Main control room	C-II	2 near the exit (See Note 1 on the next page)
Stairway enclosure	B-II	Within 3 m (10 ft) of each stairway on each deck level 1 in each main corridor, not more than 45 m (150 ft.) apart
Lifeboat embarkation & lowering stations	--	None required
Radio room	C-II	2 near the exit (See Note 1)
<i>ACCOMMODATIONS</i>		
State rooms (cabins)	A-II	One in each room occupied by more than 4 persons
Toilet spaces, lockers small storerooms, pantries	--	None required
<i>SERVICE SPACES</i>		
Galleys	A, B, C-II	1 A-B-C fire classed for every 232 m ² (2500 ft ²) or fraction thereof, suitable for hazards involved
Paint storerooms	B-II	1 outside each room in vicinity of exit (See Note 2 on the next page)
Storerooms	A-II	1 for every 232 m ² (2500 ft ²) or fraction thereof, located in vicinity of exits, either inside or outside of spaces (See Note 2)
Workshop and similar spaces	C-II	1 outside each space in vicinity of an exit (See Note 2)
<i>ENCLOSED MACHINERY SPACES</i>		
Gas/oil-fired boilers: spaces containing gas/oil-fired boilers, either main or auxiliary, or their fuel oil units	B-II	2 required in each space
Internal combustion or gas turbine machinery spaces	B-V	1 required in each space
	B-II	1 for every 745 kW (1,000 brake horsepower) but not less than 2 nor more than 6 in each space
	B-III	1 required in each space
<i>ENCLOSED AUXILIARY SPACES</i>		
Internal combustion engines or gas turbines	B-II	1 outside the space containing engines or turbines in vicinity of exit (See Note 2)
Electric emergency motors or gas turbines	C-II	1 outside the space containing motors or generators in vicinity of exit (See Note 2)
Steam drive auxiliary	--	None required
Fuel tanks	--	None required
<i>MISCELLANEOUS AREAS</i>		
Helicopter landing decks	B-V	1 at each access route
Helicopter fueling facilities	B-IV	1 at each fuel transfer facility
Cranes with internal combustion engines	B-II	1 required in vicinity of crane cab exit
Production areas	B-III or B-IV	(See Note 3)
Drilling areas	B-III or B-IV	(See Note 3)
Open areas	B-II	1 for every 3 internal combustion or gas turbine engines
	C-II	1 for every 2 electric generators and motors of 3.7 kW (5 hp) or greater
<i>CHEMICALS AND FUELS WITH FLASH POINT BELOW 60°C~140°F</i>		
Pump room	B-II	1 required in vicinity of exit (See Note 4)
Storage tank area	B-V	1 required on open deck capable of reaching the storage tanks, tank vents, and transfer connections (See Note 4 and Note 5)

Notes:

- 1 One of which must be placed inside (dry chemical extinguishers not recommended for these applications).
- 2 Vicinity is intended to mean within 1 m (3 ft).
- 3 One B-III or B-IV extinguisher is to be provided at every entrance to any escape route, under no circumstances are two (2) extinguishers to be placed more than 15.24 m (50 ft) apart.
- 4 For methanol, foam extinguishers may be considered if the extinguishers are of the polar solvent type foam (alcohol-resistant type)
- 5 Not applicable to integral crude oil tanks protected by a deck foam system as per 4.H.3.4.4.

4. Fire and Gas Detection and Alarm Systems

4.1 Fire Detectors

- i) Open or enclosed areas are to be provided with automatic fire detection such that all potential fire outbreak points are monitored.
- ii) The automatic fire detection system will sound an alarm and initiate necessary ESD functions for the facility.
- iii) Guidelines for the selection and use of fire detectors are contained in API RP 14C and API RP 14G.

4.2 Gas Detectors

4.2.1 Combustible Gases

- i) In all enclosed and semi-enclosed areas that might accumulate combustible gases, gas sensors of an explosion (flame)-proof type are to be installed and operated in accordance with API RP 14C and API RP 14F, as applicable.
- ii) Consideration is to be given to providing combustible gas sensors near points of a possible leak at process equipment and piping systems located in open areas.
- iii) Sensors are also to be provided at fresh air inlets to non-classified areas.

4.2.2 Hydrogen Sulfide

Where hydrogen sulfide gas may be present in the well fluid in excess of 20 ppm, hydrogen sulfide gas detection systems are to be installed in accordance with API RP 55, as applicable.

4.2.3 Detector Set Points

- i) The low and high gas alarm set points are to be 20% L.E.L. and 60% L.E.L. for combustible gases, and 10 ppm and 50 ppm for hydrogen sulfide.
- ii) ESD functions are to be initiated upon high gas detection.

4.3 Smoke Detectors

A smoke detection and alarm system is to be provided for control rooms, switchgear rooms, and other areas where slow-developing fires might be expected.

4.4 Alarm Panel

- i) A master fire and gas panel is to be provided to receive and process all fire and gas detection signals.
- ii) The panel is to be located in the central control room or other normally manned non-classified area.
- iii) The panel arrangement is to comply with Section 3.G.

4.5 Fire and Gas Detection Wiring

Wiring arrangement is to comply with Section 4.F.

4.6 General Alarm

- i) Means are to be provided for manually activating a general alarm system capable of producing a distinctive audible sound in all areas of the facility.
- ii) Alarm-actuating devices are to be located at points of egress from accommodation areas, process areas, and machinery spaces.
- iii) Power for the general alarm system is to comply with Section 4.F.

5. Structural Fire Protection

5.1 General

The term “structural fire protection” refers to the passive method of providing fire protection to the spaces/compartments of the unit through the usage of fire divisions and the limitation of combustibles in the construction materials.

- i) Maintaining the adequacy of the fire division includes proper protection of penetrations in those divisions, which includes electrical, piping, or ventilation systems penetrations.
- ii) The structural fire protection requirements of this Subsection are intended to address the need for fire protection of boundaries separating new and/or existing areas/spaces onboard the installation from the process facility equipment.
- iii) In addition, it is the intention of this rules to ensure that separate accommodations platforms, where attached to the production facility via a bridge, are sufficiently protected so they may serve as the emergency muster area or “safe haven” for personnel on the facility.
- iv) Existing spaces that do not share common boundaries with the process facility equipment are to be treated based on the requirements that were in effect at the time of construction.
- v) Newly built spaces that do not share common boundaries with the process facility equipment and all portable/temporary living quarters are to comply with the latest Rule requirements.
- vi) Spaces/Compartments that have been newly built or that have been modified internally either to enlarge or to change the function of that space (category change) are to comply with the latest Rule requirements.

5.2 Fire Integrity of Bulkheads and Decks

- i) The minimum fire integrity of bulkheads and decks is to be as prescribed in 4.H/Table 3A and 4.H/Table 3B.
- ii) Windows and sidescuttles that face the production facilities are to possess a fire rating equivalent to the bulkheads in which they are fitted.

Table 3A Fire Integrity of Bulkheads Separating Adjacent Spaces/Areas

<i>Spaces</i>		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Control Stations including Central Process Control Rooms	(1)	A-0	A-0	A-60	A-0	A-15	A-60	A-15	H-60 (d)	A-60	A-60	*	A-0	
Corridors	(2)		C	B-0	B-0 A-0 (b)	B-0	A-60	A-0	H-60 (d)	A-0	A-0	*	B-0	
Accommodation Spaces	(3)			C	B-0 A-0 (b)	B-0	A-60	A-0	H-60 (d)	A-0	A-0	*	C	
Stairways	(4)				B-0 A-0 (b)	B-0 A-0 (b)	A-60	A-0	H-60 (d)	A-0	A-0 *	*	B-0 A-0 (b)	
Service Spaces (low risk)	(5)					C	A-60	A-0	H-60 (d)	A-0	A-0	*	B-0	
Machinery Spaces of Category A	(6)						* _(a)	A-0 (a)	H-60 (d)	A-0	A-60	*	A-0	
Other Machinery Spaces	(7)		(Symmetrical)						A-0 (a) (c)	H-0 (d)	A-0	A-0	*	A-0
Process Areas, Storage Tank Areas, Wellhead/manifold Areas	(8)								----	H-60 (d)	H-60 (d)	*	H-60 (d)	
Hazardous Areas	(9)									---	A-0	*	A-0	
Service Spaces (high risk)	(10)										A-0 (c)	*	A-0	
Open Decks	(11)											---	*	
Sanitary and Similar Spaces	(12)												C	

Please see the notes under 4.H/ Table 3B for further interpretations

Table 3B Fire Integrity of Decks Separating Adjacent Spaces/Areas

<i>Space below ↓</i>	<i>Spaced above →</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Control Stations including Central Process Control Rooms	(1)	A-0	A-0	A-0	A-0	A-0	A-60	A-0	H-60 (d)	A-0	A-0	*	A-0
Corridors	(2)	A-0	*	*	A-0	*	A-60	A-0	H-60 (d)	A-0	A-0	*	*
Accommodation Spaces	(3)	A-60		*		*	A-60	A-0	X	A-0	A-0	*	*
Stairways	(4)	A-0	A-0	A-0	*	A-0	A-60	A-0	H-60 (d)	A-0	A-0	*	A-0
Service Spaces (low risk)	(5)	A-15	A-0	A-0	A-0	*	A-60	A-0	H-60 (d)	A-0	A-0	*	A-0

Machinery Spaces of Category A	(6)	A-60	A-60	A-60	A-60	A-60	*	A-60	H-60 (d)	A-60	A-60	*	A-0
Other Machinery Spaces	(7)	A-15	A-0	A-0	A-0	A-0	A-0 (a)	*	H-0 (d)	A-0	A-0	*	A-0
Process Areas, Storage Tank Areas, Wellhead/ manifold Areas	(8)	H-60 (d)	H-60 (d)	X	H-60 (d)	H-60 (d)	H-60 (d)	H-60 (d)	---	---	H-60 (d)	---	H-60 (d)
Hazardous Areas	(9)	A-60	A-0	A-0	A-0	A-0	A-60	A-0	---	---	A-0	---	A-0
Service Spaces (high risk)	(10)	A-60	A-0	A-0	A-0	A-0	A-0	A-0	H-60 (d)	A-0	A-0 (c)	*	A-0
Open Decks	(11)	*	*	*	*	*	*	*	---	---	*	---	*
Sanitary and Similar Spaces	(12)	A-0	A-0	*	A-0	*	A-0	A-0	H-60 (c)	A-0	*		*

Notes:

- (a) If a space contains an emergency power source or components of an emergency power source, and adjoins a space containing a unit's service generator or components of a unit's service generator, the boundary bulkhead or deck between those spaces is to be an A-60 class division.
 - (b) For clarification as to which note applies, see Part 5. Offshore technology Volume IV section 10.B.4.5 and 4.7.
 - (c) Where spaces are of the same numerical category and subscript (c) appears in the tables, a bulkhead or deck of the rating shown is only required when the adjacent spaces are for a different purpose. For example, in category (10), a galley next to another galley does not require a bulkhead, but a galley next to a paint room requires an A-0 bulkhead.
 - (d) If the results of a Risk Analysis or Fire Load Analysis (reviewed and accepted by BKI) justify such, an "A-60" fire division may be used in lieu of an "H-60" bulkhead. An "A-0" wall used in conjunction with a water curtain system designed to provide a density of at least 6.1 liters/min/m² (0.15 gpm/ft²) of exposed surface area may be used as an equivalent means of meeting the "A-60" class division.
 - (e) Intumescent coatings may be acceptable in providing the "H" rating. The intumescent coating used is to have limited flame spread properties, low smoke development and low heat generation. In addition, an assessment is to be made of the toxicity of gases emitted in the event of a fire. The condition (intactness) of the coatings will be the subject of surveyor inspection during attendance of the unit following normal survey intervals.
- * Where an asterisk appears in the tables, the division is to be of steel or equivalent material, but is not required to be of an A-class standard. However, where a deck is penetrated for the passage of electric cables, pipes, and vent ducts, such penetrations are to be made tight to prevent the passage of flame and smoke.

Where an X appears in the table, the configuration is not allowed.

5.2.1 "B" Class Divisions

- i) All bulkheads required to be "B" class divisions are to extend from deck to deck and to the deckhouse side or other boundaries, unless continuous "B" class ceilings or linings are fitted on both sides of the bulkhead, in which case the bulkhead may terminate at the continuous ceiling or lining.
- ii) In corridor bulkheads, ventilation openings may be permitted only in and under the doors of cabins, public spaces, offices and sanitary spaces. These openings are to be provided only in the lower half of the door.
- iii) Where such an opening is in or under a door, the total net area of such opening(s) is not to exceed 0.05 m².
- iv) When such an opening is cut in a door, it is to be fitted with a grille constructed of non-combustible materials. Such openings are not to be provided in a door in a division forming a stairway enclosure.

5.2.2 Stairways

Stairways are to be constructed of steel or equivalent material.

5.2.3 Stairway Protection

- i) Stairways, that penetrate only a single deck, are to be protected at least at one level by “A” or “B” class divisions and self-closing doors so as to limit the rapid spread of fire from one deck to another.
- ii) Personnel lift trunks are to be protected by “A” class divisions.
- iii) Stairways and lift trunks that penetrate more than a single deck are to be surrounded by “A” class divisions and protected by self-closing doors at all levels.
- iv) Self-closing doors are not to be fitted with hold-back hooks. However, hold-back arrangements incorporating remote release fittings of the fail-safe type may be utilized.

5.2.4 Draft Stops

Air spaces enclosed behind ceilings, paneling or linings are to be divided by close-fitting draft stops spaced not more than 14 m apart.

5.2.5 Insulation Materials

- i) Except for insulation in refrigerated compartments, insulation material, pipe and vent duct lagging, ceilings, linings and bulkheads are to be of non-combustible material.
- ii) Insulation of pipe fittings for cold service systems and vapor barriers and adhesives used in conjunction with insulation need not be non-combustible, but they are to be kept to a minimum and their exposed surfaces are to have low flame spread characteristics.
- iii) In spaces where penetrations of oil products are possible, the surfaces of the insulation are to be impervious to oil or oil vapors.
- iv) The framing, including grounds and the joint pieces of bulkheads, linings, ceilings and draft stops, are to be of non-combustible material.

5.2.6 Exposed Surfaces

- i) All exposed surfaces in corridors and stairway enclosures, and surfaces in concealed or inaccessible spaces in accommodation and service spaces and control stations, are to have low flame spread characteristics.
- ii) Exposed surfaces of ceilings in accommodation and service spaces and control stations are to have low flame spread characteristics.

5.2.7 Veneers

- i) Bulkheads, linings and ceilings may have combustible veneers, provided the thickness of such veneers does not exceed 2 mm within any space other than corridors stairway enclosures and control stations where the thickness is not to exceed 1.5 mm.
- ii) Alternatively, veneers that have a calorific value not exceeding 45 mJ/m² of the area for the thickness used may be accepted irrespective of the thickness of those veneers.

5.2.8 Deck Coverings

Primary deck coverings, if applied, are to be of an approved material which will not readily ignite or give rise to toxic or explosive hazards at elevated temperatures.

5.2.9 Paints, Varnishes and Other Finishes

Paints, varnishes and other finishes used on exposed interior surfaces are not to offer an undue fire hazard and are not to be capable of producing excessive quantities of smoke.

5.3 Wellhead Areas

- i) “A-0” firewalls are to be used to provide protection from potential uncontrolled flare front wellheads with shut-in pressure exceeding 42 kg/cm² (600 psi).
- ii) These firewalls are independent of the requirements for structural fire protection of spaces.
- iii) The intent of these firewalls is to provide protection for escape routes, temporary refuges, lifeboat embarkation stations, fire pumps and potential fire hazards.
- iv) The dimensions of the firewall and distance from the wellhead are to be determined based on the results from fire load calculations or other recognized method. See 3.C.3.3.

5.4 Fired Vessels

- i) “A-0” firewalls are to be used to provide protection from potential fire hazard of fired vessels.
- ii) These firewalls are independent of the requirements for structural fire protection of spaces.
- iii) The intent of these firewalls is to provide protection for escape routes, temporary refuges, lifeboat embarkation stations, fire pumps and potential fire hazards.
- iv) The dimensions of the fire wall and distance from the direct fired heaters are to be determined based on the results from fire load calculations or other recognized method. See 3.C.3.5.

5.5 Helideck

- i) All helidecks are to be constructed of steel or other material which provides equivalent structural and fire integrity properties to that of steel.
- ii) Helidecks which form the deckhead (roof) of the accommodations are to be insulated to an A-60 class standard.
- iii) If the helideck is located less than one (1) meter above the deckhouse top, the helideck is to be constructed to an “A” class standard.
- iv) Deckhouse roofs (below the helideck) are to have no openings.

5.6 Ventilation

Standards for ventilation are to be in accordance with the requirements contained in this Paragraph. Ventilation systems are to be designed with an intent on maintaining structural fire divisions.

5.6.1 Non-Ducted HVAC Systems

- i) Non-ducted HVAC systems (i.e., those that use the plenum (concealed space between the ceiling and overhead deck) for return air) are discouraged.
- ii) The use of a non-ducted system will need prior review of the design philosophy, taking into consideration the movement of smoke between spaces and the maintenance of “smoke-free” escape routes. Prior design approval is mandatory before construction of such a system.

5.6.2 Air Balance Ducts

- i) The use of air balance ducts (“jumper ducts”) is not allowed in “A” Class Division or “B” Class Divisions that are required to extend deck to deck.
- ii) Air balance ducts are also not to serve corridors.

5.6.3 Ventilation Duct Material

Ventilation ducts are to be of non-combustible material. Short ducts, however, not generally exceeding 2 m (78.5 in.) in length and with a cross-sectional area not exceeding 0.02 m² (31 in²), need not be non-combustible, subject to the following conditions:

- i) These ducts are to be of a material which has a low fire risk;
- ii) They may only be used at the end of the ventilation device;
- iii) They are not to be situated less than 600 mm, measured along the duct, from where it penetrates any “A” or “B” class division, including continuous “B” class ceilings.

5.6.4 Ventilation Ducts Passing Through "A" Class Divisions

Where ventilation ducts with a cross-sectional area exceeding 0.02 m² (31 in²) pass through class "A" bulkheads or decks, the opening is to be lined with a steel sheet sleeve unless the ducts passing through the bulkheads or decks are of steel in the vicinity of penetrations through the deck or bulkhead; the ducts and sleeves at such places are to comply with the following:

- i) The ducts or sleeves are to have a thickness of at least 3 mm and a length of at least 900 mm (35.4 in.).
 - a) When passing through bulkheads, this length is to be divided, preferably into 450 mm (17.7 in.) on each side of the bulkhead.
 - b) These ducts, or sleeves lining such ducts, are to be provided with fire insulation.
 - c) The insulation is to have at least the same fire integrity as the bulkhead or deck through which the duct passes.
- ii) Ducts with a cross-sectional area exceeding 0.075 m², (116 in²), except those serving hazardous areas, are to be fitted with fire dampers in addition to meeting the requirements of the above paragraph [4.H.5.6.4i)].
 - a) The fire damper is to operate automatically, but must also be capable of being closed manually from both sides of the bulkhead or deck.
 - b) The damper is to be provided with an indicator, which shows whether the damper is open or closed.
 - c) Fire dampers are not required, however, where ducts pass through spaces surrounded by "A" class divisions, without serving those spaces, provided those ducts have the same fire integrity as the divisions which they pierce.

5.6.5 Ventilation of Machinery Spaces of Category A, Galleys and Hazardous Areas

Ventilation ducts serving machinery spaces of Category A, galleys or hazardous areas are not to pass through accommodation spaces, services spaces or control stations.

Except for ventilation ducts serving hazardous areas, ducts serving machinery spaces of Category A or galleys may pass through accommodation spaces, control stations and galleys if the ducts are:

- i) Constructed of steel having a thickness of:
 - a) Minimum of 3 mm (0.12 in.), for ducts of 300 mm (11.8 in.) in width or less, and
 - b) Minimum of 5 mm (0.20 in.), for ducts of 760 mm (30 in.) in width and over;In the case of ducts the width or diameter of which is between 300 mm (11.8 in.) and 760 mm (30 in.), the thickness is to be obtained by interpolation; and
- ii) Fitted with automatic fire dampers close to the boundaries penetrated; and
- iii) Insulated to "A-60" standard from the machinery spaces or galleys to a point at least 5 m (197 in.) beyond each fire damper; or constructed of steel in accordance with 4.H.5.6.4i) above; and
- iv) Insulated to "A-60" standard throughout the accommodation spaces, service spaces or control stations.

5.6.6 Ventilation of Accommodation Spaces, Service Spaces or Control Stations

Ventilation ducts serving accommodation spaces, service spaces or control stations are not to pass through machinery spaces of Category A, galleys or hazardous areas.

Except for hazardous areas, ventilation ducts serving the accommodation spaces, service spaces or control stations may pass through machinery spaces of Category A or galleys, provided that:

- i) Where they pass through a machinery space of category A or a galley, the ducts are constructed of steel in accordance with 4.H.5.6.5i) above, and
- ii) Automatic fire dampers are fitted close to the boundaries penetrated; and
- iii) The integrity of the machinery space or galley boundaries is maintained at the penetrations ; or where they pass through a machinery space of category A or a galley, the ducts are constructed of steel in accordance with 4.H.5.6.5i) above; and
- iv) Are insulated to "A-60" standard within the machinery space or galley.

5.6.7 Ventilation Ducts Passing through "B" Class Division

Ventilation ducts with a cross-sectional area exceeding 0.02 m² (31 in²) that pass through “B” class bulkheads are to be lined with steel sheet sleeves of 900 mm (35.4 in) in length, divided preferably into 450 mm (17.7 in) on each side of the bulkhead, unless the duct is of steel for this length.

5.6.8 Galley Ventilation

5.6.8(a) Separation of Galley Ventilation.

- i) Galley ventilation system is to be separate from the ventilation system serving accommodation spaces. This can be achieved by using separate air-handlers and dedicated duct work for the galley ventilation which is not common with rest of the accommodations.
- ii) Alternatively, a dual discharge system may be acceptable, provided the two (2) systems are completely independent.

5.6.8(b) Galley Exhaust Ducts.

Where they pass through accommodation spaces or spaces containing combustible materials, the exhaust ducts from galley ranges are to be of equivalent fire integrity to “A” class divisions. Each such exhaust duct is to be fitted with the following:

- i) A grease trap readily removable for cleaning;
- ii) A fire damper located in the lower end of the duct;
- iii) Arrangements, operable from within the galley, for shutting off the exhaust fans; and
- iv) Fixed means for extinguishing a fire within the duct.

5.6.9 Main Inlets and Outlets

The main inlets and outlets of all ventilation systems are to be capable of being closed from outside the spaces being ventilated.

5.6.10 Means of Stopping Ventilation

- i) Power ventilation of accommodation spaces, service spaces, control stations, machinery spaces and hazardous areas is to be capable of being stopped from an easily accessible position outside the space being served.
- ii) The accessibility of this position in the event of a fire in the spaces served is to be specially considered.
- iii) The means provided for stopping the power ventilation serving machinery spaces or hazardous areas is to be entirely separate from the means provided for stopping ventilation of other spaces.

5.6.11 Prevention of Ingress of Flammable, Toxic or Noxious Gases

The ventilation of the accommodation spaces and control stations is to be arranged in such a way as to prevent the ingress of flammable, toxic or noxious gases, or smoke from surrounding areas.

5.6.12 Jumper Ducts

Jumper ducts provided for air balances between adjacent spaces are only acceptable in “C” class divisions.

5.7 Penetrations

All penetrations through bulkheads and decks are to have the same fire integrity as the bulkhead and deck through which they penetrate. This is to be accomplished using an BKI accepted procedure with approved materials or by a procedure that has been tested by an approved testing facility and approved by a major governmental maritime administration.

5.8 Materials/Certification

All materials used in the construction of structural fire divisions and protection of the penetrations are to be certified for the fire rating in which they are fitted. This includes structural fire protection and thermal insulation, joiner bulkheads, doors, HVAC ducts, flooring materials, windows, fire dampers, etc.

6. Muster Areas

6.1 General

All units are to have a designated muster station(s) where personnel can gather prior to entering the lifeboats.

6.2 Materials

- i) All materials that comprise the muster stations routes are to be of steel or equivalent material.
- ii) Fiber Reinforced Plastic (FRP) grating may be used if the layout is designed in accordance with Appendix 3, and provided that the FRP grating is approved as meeting the applicable criteria defined in same.

6.3 Muster Stations

- i) The muster station is to be of sufficient area to accommodate the number of personnel to be gathered.
- ii) The muster station is to be located in a safe location with respect to the processing equipment.
- iii) The muster station may be a meeting room inside the accommodations or may be part of the lifeboat embarkation station.

7. Means of Escape

7.1 General

- i) Arrangement of escape routes is to be in accordance with the requirements contained in this Subsection.
- ii) Escape routes are to be arranged to provide the most direct route to an area of temporary refuge or safe haven.

7.2 Materials

- i) All materials that comprise the escape routes are to be of steel or equivalent material.
- ii) Fiber Reinforced Plastic (FRP) grating may be used if the layout is designed in accordance with Appendix 3, and provided that the FRP grating is approved as meeting the applicable criteria as defined in same.

7.3 Escape Routes

- i) At least two (2) means of escape are to be provided for all continuously manned areas and areas that are used on a regular working basis.
- ii) The two (2) means of escape must be through routes that minimize the possibility of having both routes blocked in an emergency situation.
- iii) Escape routes are to have a minimum width of 0.71 m (28 in.).
- iv) Dead-end corridors exceeding 7 m (23 ft) in length are not permitted.
- v) Dead-end corridors are defined as a pathway which (when used during an escape) has no exit.

7.4 Marking and Lighting of Escape Routes

Escape route paths are to be properly identified and provided with adequate lighting.

7.5 Escape Route Plan

- i) An escape route plan is to be prominently displayed at various points of the facility.

- ii) Alternatively, this information may be included in the Fire Control or Fire/Safety Plan.

8. Lifesaving Requirements

8.1 General

- i) Lifesaving appliances and equipment are to be in accordance with the requirements contained in this Subsection.
- ii) Lifesaving Appliances and equipment are to be provided, taking into account the arrangement of the installation and its area of operation.
- iii) Where the words “of an approved type” are indicated, the equipment is to meet the requirements of SOLAS or equivalent standard.
- iv) Launching appliances for lifeboats and liferafts are also to meet the requirements of SOLAS or equivalent standard.

8.2 Lifeboat Embarkation Areas

- i) All materials that comprise the lifeboat embarkation platform are to be of steel or equivalent material.
- ii) Fiber Reinforced Plastic (FRP) grating may be used if the layout is designed in accordance with Appendix 3, and provided that the FRP grating is approved as meeting the applicable criteria defined in same.

8.3 Lifesaving Appliances and Equipment

8.3.1 Lifeboats

- i) Lifeboats of an approved type with an aggregate capacity to accommodate the total number of persons onboard are to be provided and installed in safe areas on two (2) sides of the installation.
- ii) The installation of lifeboats on one (1) side of the installation can be considered based on the submittal of a detailed risk analysis. Items to be addressed in such a risk analysis are to include, but are not limited to:
 - a) Prevailing and worst-case environmental conditions
 - b) Likely location of personnel onboard the facility
 - c) Consequences from all fire and explosion hazards onboard the facility
 - d) Egress routes from locations on the platform where personnel are normally employed or living
 - e) Location of other LSA (liferafts)
 - f) Probability of casualties other than fire and explosion incidents including marine collisions.

8.3.2 Liferafts

- i) Inflatable liferafts of an approved type are to be provided onboard such that their total capacity is sufficient to accommodate the total number of people expected to be onboard the facility.
- ii) Liferafts are to be placed next to areas where personnel may be working, in sufficient quantity to hold the maximum number of people that might be present in the area at any one time.

8.3.3 Life Buoys

- i) At least four (4) life buoys of an approved type, with floating water lights, are to be provided.
- ii) One (1) ring life buoy is to be placed in a suitable rack on each side of the structure in an acceptable location.
- iii) Multi-level structures may require the placement of additional life buoys.

8.3.4 Life Jackets

- i) At least one (1) life jacket of an approved type is to be provided for each person on a manned facility.
- ii) Life preservers/work vests are to be stored in readily accessible locations.
- iii) Life jackets numbering the same quantity as the maximum aggregate capacity of each life boat station must be stored next to the lifeboat station.

8.3.5 Work Vests

When personnel baskets are used to transfer personnel from the facility to work boats, or vice versa, a work vest is to be provided and kept with the personnel basket for each person riding in the basket.

8.3.6 Breathing Apparatus

- i) For operations involving hydrogen sulfide, each person expected on the facility is to be provided with a self-contained breathing apparatus of an approved type for escape purposes.
- ii) The breathing apparatus for maintenance personnel is to have a minimum of thirty (30) minutes air supply.
- iii) A designated safe area with proper supply of air is also to be provided and shown on the fire control/safety plan.

8.4 Means of Embarkation

8.4.1 General

- i) The means of embarkation requirements of the applicable Rules and/or Regulations are to apply.
- ii) In the absence of means of embarkation requirements by the applicable Rules and/or Regulations, the requirements of 4.H.8.3.2 below apply.

8.4.2 Means of Embarkation

- i) Each facility is to have means of embarkation to allow personnel to leave the facility in an emergency. These are in addition to the equipment described in 4.H.6.
- ii) The means of embarkation are to consist of at least two (2) fixed ladders or stairways, widely separated, and extending from the main and cellar decks to the water line.
- iii) The ladders or stairways will preferably be located near lifeboat-launching stations.
- iv) Ladder construction is to be in accordance with the appropriate governmental authority, or other recognized standard.

9. Personnel Safety Equipment and Safety Measures

9.1 Fireman's Outfits

All fireman's outfits and equipment are to be of an approved type (i.e., equipment is to meet the requirements of SOLAS or equivalent standard).

The requirements below are in addition to those required by the applicable Rules and/or Regulations.

9.1.1 Fireman's Outfit

- i) A minimum of two (2) sets of fire-fighting outfits and equipment is to be provided and stowed in a suitable container.
- ii) The protective clothing is to be made of a material that will protect the skin from radiant heat of a fire, and be water-resistant.
- iii) Boots and gloves are to be made of rubber or other electrically non-conducting material.
- iv) The protective helmet is to be of rigid construction to resist impact, and be equipped with a face shield.
- v) The fireman's outfits or sets of personal equipment are to be stored as to be easily accessible and ready for use, and where more than one (1) fireman's outfit or more than one (1) set of personal equipment is carried, they are to be stored in widely separated positions.
- vi) One of the outfits should be readily accessible from the helicopter deck.

9.1.2 Breathing Apparatus

- i) A minimum of two (2) self-contained breathing apparatus of an approved type is to be provided and stowed with the fireman's outfits.
- ii) There is to be a sufficient number of spare compressed air charges.
- iii) The breathing apparatus is to have a minimum of thirty (30) minutes air supply.

9.2 Guard Rails

The perimeter of all open deck areas, walkways around accommodation spaces, catwalks and openings, are to be protected with guardrails.

- i) The height of the guard rails is to be at least 1 m (39.5 in.) above the deck, except where this height would interfere with normal operation, in which case a lesser height may be considered if adequate protection is provided.
- ii) The opening below the lowest course of the guardrails is not to exceed 230 mm (9 in.).
- iii) The other courses are not to have more than 380 mm (15 in.) of clear opening.
- iv) Toe plates are to be provided at the base of all guardrails.

9.3 Insulation of Hot Surfaces

9.3.1 Personal Protection

- i) All exposed surfaces with which personnel are likely to come in contact are to have temperatures that do not exceed 71°C (160°F).
- ii) If this cannot be achieved, then the exposed surfaces are to be insulated or shielded.

9.3.2 Spillage Protection

Surfaces with temperatures in excess of 204°C (400°F) are to be protected from contact with liquid hydrocarbon spillage and mist.

9.3.3 Combustible Gases

Surfaces in excess of 482°C (900°F) are to be protected from contact with combustible gases.

9.3.4 Protection of Insulation

Insulation is to be protected from weather, oil spillage, mechanical wear, and physical damage.

Section 5

Surveys

A. Surveys During Construction and Commissioning

1. General

This Section provides the survey requirements during construction and start-up (commissioning) of facility installed on an offshore installation. The technical documentation requirements for review are given in section 3.B, and Section 4.B.

2. Surveys During Construction

2.1. General

During construction of systems, subsystems, equipment, and/or components for an offshore production facility, BKI Surveyors are to have access to manufacturers' or fabricators' facilities to witness construction and/or testing as required by this Rules, and the applicable design codes and/or standards.

The manufacturer/fabricator is to contact the BKI Surveyor to make necessary arrangements to examine systems, subsystem, equipment, and/or components.

If the BKI Surveyor finds reason to recommends repairs or additional surveys, notice will be immediately given to the Owner or his representative so that appropriate action may be taken.

2.2. Surveys at Vendor's Shop

Survey requirements for equipment and packaged units at vendor's shop are summarized in Sec. 5.A/Table 1.

Each vendor is required to have an effective quality system, which is to be verified by the attending Surveyor prior to the start of fabrication.

2.2.1. Pre-fabrication Meeting

When the Surveyor's attendance at the manufacturer's plant and at the assembly site is required by the applicable BKI Rules, the manufactured/assembled system and/or equipment will be verified for satisfactory compliance with the codes and/or standards, and the requirements of this Rule.

It is recommended pre-fabrication or kick-off meeting between the manufacturer/fabricator and BKI-designated Surveyor(s) is scheduled in order to, but not limited to:

- i) Confirm and/or establish the main point of contacts (PoC) for the manufacturer and BKI
- ii) Review the project quality plans
- iii) Review proposed manufacturing specification
- iv) Review project manufacturing and delivery schedules
- v) Review and confirm project "hold-points"
- vi) Review any proposed sub-contractor lists and/or qualifications
- vii) Confirm specification, drawings and/or documentation associated with the manufacturing process

2.2.2 Quality Control Program

A Quality Control Program (QCP) compatible with the type, size and intended service of the offshore installations is to be developed and submitted to BKI for approval. Required hold points on the QCP that is to form the basis for all future BKI surveys at the fabrication yard shall be agreed upon by the attending Surveyor. As a minimum, all of the items enumerated in the following applicable Subsections are to be covered by the QCP. BKI shall verify that all tests and inspections specified in the QCP are satisfactorily carried out by a competent person, and BKI surveys shall be considered to supplement and not replace inspections that should be carried out by the fabricator or operator.

The fabricator is to maintain a system of material traceability to the satisfaction of the attending Surveyor. Data as to place of origin and results of tests for materials shall be retained and are to be readily available to BKI upon request.

Where equipment and components are assembled in blocks or modules, the Surveyor is to inspect the fit-up, piping and electrical connections, and to witness the required tests on the completed assembly in guidance with the QCP and in accordance with the approved plans and Rule/Guide requirements. The progress and suitability of structural fit-up and joining of constructed/fabricated blocks/modules are to be to the satisfaction of the attending Surveyor. All joints are to be subjected to visual examination, proven tight, and the extent of Non-Destructive Examination (NDE) carried out is to be to the satisfaction of the attending Surveyor.

2.2.3 BKI Survey

BKI Surveyor's attendance is typically for the following purposes, but not limited to:

- i) To confirm that the facilities to manufacture, fabricate or repair of systems, subsystem, equipment or and/or components have and maintain an effective quality control program covering design, procurement, manufacturing and testing, as applicable, and meeting the requirements of a recognized standard applied to their products.
- ii) To qualify or verify welder's qualifications to the extent deemed necessary by the attending BKI Surveyor.
- iii) To qualify or verify welding procedure specifications (WPS) and corresponding weld procedure qualification records (PQR) to the extent deemed necessary by the attending BKI Surveyor
- iv) To review and verify material certificates/documentation or material test reports (MTR's)
- v) To survey fit-up prior to major weldments
- vi) To survey final weldments
- vii) To witness, as far as deemed necessary, nondestructive examination tests of welds and to review records of nondestructive examinations
- viii) To review records of post-weld heat treatment, in particular for piping subjected to pressurized sour service and subject to NACE MR0175/ISO 15156 requirements
- ix) To verify dimensions are as shown on approved drawings
- x) To check dimensional tolerances and alignment of mating surfaces
- xi) To witness pressure and/or proof-load testing of equipment and as a unit, as applicable and as specified in the fabrication procedures

- xii) To witness final testing and functional testing of subassemblies and completed units, as specified in the fabrication procedures
- xiii) To verify all purged and pressurized systems, motor controllers, SCR banks, consoles and instrumentation and control panels are in compliance with approved drawings
- xiv) To carry out other survey activities as agreed upon during prefabrication meeting

Table 1. Surveys During Construction

	A	B	C	D	E	Specific Test(s)
Hydrocarbon Production and Process System Equipment						
Production/Process Pressure Vessels	X	X	X			5.A.2.2.4i)
Storage Tanks	X	X	X			5.A.2.2.4v), vi)
Heat Exchangers	X	X	X			5.A.2.2.4i)
Fired Vessels	X	X	X			5.A.2.2.4i)
Packaged Process Units	X	X	X	X		5.A.2.2.4i), ii), vii), viii), x)
Meters, Strainers, Filters and Other Fluid Conditioners						
< 254 mm (10 in.) and 10.54 kg/cm ² (150 psi)					X	---
≥ 254 mm (10 in.) or 10.54 kg/cm ² (150 psi)	X	X	X			5.A.2.2.4i)
Pumps						
< 7 kg/cm ² (100 psi) and 757 liters/min (200 gpm)					X	---
≥ 7 kg/cm ² (100 psi) or 757 liters/min (200 gpm)			X	X		5.A.2.2.4ii)
Compressors						
< 7 kg/cm ² (100 psi) and 28.3 m ³ (1000 scfm)					X	---
≥ 7 kg/cm ² (100 psi) or 28.3 m ³ (1000 scfm)			X	X		5.A.2.2.4iii)
Flowlines and Manifolds	X	X	X			5.A.2.2.4vii)
Scraper Launchers/Receivers	X	X	X			5.A.2.2.4i)
Flare Systems	X	X				5.A.2.2.4vii)
Subsea Systems	X	X	X	X		5.A.2.2.4i), viii)
Process Support System Equipment						
Pressure Vessels						
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)					X	---
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X	X	X			5.A.2.2.4i)
Heat Exchangers						
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)					X	---
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X	X	X			5.A.2.2.4i)
Rotating Equipment						
Pumps						
Air Compressors					X	---
Engines And Turbines						
< 100 kW (134 hp)					X	---
≥ 100 kW (134 hp)			X	X		5.A.2.2.4iv)
Packaged Support Systems						
< 7 kg/cm ² (100 psi) and 93.3°C (200°F)					X	---
≥ 7 kg/cm ² (100 psi) or 93.3°C (200°F)	X	X	X	X		5.A.2.2.4i), ii), vii), viii), x)

Table 1. Surveys During Construction (continued)

	A	B	C	D	E	Specific Test(s)
Electrical System						
Generators						
< 100 kW (134 hp)					X	---
≥ 100 kW (134 hp)				X		5.A.2.2.4viii)
Motors						
< 100 kW (134 hp)					X	---
≥ 100 kW (134 hp)				X		5.A.2.2.4viii)
Distribution Transformers					X	---
Switchboard, MCC, Panelboards					X	---
Storage Batteries					X	---
Instrument and Control System						
Control Panels					X	---
Fire Protection and Safety Equipment						
Fire Pumps				X		5.A.2.2.4ii)
Fire Pump Skid Package				X		---
Alarm Panels				X		---
Fixed Fire Extinguishing Systems (Nozzles, Controls, Bottles, etc.)			X			---
Fire and Gas Detection Systems (sensors, Panel, Cables,			X			---
Equipment Skid Structure						
For modules that require design review, see 3-3/7.3 and 3-2/5.27 or		X				

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- A BKI attendance at vendor's shop to verify materials for compliance with drawings/specification and their traceability record, and to review welding and NDE specifications and procedures, and welder and NDE personnel qualification records.
- B BKI attendance at vendor's shop during critical phases of fabrication such as fit-up, alignment, and NDT examination, etc.
- C BKI attendance at vendor's shop to witness and report on pressure testing.
- D BKI attendance at vendor's shop to witness and report on operational tests to verify proper functioning of equipment.
- E Exempt from BKI survey and testing when vendor or manufacturer has provided manufacturer's affidavit of compliance (MAC) that equipment or component is designed, manufactured, and tested in accordance with an applicable code or standard.

2.2.4 General Testing Requirements

Where production or processing systems, subsystems, equipment or components listed above are indicated as being tested under survey, the following list indicates general testing references:

System and Equipment	Testing References
Pressure Vessels	ASME Section VIII Div. 1/ Div. 2/ or
Pumps	API Std. 610
Compressors	API Std. 617, 618, 619
Gas Turbines	API Std. 616
Storage Tanks	API Std. 620
Piping Systems	API RP 14E, ASME B31.3
Electrical Systems	API RP I4F
Instrument and Control Systems	API RP 554

2.2.5 Specific Testing Requirements

The following specific tests, are to be witnessed by the Surveyor. Other tests required by project specifications may also be witnessed and reported on by the Surveyor.

- i) Pressure Vessels
 - a) Each vessel is to be subjected to a hydrostatic test which at every point in the vessel is at least equal to 1.3 times the maximum allowable working pressure.
 - b) For pressure vessels that cannot be hydraulically tested, a pneumatic test equal to 1.1 times the maximum allowable working pressure is to be performed.
- ii) Pumps
 - a) Each pressure casing or pressure-retaining part is to be hydrostatically tested with water at ambient temperature at a minimum of 1.5 times the maximum allowable casing pressure.
 - b) An operational test of the pump is to be performed to demonstrate satisfactory performance.
- iii) Compressors
 - a) Pressure and operational tests in accordance with the requirements of 5.A.2.2.4ii), are to be performed.
 - b) Each compressor intended for toxic or flammable gas service is to be pressurized with an inert gas to the rated discharge pressure.
 - c) The casing is to be held at the test pressure for a minimum of 30 minutes to check for gas leaks, when subjected to a soap-bubble test or to other approved leak test.
- iv) Gas Turbines
 - a) Pressure and operational tests in accordance with the requirements of 5.A.2.2.4ii), are to be performed.
 - b) See API Std. 616 for details of the mechanical running test.
- v) Low Pressure Storage Tanks – 0.011 to 1.05 kg/cm² (2.5 oz/in² to 15 psi) for Crude or Flammable Fluids (with Flash Points < 60°C or 140°F) (2.5 oz/in² to 15 psi) or (0.0109 to 1.05 kg/cm²)
 - a) Depending on the design of the tank, each storage tank is to be subjected to a combination hydrostatic-pneumatic test, or a completely hydrostatic test.
 - b) If the tank has not been designed to be filled with liquid to the tank, the tank is filled with water to its high liquid design level, and a test pressure of 1.25 times, design pressure of the vapor space is applied to the vapor space.
 - c) If the tank has been designed to be filled with liquid to the tank top, it is to be hydrostatically tested with a pressure under the topmost point equal to 1.25 times the vapor space design pressure.
 - d) Partial vacuum tests are to be conducted for tanks that are designed to withstand the partial vacuum.

- vi) Atmospheric Storage Tanks for Crude or Flammable Fluids with Flash Points less than 60°C
 - a) Atmospheric storage tanks are to be hydrostatically tested to the maximum liquid head to which the tank is to be subjected.
- vii) Piping Systems
 - a) All piping systems are to be hydrostatically leak-tested prior to being placed into service. The test pressure is to be 1.5 times the design pressure, or 3.5 kg/cm² (50 psig), whichever is greater.
 - b) Where it is necessary to perform a pneumatic leak test, the test pressure is to be 1.1 times the design pressure.
 - c) All joints, including welds, are to be left uninsulated and exposed for examination during leak testing.
- viii) Electrical Systems (Generators & Motors)
 - a) Check windings for dryness. It is recommended that space heating be operated for a sufficient time prior to start-up to assure dryness.
 - b) Measurement of stator insulation resistance to the motor or generator frame is to be made with an instrument applying a minimum of 600 volts across the insulation. The suggested minimum insulation resistance is 2.0 megohms; new or rebuilt machines should provide at least 10 megohms in insulation resistance readings.
 - c) If generators are to be operated in parallel, check their phase rotation and the synchronizing circuits for proper operation.
 - d) Check motor starter overload relay heater elements for proper sizing.
 - e) Check circuit breaker trip settings and fuse sizes.
 - f) Jog motors to check for proper direction of rotation, but only after uncoupling any loads which might be damaged by reverse rotation.
 - g) Check motor-to-load and generator-to-prime mover alignments.
 - h) Perform an insulation test of all electrical circuits to verify that cables are not damaged during installation.
 - i) Verify all components are properly grounded.
 - j) After motors and generators are started, check for abnormal line currents, vibration, and high bearing temperatures.
 - k) Witness full-load heat run and saturation curve tests for the first unit of a particular design.
- ix) Electrical Systems (Switchboards)
 - a) Check all bus-bars for correct sizing and spacing.
 - b) Check all components for correct voltage and current rating.

Verify all components are properly grounded.

- d) The various circuits of switchboard and panelboard assemblies are to be tested by conducting dielectric strength test and insulation resistance measurements.
 - e) Satisfactory tripping and operation of all relays, contactors and various safety devices is to be demonstrated.
- x) Instrument and Control System
- a) Witness calibration of all pressure, level and temperature switches necessary for functioning of controls in accordance with SAFE Charts.
 - b) Review calibration records of all other instruments.
 - c) Verify all instruments used as pressure-retaining parts have correct pressure ratings.
 - d) Verify all electrical/electronic instruments to be installed in a hazardous location are suitable for that environment.
 - e) Verify all electrical/electronic instruments are properly grounded.
 - f) Verify all electrical circuits are installed in a 'fail safe' manner, that is, all circuits in normal working state are to be electrically continuous, and non-continuous when in an abnormal state.
 - g) Check logic functions with normal voltage applied to the control circuits, but preferably with the power circuits not energized.
 - h) Check each sensor and end device individually for proper operation before incorporating them into the system
- xi) Fire Extinguishing System

2.3 Module Fabrication

Where equipment and components are assembled as skid mounted units or modules, the Surveyor is to inspect:

- i) Fit-up
- ii) Piping connections
- iii) Electrical connections
- iv) Witness pressure test
- v) Functional tests of the completed assembly in accordance with approved plans

2.4 Module Assembly

Survey during assembly is to be carried out in accordance with approved procedures, and to include the following where applicable:

- i) All piping assembly is to be verified for compliance with approved drawings and procedures.

- ii) All welds are to be visually inspected, and non-destructive testing (NDT) carried out as required.
- iii) Upon completion of assembly, the affected sections are to be hydrostatically tested to 1.5 times the design working pressure.
- iv) All electrical assembly is to be verified for compliance with the approved drawings and procedures.
- v) Proper support for all cables and proper sealing of cable entries to equipment are to be verified.
- vi) Upon completion of all assembly, the affected sections of the equipment and cabling are to be insulation satisfactorily tested in accordance with approved procedures. All grounding is also to be verified for completion and appropriate connections
- vii) All instrumentation assembly is to be verified for compliance with the approved drawings and procedures. All tubing supports are to be verified. Upon completion, all systems are to be satisfactorily functional tested in accordance with approved procedures.
- viii) All mechanical equipment assembly is to be verified for compliance with the approved drawings and procedures, including the grounding of the equipment. Upon completion, all equipment is to be satisfactorily functional tested in accordance with approved procedures.

3. Commissioning and Start-up Surveys

The start-up and commissioning of all hydrocarbon production systems are to be satisfactorily verified by an attending the Surveyor. The scope of the survey is to include the following, but not limited to:

- i) The start-up and commissioning are to be performed in accordance with the approved procedures.
- ii) Verify personnel safety precautionary measures to be taken during commissioning, which are to include checks of operational readiness of all lifesaving, fire and gas detection, fire fighting equipment, ESD systems, unobstructed escape routes, etc.
- iii) Verify establishment of communication procedures prior to commissioning.
- iv) Verify that emergency procedures are provided to deal with any contingencies such as spillage, fire, and other hazards. If necessary, drills are to be carried out to confirm the readiness of these procedures.
- v) Verify start-up and testing of all support utility systems, including main and auxiliary sources for the process system, prior to commissioning.
- vi) Verify proper assembly and testing of the entire process system, prior to commissioning. This is to include testing of the entire system for leaks, of the process control functions and the emergency shutdown system.
- vii) Verify purging of the entire production system of oxygen to an acceptable level, prior to the introduction of hydrocarbons into the production system.
- viii) Verify the introduction of hydrocarbon into the process system, and the system's capability to control the flow of the well affluent in the system in a stabilized manner, without undue control upsets.
- ix) Verify the starting up of the flare system, if applicable, including precautions taken to eliminate

the risk of explosion or fire. The functional capability of the flare system is to be verified.

- x) Verify that the post-commissioned process system is in satisfactory functioning order for a duration of at least 12 hours.
- xi) Equipment required to be verified but not used during the start-up and commissioning is to be identified for verification at the next annual survey.

4. Start-up and Commissioning Procedures and Manual

The start-up and commissioning manual is to include, at minimum, the procedures listed in 5.A.4.1 and 5.A.4.2.

4.1 Functional Testing Procedures

During commissioning, the following systems are to be functionally tested in accordance with approved procedures.

4.1.1 Piping and Equipment

- i) Pressure/Leak Test
- ii) Purging

4.1.2 Utility Systems

- i) Power Generation (Main & Emergency)
- ii) Process Support Facilities
- iii) Instrument Air
- iv) Cooling Water

4.1.3 Fire Fighting and Safety Systems

- i) Fire Pumps
- ii) Fixed Fire Fighting Systems
- iii) Manual Equipment
- iv) Lifesaving Equipment

4.1.4 Detection and Alarm

- i) Fire Detection
- ii) Gas Detection
- iii) Fire and Gas Panel
- iv) ESD Systems

4.1.5 Process Systems

- i) Flare (pilot, ignition, snuffing and flare operational tests)
- ii) Instrumentation and Control (wellhead control and process control system)
- iii) Safety Shutdown Valves
- iv) Process Components

4.2 Start-up Procedure

A step-by-step procedure is to be followed for the displacement of air or other fluid from the process systems prior to start-up. The Surveyor is to be permitted access to suitable vantage points to verify that the start-up procedures are satisfactorily accomplished. The Surveyor is to observe the facilities operating at the initial production capacity for at least a 12 hour period of uninterrupted normal operation. As applicable, the Surveyor is also to observe the facilities operating at various capacities under various conditions.

B. Surveys for Maintenance of Class

1. General

The provisions of this Section contain survey requirements for the maintenance of classification for facilities installed on an offshore installation.

For modifications, the documentation requirements for review are given in 3.B.12 or 4.B.11.

2. Commissioning

For purposes of this Section, the commissioning date will be the date on which a Surveyor issues the Interim Classification Certificate for the offshore facilities.

3. Surveys

3.1 Annual Survey

To maintain classification of the facilities, an annual survey is to be carried out by a Surveyor within three months before of each anniversary date of the initial Classification Survey.

3.2 Special Survey

A Special Survey of the facilities is to be carried out within five (5) years of the initial Classification Survey, and at five-year intervals thereafter.

3.3 Timing of Surveys

Required surveys are to be completed within three (3) months of their due dates, unless extended by agreement with BKI.

Any part of an offshore installation may be offered for survey prior to the due date when so desired, in which case the survey will be credited as of that date.

3.4 Continuous Survey Program

A continuous survey program may be arranged whereby all required surveys are carried out on a continuing basis.

3.5 Survey Based on Preventative Maintenance Techniques

A properly conducted preventative maintenance/condition monitoring plan may be credited as satisfying the requirements of Special Continuous Survey. This plan must be in accordance with BKI Guidelines for Planned Maintenance Program and BKI Guidance for Survey Based on Reliability Centered Maintenance.

4. Maintenance Records

Maintenance records are to be kept and made available for review by the attending Surveyor. The maintenance records are to be reviewed to establish the scope and content of the required Annual and Special Surveys which are to be carried out by a Surveyor.

During the service life of the facilities, maintenance records are to be updated on a continuing basis.

The operator is to inform BKI of any changes to the maintenance procedures and their frequencies, as may be caused, for example, by changes or additions to the original equipment.

The Surveyor may determine during his periodic survey if the changes are sufficient to warrant review by the BKI technical staff.

4.1 Annual Survey

At each Annual survey, in addition to a general review of the maintenance records, the Surveyor is to verify the effectiveness of the following items by visual examination and operational testing, as appropriate.

- i) Examination of corrosion protection system
- ii) Examination and testing of remote shutdown arrangements for fuel and ventilation equipment
- iii) Examination and testing of safety shutdown devices
- iv) Examination and testing of emergency control stations
- v) External examination and testing of safety relief valves
- vi) External examination during operation of all machinery, pumps and pumping arrangements, including valves, cocks and pipes
- vii) Examination of preventative maintenance records
- viii) Examination of fire hoses, nozzles, and spanners at each fire station
- ix) Examination of fire protection system, including fire water pumps and related piping, hydrants, control valves and alarm systems
- x) Operational check of fire protection systems, including fire pumps, water spray systems, and alarm and detection systems
- xi) Examination of personnel protection, rescue and escape systems and devices, including alarm devices and emergency lighting for escape routes, landing platforms, etc.

- xii) General examination of structure, piping, electrical systems and machinery foundations for damage, deterioration, or hazard. (i.e., flare tower or ground flare, production systems, power generation, etc.)
- xiii) Examination of enclosed hazardous areas, including ventilation, electric lighting, electric fixtures and instrumentation
- xiv) Verification of the integrity of explosion-proof equipment
- xv) Operational test of emergency lighting systems, navigation and obstruction lights
- xvi) External examination of boilers, separators, and similar process equipment and associated relief valves
- xvii) Examination of steam-generating units

4.2 Special Survey

The Special Survey is to include all items listed under the Annual Survey with the following additions:

- i) Checking and weighing the contents of fixed fire protection systems, including the capability and stability of storage foam liquids. Blowing through and ensuring that piping for fixed fire extinguishing systems is not choked.
- ii) Non-explosion proof electric motors are to be examined, including automatic power disconnect to motors that are arranged to shut down in case of loss of ventilation.
- iii) Gauging of pressure vessels, heat exchangers, and storage tanks, as considered necessary
- iv) Internal examination of pressure vessels, pumps, compressors, and safety relief valves
- v) Random thickness gauging of process piping, as considered necessary
- vi) Hydrostatic testing of process related piping systems to 1.25 times the maximum allowable working pressure as considered necessary.
- vii) Lube oil examination record review
- viii) Measurement of the insulation resistance of generators and motors
- ix) Running of generators of under load, separately and in parallel
- x) Examination of cable runs, bus ducts, insulators, etc.
- xi) Testing of circuit breakers, relays, etc.
- xii) Examination of electrical equipment and circuits for possible damage or deterioration
- xiii) Vibration checks of rotating machinery
- xiv) Internal examination of steam and gas turbines, as considered necessary
- xv) Testing of protective devices for engines, turbines, and gas compressors
- xvi) Internal examination of diesel engines and gas engines rated 1000 hp output and above, as considered necessary
- xvii) Operational check of process control equipment.

4.3 Inspection Plan

The requirements of 5.B.4.1 and 5.B.4.3 above are intended to define the general scope of required surveys.

Due to the varied nature and purposes of offshore installations, it is not considered practicable to establish a firm schedule of requirements.

The Annual and Special Surveys are to be carried out in accordance with the reviewed inspection plan to confirm the fitness of the facility for continued operation.

5. Modifications

When it is necessary to carry out any modifications to the machinery, piping, process equipment, etc., which may affect classification, the details of such modifications are to be submitted for review.

If BKI determines that the modification will affect classification, the facility to be modified will be subject to the review, testing and inspection requirements of the Rules.

6. Damage and Repairs

If an offshore installation that has been classed suffers any damage to machinery, piping, process equipment, etc., which may affect classification, BKI is to be notified and the damage examined by a Surveyor.

Details of intended repairs are to be submitted for approval, and the work is to be carried out to the satisfaction of the Surveyor.

7. Certification on Behalf of Coastal States

When BKI is authorized to perform surveys on behalf of a governmental authority, and when requested by the Owner, items as specified by the governmental authority or Owner will be surveyed. Reports indicating the results of such surveys will be issued accordingly.

C. Risk Based Surveys for Maintenance of Class

1. General

The provisions of this Section contain survey requirements specific to the maintenance of classification for facilities installed on an offshore installation for which inspection plans have been developed using risk based techniques.

While this Section provides risk based survey requirements as an alternative for maintenance of Class, some Subsections on the Classification Process contained in the BKI Guidance for Risk Evaluation for The Classification of the Marine – Related Facilities and Section 1 of this Rules are applicable.

Where no specific references or guidance are given in this Section, the relevant requirements of Sections 1.A.3 through 1.A.14 of the above-referenced and Section 1, B through E of this Rules remain valid.

Due to the varied nature and purposes of offshore installations, and the varied contents of inspection plans developed as part of an Owner's risk based approach to Classification, it is not considered practicable to establish a firm schedule of survey requirements in this Section for maintenance of Class.

Where modifications to the facilities are to be carried out after issuance of the Classification Certificate, all documentation requirements for review as defined in 3.B.12 or 4.B.11 of this Rules remain the same. Further, the design documentation described in 3.B.1 or 4.B.1 is to be available to the attending Surveyor at the time of the modifications.

2. Requirements for Risk Based Survey

Where the risk based approach is to be adopted, the Owner's proposed maintenance and inspection plans, including details of frequency and extent of activities, are to be submitted for review.

- i) Where these plans deviate from the Survey requirements of Section 5.B, the risk assessment methodology required below is to specifically address these deviations, which are not to result in an unacceptable level of safety or integrity of the facilities.
- ii) In addition to the maintenance and inspection plans noted above, the following documentation is to be submitted to BKI at least six (6) months before the plan is to be put into effect. This documentation is to establish, at a minimum:
 - a) The basis and methodology employed in the risk based techniques;
 - b) The means by which the technique is used to establish maintenance plans;
 - c) The means by which the technique is used to update and modify maintenance and inspection plans;
 - d) The means by which the following items are to be controlled:
 - 1) Accident and Non-Conformity Reporting
 - 2) Overdue Inspections/Surveys
 - 3) Internal Audits and Management Reviews
 - 4) Control, Storage and Retention of Documents and Data
 - 5) Change Procedures for BKI approved plans

Where the risk based approach is to be adopted on facilities installed on a floating installation, the risk assessment on which the inspection and maintenance plan is based is to be site-specific. If the installation is to be relocated, the risk assessment is to be reviewed by the Owner and resubmitted to BKI for approval.

3. Surveys

3.1 General

- i) To credit a Special Survey based on risk based inspection techniques, the facilities are to be subject to a continuous survey program, whereby the survey of all applicable items is to be carried out on a continuous basis over the five-year special survey cycle. If this program includes a preventative maintenance/condition monitoring plan, this plan is to be in accordance with BKI Guidelines for Planned Maintenance Program and BKI Guidance for Survey Based on Reliability Centered Maintenance.
- ii) The inspection plan detailing the timing and extent of activities will be reviewed to establish the scope and content of the Annual and Special Surveys which are required to be carried out by a Surveyor, who will also monitor the Owner's in-house quality management system required by 5.C.2.1.4 above.
- iii) During the service life of the facilities, maintenance and inspection records are to be updated on a continuing basis and be available for reference by the attending Surveyor.

- iv) The operator is to inform BKI of any changes to the maintenance procedures and their frequencies, as may be caused, for example, by changes, additions, or deletions to the original equipment.

3.2 Initial Survey

- i) An Initial Survey is to be carried out to confirm that systems and plans required by 5.C.2 have been properly implemented.
- ii) The survey is to be carried out a minimum of three (3) months after the date of implementation of the approved plans, but no later than concurrently with the next due annual survey.

3.3 Annual Survey

- i) An Annual Survey is to be carried out by a Surveyor within three months before or after each anniversary date of the initial/renewal Classification Survey.
- ii) The survey is to be carried out in accordance with the approved risk based inspection plan to confirm the fitness of the facility for continued operation.
- iii) Where the inspection plan specifically applies BKI Rules, the applicable items listed in 5.B.4.1 of this Section are to be complied with.

3.4 Special Survey

- i) A Special Survey of the facilities is to be carried out within five years of the initial Classification Survey and at five-year intervals thereafter.
- ii) The survey is to include all items in the approved risk based inspection plan listed under the Annual Survey, confirmation of the completion of the continuous survey program and where the inspection plan specifically applies BKI Rules, the applicable items listed in 5.B.4.2 of this Section are to be complied with.

4. Notification and Availability for Survey

The requirements of Section 1.D.1.6. of the Part 5 – Offshore Technology, Volume 1 Rules for Classification and Survey notwithstanding, the maintenance and inspection plan required by 5.C.2 is to be structured as to confirm that all BKI survey activity is carried out during the annual and special surveys.

- i) If it is not possible for BKI survey activity to be carried out during the annual and special surveys, in case of a planned/unplanned maintenance shutdown, or as a result of serious damage, adequate notification for Surveyor attendance is to be given by the owners.
- ii) If the situations noted above occurs within two (2) months outside of the beginning or end of an annual survey window, due consideration may be given for the Annual Survey to be brought forward or postponed to coincide with the maintenance period.
- iii) If an Annual Survey is brought forward, the next due Annual Survey is to be carried out within 18 months of completion of that survey.

5. Modifications

When it is intended to carry out any modifications to the machinery, piping, process equipment, etc., which may affect classification, the details of such modifications are to be submitted for review.

If BKI determines that the modification will affect classification, the facility to be modified will be subject to the review, survey and testing requirements of the Rules and/or the applicable design codes and standards.

6. Damage and Repairs

If an offshore installation suffers any damage to machinery, piping, process equipment, etc., which may affect classification, BKI is to be notified and the damage examined by a Surveyor.

- i) Details of intended repairs are to be submitted for approval, and the repair is to be carried out to the satisfaction of the Surveyor.
- ii) When machinery, piping, or process equipment suffers unexpected failure, and is subsequently repaired or replaced without Surveyor attendance, details of the failure, including damaged parts where practicable, are to be retained on board for examination by the Surveyor during the next scheduled visit.
- iii) Alternatively, the part or parts may be landed ashore for further examination and testing as required.
- iv) If failures noted above are deemed to be a result of inadequate or inappropriate maintenance, the maintenance and inspection plan is to be amended and resubmitted for approval.

7. Certification on Behalf of Coastal and Flag States

When BKI is authorized to perform surveys on behalf of a governmental authority, and when requested by the Owner, items as specified by the governmental authority or Owner will be surveyed. Reports indicating the results of such surveys will be issued accordingly.

Where the periodicity and types of surveys on behalf of a governmental authority differ from those required by the applicable Subsections of this Section, the Coastal or Flag State requirements take precedence.

Appendix 1

Plastic Pipe Installations

A. General

1. General

Pipes and piping components made of thermoplastic or thermosetting plastic materials, with or without reinforcement, may be used in piping systems referred to in Appendix 1.A. Table 1 of this appendix, subject to compliance with the following requirements.

For the purpose of this Rules, “plastic” means both thermoplastic and thermosetting plastic materials, with or without reinforcement, such as polyvinyl chloride (PVC) and fiber-reinforced plastics (FRP).

2. Specification

Rigid plastic pipes are to be in accordance with a recognized national or international standard acceptable to BKI.

Specification for the plastic pipe, including thermal and mechanical properties and chemical resistance, is to be submitted for review.

B. Design

1. Internal Pressure

A pipe is to be designed for an internal pressure not less than the design pressure of the system for its intended purpose. The maximum internal pressure, P_{int} , for a pipe is to be the lesser of the following:

$$P_{int} = P_{sth}/4 \quad \text{or} \quad P_{int} = P_{lth}/2.5$$

Where,

P_{sth} = short-term hydrostatic test failure pressure

P_{lth} = long-term hydrostatic test failure pressure (>100,000 hours)

The hydrostatic tests are to be carried out under the following conditions:

- i) Atmospheric pressure = 1 bar (1 kgf/cm², 14.5 psi)
- ii) Relative humidity = 30%
- iii) Fluid temperature = 25°C (77°F)

The hydrostatic test failure pressure can be verified experimentally or determined by a combination of testing and calculation methods, which are to be submitted to BKI for approval.

2. External Pressure

External pressure is to be considered for any installation that may be subject to vacuum conditions inside the pipe or a head of liquid on the outside of the pipe.

- i) A pipe is to be designed for an external pressure not less than the sum of the pressure imposed by the maximum potential head of liquid outside the pipe plus full vacuum, 1 bar (1 kgf/cm², 14.5 psi), inside the pipe.
- ii) The maximum external pressure for a pipe is to be determined by dividing the collapse test pressure by a safety factor of 3.

- iii) The collapse test pressure may be verified experimentally or be determined by a combination of testing and calculation methods, which are to be submitted to BKI for approval.

3. Axial Strength

The sum of the longitudinal stresses due to pressure, weight and other dynamic and sustained loads is not to exceed the allowable stress in the longitudinal direction.

Forces due to thermal expansion, contraction and external loads, where applicable, are to be considered when determining longitudinal stresses in the system.

In the case of fiber-reinforced plastic pipes, the sum of the longitudinal stresses is not to exceed one half of the nominal circumferential stress derived from the maximum internal pressure, determined according to Appendix 1.B.1, unless the allowable longitudinal stress is verified experimentally or by a combination of testing and calculation methods.

4. Temperature

The maximum allowable working temperature of a pipe is to be in accordance with the manufacturer's recommendations, but in every instance, is to be at least 20°C (36°F) lower than the minimum heat distortion temperature of the pipe material, determined according to ISO 75 method A or equivalent.

The minimum heat distortion temperature is not to be less than 80°C (176°F).

Where low temperature services are considered, special attention is to be given with respect to material properties.

5. Impact Resistance

Plastic pipes and joints are to meet a minimum resistance to impact in accordance with a recognized national or international standard such as ASTM D2444 or equivalent.

6. Fire Endurance

Fire endurance requirements for pipes based on system and location are specified in Appendix 1.B.Table 1. Pipes and their associated fittings whose functions or integrity are essential to the safety of the vessel are to meet the fire endurance requirements described below.

6.1 Level 1

- i) Level 1 will ensure the integrity of the system during a full scale hydrocarbon fire, and is particularly applicable to systems where loss of integrity may cause outflow of flammable liquids and worsen the fire situation.
- ii) Piping having passed the fire endurance test specified in Appendix 1.F for a minimum duration of one hour without loss of integrity in the dry condition is considered to meet Level 1 fire endurance standard (L1).

6.2 Level 2

- i) Level 2 intends to ensure the availability of systems essential to the safe operation of the vessel after a fire of short duration, allowing the system to be restored after the fire has been extinguished.
- ii) Piping having passed the fire endurance test specified in Appendix 1.F for a minimum duration of 30 minutes without loss of integrity in the dry condition is considered to meet Level 2 fire endurance standard (L2).

6.3 Level 3

- i) Level 3 is considered to provide the fire endurance necessary for a water-filled piping system to

- survive a local fire of short duration.
- ii) The system's functions are capable of being restored after the fire has been extinguished.
- iii) Piping having passed the fire endurance test specified in Appendix 1.G for a minimum duration of 30 minutes without loss of integrity in the wet condition is considered to meet Level 3 fire endurance standard (L3).

6.4 Level 3 Modified Test

- i) Level 3 modified test for deluge systems is considered to provide the fire endurance necessary for a piping system to survive a local fire of short duration, with a simulated dry condition and subsequent flowing water condition.
- ii) The system's functions are capable of being restored after the fire has been extinguished.
- iii) Piping having passed the fire endurance test specified in Appendix 1.H for a minimum duration of 5 minutes in dry condition and 25 minutes in wet condition without loss of integrity, is considered to meet the Wet/Dry fire endurance standard (L3-WD).

6.5 Fire Endurance Coating

When a fire protective coating of pipes and fittings is necessary for achieving the fire endurance standards required, the following requirements apply:

- i) Pipes are generally to be delivered from the manufacturer with the protective coating applied, with onsite application limited to that necessary for installation purposes (i.e., joints). See Appendix 1.C.7 regarding the application of the fire protection coating on joints.
- ii) The fire protection properties of the coating are not to be diminished when exposed to salt water, oil or bilge slops. It is to be demonstrated that the coating is resistant to products likely to come in contact with the piping.
- iii) In considering fire protection coatings, such characteristics as thermal expansion, resistance against vibrations and elasticity are to be taken into account.
- iv) The fire protection coatings are to have sufficient resistance to impact to retain their integrity.

7. Flame Spread

All pipes except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, are to have low flame spread characteristics.

- i) The test procedures in IMO Resolution A.653 (16), modified for pipes as indicated in Appendix 1, Section 9, are to be used for determining the flame spread characteristics.
- ii) Piping materials giving average values for all of the surface flammability criteria not exceeding the values listed in Resolution A.653(16) (surface flammability criteria of bulkhead, wall and ceiling linings) are considered to meet the requirements for low flame spread.
- iii) Alternatively, flame spread testing in accordance with ASTM D635 may be used in lieu of the IMO flame spread test, provided such test is acceptable to the Administration.
- iv) Under the ASTM D635 test method, the plastic pipe may be considered self-extinguishing if none of the ten, or no more than one of the twenty, specimens have burned to the 100-mm (3.9 in.) mark.

8. Electrical Conductivity

8.1 Piping Conductivity

Piping conveying fluids with a conductivity less than 1000 pico-siemens per meter is to be electrically conductive.

8.2 Hazardous Areas

Regardless of the fluid being conveyed, plastic pipes are to be electrically conductive if the piping passes through a hazardous area.

8.3 Electrical Resistance

Where electrically conductive pipe is required, the resistance per unit length of the pipes and fittings is not to exceed 1×10^5 Ohm/m (3×10^4 Ohm/ft). See also Appendix 1.C.4.

8.4 Non-homogeneous Conductivity

Pipes and fittings with layers having different conductivity are to be protected against the possibility of spark damage to the pipe wall.

9. Marking

Plastic pipes and other components are to be permanently marked with identification in accordance with a recognized standard. Identification is to include pressure ratings, the design standard to which the pipe or fitting is manufactured, and the material with which the pipe or fitting is constructed.

Table 1. Fire Endurance Requirement Matrix

PIPING SYSTEMS		LOCATION										
		A	B	C	D	E	F	G	H	I	J	K
HYDROCARBON & CARGO [Flammable cargoes with flash point < 60°C (140°F)]												
1	Cargo lines	NA	NA	L1			0	NA	0	0	NA	L1 ⁽²⁾
2	Crude oil washing lines	NA	NA	L1			0	NA	0	0	NA	L1 ⁽²⁾
3	Vent lines	NA	NA	NA			0	NA	0	0	NA	X
3a	Process lines	NA	NA	NA			0	NA	0	0	NA	L1 ⁽²⁾
3b	Produced water lines	NA	NA	NA			0	NA	0	0	NA	L3 ⁽¹⁰⁾
INERT GAS												
4	Water seal effluent line	NA	NA	0 ⁽¹⁾			0 ⁽¹⁾	0 ⁽¹⁾	0 ⁽¹⁾	0 ⁽¹⁾	NA	0
5	Scrubber effluent line	0 ⁽¹⁾	0 ⁽¹⁾	NA			NA	NA	0 ⁽¹⁾	0 ⁽¹⁾	NA	0
6	Main line	0	0	L1			NA	NA	NA	0	NA	L1 ⁽⁶⁾
7	Distribution lines	NA	NA	L1			0	NA	NA	0	NA	L1 ⁽²⁾
FLAMMABLE LIQUIDS [flash point > 60°C (140°F)]												
8	Cargo lines	X	X	L1			NA ⁽³⁾	0	0	0	NA	L1
9	Fuel oil	X	X	L1			NA ⁽³⁾	0	0	0	L1	L1
10	Lubricating oil	X	X	L1			NA	NA	NA	0	L1	L1
11	Hydraulic oil	X	X	L1			0	0	0	0	L1	L1
SEA WATER (See Note 1)												
12	Bilge main and branches	L1 ⁽⁷⁾	L1 ⁽⁷⁾	L1			NA	0	0	0	NA	L1
13	Fire main	L1	L1	L1			NA	NA	0	0	X	L1/L3 ⁽¹¹⁾
13a	Water spray (Deluge)	L1	L1	L1			NA	NA	0	0	X	L1/LWD ⁽¹¹⁾
14	Foam system	L1	L1	L1			NA	NA	NA	0	L1	L1
15	Sprinkler system	L1	L1	L3			NA	NA	0	0	L3	L3
16	Ballast	L3	L3	L3			0	0	0	0	L2	L2
17	Cooling water, essential services	L3	L3	NA			NA	NA	0	0	NA	L2
18	Tank cleaning services, fixed machines	NA	NA	L3			0	NA	0	0	NA	L3 ⁽²⁾
19	Non-essential systems	0	0	0			NA	0	0	0	0	0
FRESH WATER												
20	Cooling water, essential services	L3	L3	NA			NA	0	0	0	L3	L3
21	Condensate return	L3	L3	L3			NA	NA	NA	0	0	0
22	Non-essential systems	0	0	0			NA	0	0	0	0	0
SANITARY/DRAINS/SCUPPERS												
23	Deck drains (internal)	L1 ⁽⁴⁾	L1 ⁽⁴⁾	NA			NA	0	0	0	0	0
24	Sanitary drains (internal)	0	0	NA			NA	0	0	0	0	0
25	Scuppers and discharges (overboard)	0 ^(1.8)	0 ^(1.8)	0 ^(1.8)			0	0	0	0	0 ^(1.8)	0
VENT/SOUNDING												
26	Water tanks/dry spaces	0	0	0			0	0	0	0	0	0
27	Oil tanks [flash-point > 60°C (140°F)]	X	X	X			X ⁽³⁾	0	0	0	X	X
MISCELLANEOUS												
28	Control air	L1 ⁽⁵⁾	L1 ⁽⁵⁾	L1 ⁽⁵⁾			NA	0	0	0	L1 ⁽⁵⁾	L1 ⁽⁵⁾
29	Service air (non-essential)	0	0	0			NA	0	0	0	0	0
30	Brine	0	0	NA			NA	NA	NA	0	0	0
31	Auxiliary low pressure steam (Pressure ≤ bar [7 kgf/cm ² , 100 psi])	L2	L2	0 ⁽⁹⁾			0	0	0	0	0 ⁽⁹⁾	0 ⁽⁹⁾

Table 1. Fire Endurance Requirement Matrix (continued)

Locations		Abbreviations	
A	Category A machinery spaces	L1	Fire endurance test in dry conditions, 60 minutes, in accordance with Appendix 1.F.
B	Other machinery spaces		
C	Cargo pump rooms	L2	Fire endurance test in dry conditions, 30 minutes, in accordance with Appendix 1.F.
D	Not needed	L3	Fire endurance test in wet conditions, 30 minutes, in accordance with Appendix 1.G.
E	Not needed		
F	Cargo tanks	LWD	Fire endurance test in dry condition, 5 minutes, and wet condition in 25 minutes, in accordance with Appendix 1.G. & Appendix 1.H.
G	Fuel oil tanks		
H	Ballast water tanks	0	No fire endurance test required
I	Cofferdams, void spaces, pipe tunnels and ducts	NA	Not applicable
J	Accommodation, service and control spaces	X	Metallic materials having a melting point greater than 925°C (1700°F)
K	Open decks		

Notes:

- 1 Where non-metallic piping is used, remotely controlled valves are to be provided at the ship's side. These valves are to be controlled from outside the space.
- 2 Remote closing valves are to be provided at the cargo tanks and hydrocarbon liquid and gas retaining components as applicable.
- 3 When cargo tanks contain flammable liquids with a flash point greater than 60°C (140°F), "0" may replace "NA" or "X".
- 4 For drains serving only the space concerned "0" may replace "L1".
- 5 When controlling functions are not required by statutory requirements "0" may replace "L1".
- 6 For pipe between machinery space and deck water seal, "0" may replace "L1".
- 7 For passenger vessels, "X" is to replace "L1".
- 8 Scuppers serving open decks in positions 1 and 2, as defined in Regulation 13 of the International Convention on Load Lines, 1966, are to be "X" throughout unless fitted at the upper end with the means of closing capable or being operated from a position above the freeboard deck in order to prevent down-flooding.
- 9 For essential services, such as fuel oil tank heating and ship's whistle, "X" is to replace "0".
- 10 Metallic ESD valves are to be provided together with fire detection, fire fighting and shutdown system
- 11 Lower level of fire resistant tests (Level 3 and Level WD) may be considered for the fire water ring main and deluge systems provided the system arrangement meet Appendix 1.G. of this Rule.

C. Installation of Plastic Pipes

1. Supports

1.1 Spacing

Selection and spacing of pipe supports in shipboard systems are to be determined as a function of allowable stresses and maximum deflection criteria.

Support spacing is not to be greater than the pipe manufacturer's recommended spacing. The selection and spacing of pipe supports are to take into account:

- Pipe dimensions
 - Mechanical and physical properties of the pipe material
 - Mass of pipe and contained fluid
 - External pressure
 - Operating temperature
 - Thermal expansion effects
 - Loads due to external forces
 - Thrust forces
 - Water hammer
 - Vibrations to which the system may be subjected
- Combinations of these loads are to be taken into consideration for the design.

1.2 Bearing

Each support is to evenly distribute the load of the pipe and its contents over the full width of the support. Measures are to be taken to minimize wear of the pipes where they come in contact with the supports.

1.3 Heavy Components

Heavy components in the piping system, such as valves and expansion joints, are to be independently supported.

1.4 Working of the Hull on a Floating Installation

The supports are to allow for relative movement between the pipes and the vessel/unit's structure, properly accounting for the difference in the coefficients of thermal expansion and deformations of the vessel/unit's hull and its structure.

1.5 Thermal Expansion

When calculating the thermal expansion, the system's working temperature and the temperature at which assembling is performed are to be taken into account.

2 External Loads

When installing piping, allowance is to be made for temporary point loads, where applicable.

These allowances are to include at least the force exerted by a load (person) of 980 N (100 kgf, 220 lbf) at midspan on any pipe more than 100-mm (4 in.) nominal diameter.

Pipes are to be protected from mechanical damage where necessary.

3 Plastic Pipe Connections

3.1 General Requirements

The following general principles are applicable to all pipe connections:

- i) The strength of fittings and joints is not to be less than that of the piping they connect.
- ii) Pipes may be joined using adhesive bonded, welded, flanged or other types of joints.
- iii) Tightening of flanged or mechanically coupled joints is to be performed in accordance with manufacturer's instructions.
- iv) Adhesives, when used for joint assembly, are to be suitable for providing a permanent seal between the pipes and fittings through the temperature and pressure range of the intended application.

3.2 Procedure and Personal Qualifications

Joining techniques are to be in accordance with manufacturer's installation guidelines.

- i) Personnel performing these tasks are to be qualified to the satisfaction of the BKI, and each bonding procedure is to be qualified before shipboard piping installation commences.
- ii) Requirements for joint bonding procedures are in Appendix 1.E.

4 Electrical Conductivity

Where electrically conductive pipe is required by Appendix 1.B.8, installation of the pipe is to be in accordance with the following:

4.1 Resistance Measurement

The resistance to earth (ground) from any point in the system is not to exceed 1 mega ohm. The resistance is to be verified and confirmed in the presence of the Surveyor.

4.2 Grounding (Earthing) Wire

Where used, grounding (earthing) wires or bonding straps are to be accessible for inspection. The Surveyor is to verify that they are in visible locations.

5 Shell Connections on Floating Installations

Where plastic pipes are permitted in systems connected to the shell of the vessel/unit, the valves and the pipe connection to the shell are to be in accordance with Part 1, Seagoing Ships, Volume III, Section 11.D

6 Bulkhead and Deck Penetrations

The integrity of watertight bulkheads and decks is to be maintained where plastic pipes pass through them.

- i) Where plastic pipes pass through "A" or "B" class divisions, arrangements are to be made to ensure that fire endurance is not impaired. These arrangements are to be tested in accordance with IMO Resolution. A.754(18), Recommendation on Fire Resistance Tests for "A", "B" and "F" Class Divisions, as amended.
- ii) If the bulkhead or deck is also a fire division, and destruction by fire of plastic pipes may cause inflow of liquid from tank, a metallic shutoff valve operable from above the bulkhead deck is to be fitted at the bulkhead or deck.

7 Application of Fire Protection Coatings

Where required by fire endurance criteria in B.6, fire protection coatings are to be applied on the joints after performing hydrostatic pressure tests of the piping system (see Appendix 1.J).

The fire protection coatings are to be applied in accordance with the manufacturer's recommendations, using a procedure approved in each particular case.

D. Manufacturing of Plastic Pipes

The manufacturer should have a quality system and be certified in accordance with BKI Rules for Approval of Manufacture and Service Supplier or ISO 9001.

The quality system is to consist of elements necessary to ensure that pipes and components are produced with consistent and uniform mechanical and physical properties in accordance with recognized standards, and is to include the following tests:

- i) Samples of pipe are to be tested to determine the short-term and long-term hydrostatic design strength. These samples are to be selected randomly from the production facilities.
- ii) For piping that is required to be electrically conductive, representative samples of pipe are to be tested to determine electrical resistance per unit length.
- iii) Random samples of pipe are to be tested to determine the adhesion qualities of its coating.

If the manufacturer does not have a certified quality system, the tests listed above will be required using samples from each batch of pipes being supplied for use aboard the facility.

Regardless of whether the manufacturer has a certified quality system, each length of pipe is to be tested at the manufacturer's production facility (shop test) to a hydrostatic pressure not less than 1.5 times the maximum allowable internal pressure of the pipe (Appendix 1.B.1).

E. Plastic Pipe Bonding Procedure Qualification

1 Procedure Qualification Requirements

1.1 Joint Bonding Parameters

To qualify joint bonding procedures, the tests and examinations specified herein are to be successfully completed. The procedure for making bonds is to include the following:

- i) Materials used
- ii) Tools and fixtures
- iii) Environmental requirements
- iv) Joint preparation requirements
- v) Cure temperature
- vi) Dimensional requirements and tolerances
- vii) Test acceptance criteria for the completed assembly

1.2 Re-qualification

Any change in the bonding procedure that will affect the physical and mechanical properties of the joint will require the procedure to be re-qualified.

2 Procedure Qualification Testing

2.1 Test Assembly

A test assembly is to be fabricated in accordance with the procedure to be qualified, and is to consist of at least one pipe-to-pipe joint and one pipe-to-fitting joint.

- i) When the test assembly has been cured, it is to be subjected to a hydrostatic test pressure at a safety factor of 2.5 times the design pressure of the test assembly, for not less than one hour.
- ii) No leakage or separation of joints is to be allowed.
- iii) The test is to be conducted so that the joint is loaded in both longitudinal and circumferential direction.

2.2 Pipe Size

Selection of the pipes used for test assembly is to be in accordance with the following:

- i) When the largest size to be joined is 200 mm (8 in.) in nominal outside diameter or smaller, the test assembly is to be the largest pipe size to be joined.
- ii) When the largest size to be joined is greater than 200 mm (8 in.) in nominal outside diameter, the size of the test assembly is to be either 200 mm (8 in.) or 25% of the largest piping size to be joined, whichever is greater.

2.3 Bonding Operator Qualification

When conducting performance qualifications, each bonder and each bonding operator are to make up test assemblies, the size and number of which are to be as required above.

F. Tests by the Manufacturer - Fire Endurance Testing of Plastic Piping in Dry Condition (For Level 1 and Level 2)

1 Test Method

1.1 Furnace Test Temperature

The specimen is to be subjected to a furnace test with fast temperature increase similar to that likely to occur in a fully-developed liquid hydrocarbon fire. The time/temperature is to be as follows:

- | | | |
|------|--------------------------|-----------------|
| i) | At the end of 5 minutes | 945°C (1733°F) |
| ii) | At the end of 10 minutes | 1033°C (1891°F) |
| iii) | At the end of 15 minutes | 1071°C (1960°F) |
| iv) | At the end of 30 minutes | 1098°C (2008°F) |
| v) | At the end of 60 minutes | 1100°C (2012°F) |

1.2 Furnace Temperature Control

The accuracy of the furnace control is to be as follows:

- i) During the first 10 minutes of the test, variation in the area under the curve of mean furnace Temperature is to be within $\pm 15\%$ of the area under the standard curve.
- ii) During the first 30 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within $\pm 10\%$ of the area under the standard curve.
- iii) For any period after the first 30 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within $\pm 5\%$ of the area under the standard curve.
- iv) At any time after the first 10 minutes of the test, the difference in the mean furnace temperature from the standard curve is to be within $\pm 100^\circ\text{C}$ ($\pm 180^\circ\text{F}$).

1.3 Furnace Temperature Measurement

The locations where the temperatures are measured, the number of temperature measurements, and the measurement techniques are to be approved by BKI.

2 Test Specimen

2.1 Pipe Joints and Fittings

The test specimen is to be prepared with the joints and fittings intended for use in the proposed application.

2.2 Number of Specimens

The number of specimens is to be sufficient to test typical joints and fittings, including joints between non-metal and metal pipes and metal fittings to be used.

2.3 End Closure

The ends of the specimen are to be closed. One of the ends is to allow pressurized nitrogen to be connected. The pipe ends and closures may be outside the furnace.

2.4 Orientation

The general orientation of the specimen is to be horizontal, and it is to be supported by one fixed support, with the remaining supports allowing free movement. The free length between supports is not to be less than 8 times the pipe diameter.

2.5 Insulation

Most materials will require a thermal insulation to pass this test. The test procedure is to include the insulation and its covering.

2.6 Moisture Condition of Insulation

- i) If the insulation contains or is liable to absorb moisture, the specimen is not to be tested until the insulation has reached an air dry condition, defined as equilibrium with an ambient atmosphere of 50% relative humidity at $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$).
- ii) Accelerated conditioning is permissible, provided the method does not alter the properties of the component material.
- iii) Special samples are to be used for moisture content determination, and conditioned with the test specimen.
- iv) These samples are to be so constructed as to represent the loss of water vapor from the specimen having similar thickness and exposed faces.

3 Test Condition

A nitrogen pressure inside the test specimen is to be maintained automatically at 0.7 ± 0.1 bar (0.7 ± 0.1 kgf/cm², 10 ± 1.5 psi) during the test.

Means are to be provided to record the pressure inside the pipe and the nitrogen flow into and out of the specimen, in order to indicate leakage.

4 Acceptance Criteria

4.1 During the Test

During the test, no nitrogen leakage from the sample is to occur.

4.2 After the Test

- i) After termination of the furnace test, the test specimen and its fire protective coating, if any, are to be allowed to cool to ambient temperature in still air, then tested to the maximum allowable pressure of the pipes as defined in Appendix 1.B.1 and Appendix 1.B.2
- ii) The pressure is to be held for a minimum of 15 minutes without leakage.
- iii) Where practicable, the hydrostatic test is to be conducted on bare pipe (i.e., coverings and insulation removed) so that any leakage will be visible.

4.3 Alternative Tests

Alternative test methods and/or test procedures considered to be at least equivalent, including open pit testing method, may be accepted in cases where the pipes are too large for the test furnace.

G. Tests by the Manufacturer - Fire Endurance Testing of Water-filled Plastic Piping (For Level 3)

1 Test Method

1.1 Burner

A propane multiple burner test with a fast temperature increase is to be used.

1.2 Pipe \leq 152 mm (6 in.) OD

For piping up to and including 152 mm (6 in.) OD:

- i) The fire source is to consist of two rows of 5 burners, as shown in Figure 1.
- ii) A constant heat flux averaging 113.6 kW/m^2 ($36,000 \text{ BTU/hr-ft}^2$) $\pm 10\%$ is to be maintained $12.5 \pm 1 \text{ cm}$ ($5 \pm 0.4 \text{ in.}$) above the centerline of the burner array. This flux corresponds to a premix flame of propane with a fuel flow rate of 5 kg/hr (11 lb/hr) for a total heat release of 65 kW (3700 BTU/min.).
- iii) The gas consumption is to be measured with an accuracy of at least $\pm 3\%$ in order to maintain a constant heat flux.
- iv) Propane with a minimum purity of 95% is to be used.

1.3 Pipes $>$ 152 mm (6 in.) OD

For piping greater than 152 mm (6 in.) OD:

- i) One additional row of burners is to be included for each 51 mm (2 in.) increase in pipe diameter.
- ii) A constant heat flux averaging 113.6 kW/m^2 ($36,000 \text{ BTU/hr-ft}^2$) $\pm 10\%$ is still to be maintained at the $12.5 \pm 1 \text{ cm}$ ($5 \pm 0.4 \text{ in.}$) height above the centerline of the burner array.
- iii) The fuel flow is to be increased as required to maintain the designated heat flux.
- iv) Propane with a minimum purity of 95% is to be used.

1.4 Burner Type and Arrangement

- i) The burners are to be of type “Sievert No. 2942” or equivalent which produces an air mixed flame.
- ii) The inner diameter of the burner heads is to be 29 mm (1.14 in.). See Fig. 1.
- iii) The burner heads are to be mounted in the same plane and supplied with gas from a manifold.
- iv) If necessary, each burner is to be equipped with a valve to adjust the flame height.

1.5 Burner Position

- i) The height of the burner stand is also to be adjustable.
- ii) It is to be mounted centrally below the test pipe, with the rows of burners parallel to the pipe’s axis.
- iii) The distance between the burner heads and the pipe is to be maintained at $12.5 \pm 1 \text{ cm}$ ($5 \pm 0.4 \text{ in.}$) during the test.
- iv) The free length of the pipe between its supports is to be $0.8 \pm 0.05 \text{ m}$ ($31.5 \pm 2 \text{ in.}$). See Fig. 2.

2 Test Specimen

2.1 Pipe Length

Each pipe is to have a length of approximately 1.5 m (5 ft).

2.2 Pipe Joints and Fittings

The test pipe is to be prepared with the permanent joints and fittings intended to be used.

Only valves and straight joints, rather than elbows and bends, are to be tested, as the adhesive in the joint is the primary point of failure.

2.3 Number of Specimens

The number of pipe specimens is to be sufficient to test all typical joints and fittings.

2.4 End Closure

The ends of each pipe specimen are to be closed. One of the ends is to allow pressurized water to be connected.

2.5 Moisture of Insulation

- i) If the insulation contains or is liable to absorb moisture, the specimen is not to be tested until the insulation has reached an air dry condition, defined as equilibrium with an ambient atmosphere of 50% relative humidity at $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$).
- ii) Accelerated conditioning is permissible, provided the method does not alter the properties of the component material.
- iii) Special samples are to be used for moisture content determination, and conditioned with the test specimen.
- iv) These samples are to be so constructed as to represent the loss of water vapor from the specimen having similar thickness and exposed faces.

2.6 Orientation

- i) The pipe samples are to rest freely in a horizontal position on two V-shaped supports.
- ii) The friction between pipe and supports is to be minimized.
- iii) The supports may consist of two stands, as shown in Fig. 2.

2.7 Relief Valve

A relief valve is to be connected to one of the end closures of each specimen.

3 Test Conditions

3.1 Sheltered Test Site

The test is to be carried out in a sheltered test site in order to prevent any draft influencing the test.

3.2 Water-filled

Each pipe specimen is to be completely filled with de-aerated water to exclude air bubbles.

3.3 Water Temperature

The water temperature is not to be less than 15°C (59°F) at the start, and is to be measured continuously during the test.

The water is to be stagnant and the pressure maintained at 3 ± 0.5 bar (3.1 ± 0.5 kgf/cm², 43.5 ± 7.25 psi) during the test.

4 Acceptance Criteria

4.1 During the Test

During the test, no leakage from the sample(s) is to occur, except that slight weeping through the pipe wall may be accepted.

4.2 After the Test

- i) After termination of the burner test, the test specimen and its fire protective coating, if any, are to be

allowed to cool to ambient temperature, then tested to the maximum allowable pressure of the pipes as defined in Appendix 1.B.1 and Appendix 1.B.2.

- ii) The pressure is to be held for a minimum of 15 minutes without significant leakage [i.e., not exceeding 0.2 liters/min. (0.05 gpm)].
- iii) Where practicable, the hydrostatic test is to be conducted on bare pipe (i.e., coverings and insulation removed) so that any leakage will be visible.

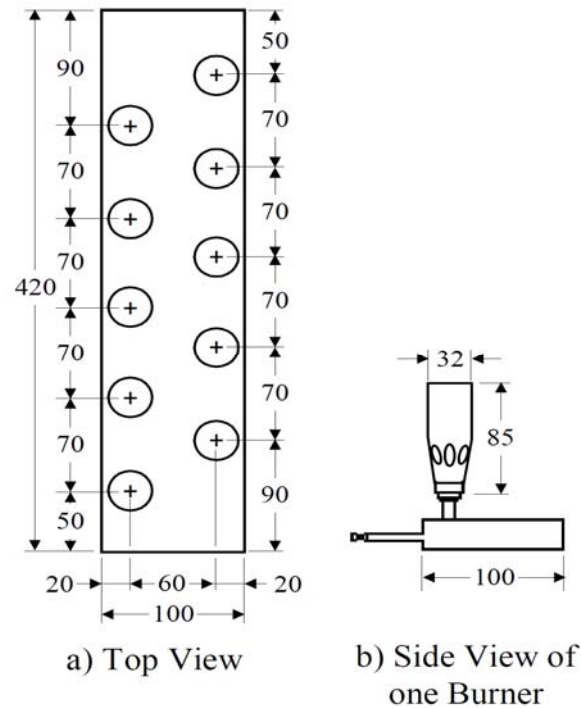


Fig. 1 Fire Endurance Test Burner Assembly

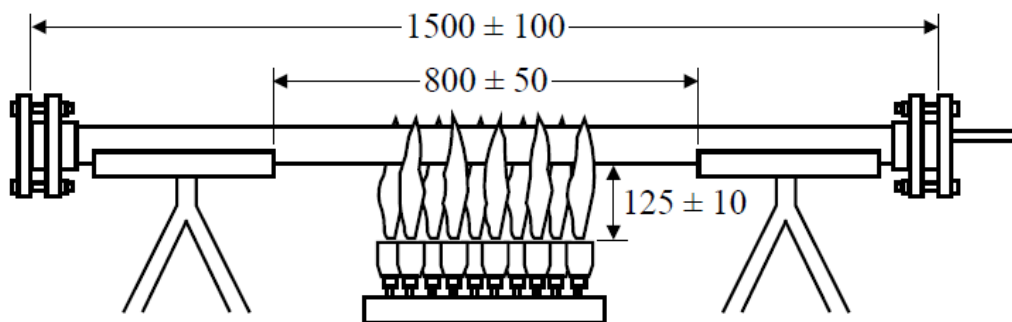


Fig. 2. Fire Endurance Test Stand with Mounted Sample

H. Tests by the Manufacturer - Wet/Dry Fire Endurance Testing of Plastic Piping Used in Deluge System (For Level 3 Modified Test-Level 3 WD) (Adopted from USCG PFM 1-98)

1. General

The wet/dry fire endurance testing is to consist of conducting the Level 3 fire endurance testing specified in Appendix 1.F, with the following modifications:

- i) For the first 5 minutes of the test, the piping is to be maintained in the dry condition at atmospheric pressure in lieu of containing stagnant water.
- ii) After completion of the first 5 minutes of the test, the pipe specimen is to be completely filled with flowing water.
- iii) Air is to be bled from the opposite end of the piping via a test connection, until a steady flow of water at the specified flow rate and pressure is observed.
- iv) The flow rate should not exceed the minimum pressure and flow rate that will be observed at the hydraulically most remote nozzle of the specific deluge system installation. The elapsed time between first introducing water to the test specimen until the specified flow rate and pressure is obtained, is not to exceed one minute. Testing at the specified flow rate and pressure will qualify the piping for all flow rates greater than that specified in the test.
- v) The total test time including dry and wet time shall be 30 minutes.

All other requirements of Level 3 testing are to be followed without deviation.

I. Tests by the Manufacturer - Flame Spread

1. Test Method

Flame spread of plastic piping is to be determined by IMO Resolution A.653(16) entitled “Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling, and Deck Finish Materials”, with the following modifications:

- i) Tests are to be performed on each pipe material and size.
- ii) The test sample is to be fabricated by cutting pipes lengthwise into individual sections, and assembling the sections into a test sample as representative as possible of a flat surface. A test sample is to consist of at least two sections. The test sample is to be at least 800 ± 5 mm (31.5 ± 0.2 in.) long. All cuts are to be made normal to the pipe wall.
- iii) The number of sections that must be assembled to form a test sample is to correspond to the nearest integer number of sections which makes up a test sample with an equivalent linearized surface width between 155 mm (6 in.) and 180 mm (7 in.). The surface width is defined as the measured sum of the outer circumference of the assembled pipe sections that are exposed to the flux from the radiant panel.
- iv) The assembled test sample is to have no gaps between individual sections.
- v) The assembled test sample is to be constructed in such a way that the edges of two adjacent sections coincide with the centerline of the test holder.
- vi) The individual test sections are to be attached to the calcium silicate backing board using wire (No. 18 recommended) inserted at 50 mm (2 in.) intervals through the board, and tightened by twisting at the back.
- vii) The individual pipe sections are to be mounted so that the highest point of the exposed surface is in the same plane as the exposed flat surface of a normal surface.
- viii) The space between the concave unexposed surface of the test sample and the surface of the calcium silicate backing board is to be left void.
- ix) The void space between the top of the exposed test surface and the bottom edge of the sample holder frame is to be filled with a high temperature insulating wool if the width of the pipe segments extend under the side edges of the frame holding the sample.

J. Testing Onboard After Installation

Piping systems are to be subjected to a hydrostatic test pressure of not less than 1.5 times the design pressure to the satisfaction of the Surveyor. For piping required to be electrically conductive, grounding (earthing) is to be checked and random resistance testing is to be conducted to the satisfaction of the Surveyor.

Appendix 2

Fire Tests for Non-metallic Hoses

API Spec. 16C “Specifications for Choke and Kill Systems”

A. Fire Test

1. Flexible Choke and Kill Lines shall withstand a 5 to 30 minute fire test as described in paragraphs 2 through 6.

The lines shall not have visible leakage under nominal working pressure as a result of the Fire Test during the test period.

2. The fire test shall consist of direct exposure to flame or to radiation within a furnace. The temperature indicated by thermocouples at the end of the time period, shall be equal to or higher than 704°C (1300°F).

3. Thermocouples are to be positioned around the flexible line within 25.4 mm (1 in.) of the outer surface of the line or end fittings. At least one thermocouple near the flexible line, and one thermocouple near the surface of the end fitting shall reach 704°C (1300°F).

4. The flexible line must be pressurized full of water. The line may be tested horizontally, or vertically, according to the choice of the manufacturer.

5. The test sample shall be a minimum of 2.5 m (10 feet) in length. At least 1.25 m of the flexible line and one end fitting shall be exposed to fire or radiation.

6. After exposure to the fire, the line must remain pressurized either until a cool down, or if a leak occurs after the test period, until the pressure is reduced to one atmosphere. The line must not burst during this period.

API Spec. 16D “Specifications for Control Systems for Drilling Well Control Equipment”

B. Flame Tests

The control lines, and any component of the control lines to a surface mounted BOP stack or diverter located in a division 1 area, as defined by API 500 (Area Classification) shall be capable of containing the normal operating pressure in a flame temperature of 1093°C (2000°F) for a period of three minutes without leakage (includes end connections).

Where hoses are used to connect the control system to the well control equipment, flame resistance test shall be conducted on a typical specimen in the following manner:

1. The test specimen shall be fitted with pressure end coupling and installed in a test facility capable of maintaining a 2000°F (±100) flame temperature over at least 180 angle degrees of the test specimen inclusive of approximately 305 mm (12 in.) of the specimen length, including one end connection.

2. The specimen is to be connected to a regulated water pressure source equal to normal operating pressure.

3. Thermocouples shall be located within the flame area to ensure that the test temperature is maintained at the end coupling, the coupling to hose transition and at a point along the hose at least 152 mm (6 in.) from the hose-to-coupling transition.

4. Deliverable hoses typical of successful test specimens shall be permanently identified in a manner to permit tracing of the test specimen and test facility. The control system manufacturers shall be responsible for maintaining hose compliance certifications on hoses which they supply in accordance with this specification.

Table 1. Non-Metallic Hose Requirements

Floating Installation			
Systems	Service	Burst Pressure	Fire Test
Marine Support	Non flammable fluids, compressed air and gas	4 × MAWP	None
	Flammable fluids, FO, LO, Hydraulic oil		SV or MODU Rules
	Fire water and deluge		ISO 15540/15541
Process and Process Support	Non-flammable fluids, compressed air and gas	3 × MAWP	None
	Flammable fluids, FO, LO, Hydraulic oil, Hydrocarbon and gas		API Spec 16C
	Choke and kill	2.5 × MAWP	
	Hydraulic oil for BOP controls	3 × MAWP	API Spec 16D
Fixed Installation			
Systems	Service	Burst Pressure	Fire Test
Process, Process and Platform Support	Non-flammable fluids, compressed air and gas	3 × MAWP	None
	Flammable fluids, FO, LO, Hydraulic oil, Hydrocarbon and gas		API Spec 16C
	Fire water and deluge		ISO 15540/15541
	Choke and kill	2.5 × MAWP	API Spec 16C
	Hydraulic oil for BOP control	3 × MAWP	API Spec 16D

Note: MAWP: Maximum Allowable Working Pressure

Appendix 3

Fiber Reinforced Plastic (FRP) Gratings

Based on U.S.C.G. Policy File Memorandum (PFM 2-98) dated 19 June 1998

1. General

1.1 FRP gratings are not specifically addressed in the individual vessel regulations. However, the resins typically used in the manufacture of these gratings are combustible and heat sensitive; therefore, FRP gratings use must be limited based on the requirements discussed below.

1.2 These requirements are not intended to eliminate any other design criteria or requirement pertaining to the material, construction, or performance of the FRP gratings in the non-fire condition.

2. FRP Grating Material Systems

2.1 All fire integrity, flame spread, smoke, and toxicity testing, where required, shall be conducted on each material system.

2.2 Changes in either the type, amount, and/or architecture, of either the reinforcement materials, resin matrix, coatings, or manufacturing processes shall require separate testing in accordance with the procedures below. Manufacturers should provide evidence, such as enrollment in a follow-up program, that the FRP gratings being installed are the same as those which were tested and approved.

3. Fire Test Requirements

3.1 Structural Fire Integrity*

The structural fire integrity matrix in Appendix 3.5 establishes the structural fire integrity characteristics that FRP gratings should possess, based on location and service. Where a specific application satisfies more than one block in the matrix, the highest level of fire integrity shall be required. The test procedures required to qualify FRP gratings to one of three levels are described in Appendix 3.4. The BKI Surveyor shall determine the location and service of the FRP gratings, keeping in mind the following considerations for each of the three performance levels:

3.1.1 Level 1 (L1)

FRP gratings meeting the L1 performance criteria are intended to be satisfactory for use in escape routes or access for firefighting, emergency operation or rescue, after having been exposed to a significant hydrocarbon or cellulosic fire incident. In addition, they are also acceptable for the services and functions described for levels L2 and L3.

3.1.2 Level 2 (L2)

FRP gratings meeting the L2 performance criteria are intended to be satisfactory for use in open deck areas where groups of people are likely to assemble, such as temporary safe refuge or lifeboat embarkation areas. In addition, they are also acceptable for the services and functions described for level L3.

3.1.3 Level 3 (L3)

FRP gratings meeting the L3 performance criteria are intended to be satisfactory for use in egress routes and any areas that may require access for firefighting, rescue or emergency operations during exposure to or shortly after exposure to a transitory hydrocarbon or cellulosic fire.

** The structural fire integrity requirements are intended for self-supporting personnel platforms or walkways, and are not intended for grating overlayed on steel decking or used in other applications such as pipe guards, sea- chest screening, safety guards, etc.*

3.2 Fire Retardance

All FRP gratings should be fire retardant; this can be demonstrated by testing to ASTM E-84, Standard Test Method for the Surface Burning Characteristics of Building Materials with a flame spread rating not to exceed 25, or by meeting the requirements in Appendix 3.3.1 or Appendix 3.3.2 below.

3.3 Flame Spread

All FRP gratings, except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, should have low flame spread characteristics as determined by one of the following test procedures:

3.3.1 Tested to ASTM E-84 with a flame spread rating not to exceed 20; or

3.3.2 Tested to IMO Resolution A.653(16), Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling and Deck Finish Materials and meeting the criteria for bulkheads, linings, or ceilings.

3.4 Smoke Generation

FRP gratings within accommodation, service and control spaces, should have low smoke characteristics as determined by one of the following test procedures:

3.4.1 Tested to ASTM E-84 with a smoke developed rating not to exceed 10; or

3.4.2 Tested in accordance with the IMO Fire Test Procedures Code (FTPC), Resolution MSC.61(67), Part 2 - Smoke and Toxicity Test, and meeting the criteria established for materials used as bulkheads, linings, or ceilings.

4 Structural Fire Integrity Test Procedures

4.1 Level 1

To be qualified as level 1 (L1), the FRP gratings shall meet the requirements for qualification as level 3 and level 2, and in addition shall be subjected to the following test procedures:

4.1.1 Three (3) FRP grating specimens, after being subjected to the level 2 testing, shall be unloaded and prepared for impact testing in the manner specified for horizontal specimens in ASTM E-695, Standard Method of Measuring Resistance of Wall, Floor, and Roof Construction to Impact Loading. The test specimens shall be secured as required in section 8.3 of ASTM E-695 except that the span shall be 200 mm less than the specimen length. A lead shot bag of 40 kg mass shall be dropped once from a height of 2 m such that the point of impact is in the center of the span. The specimens shall then be uniformly loaded as required by the level 2 test procedures.

4.1.2 The test will be considered successful if all three (3) specimens remain intact after being subjected to the impact test and the level 2 loading test. Failure will be indicated by collapse of one or more of the gratings.

4.2 Level 2

To be qualified as level 2 (L2), the FRP gratings shall meet the requirements for qualification as level 3, and in addition shall be subjected to the following test procedures:

4.2.1 On the FRP grating specimen and the steel grating specimen subjected to the level 3 post-loaded testing, the specimen shall be gradually loaded in increments not to exceed 20 kg, placed in such a manner as to represent a uniformly distributed load across the span.

4.2.2 The test will be considered successful if the FRP grating remains intact at a load greater than or equal to a uniform 4.5 kN/m² (94 lbf/ft²), or greater than or equal to the steel grating failure loading, whichever is less. Failure will be indicated by collapse of the grate.

4.3 Level 3

To be qualified as level 3 (L3), the FRP gratings should be subjected to the following fire test procedures for both the post-loaded and pre-loaded tests and conditions:

4.3.1 A fire test will be conducted in accordance with ASTM E-119, Standard Test Method for Tests of Building Construction and Materials. Two tests shall be conducted in the ASTM E-119 furnace for each FRP grating design. The first fire test shall be conducted with the specimens under the specified load (pre-loaded) and the second fire test will be conducted on unloaded specimens (post-loaded). The time-temperature curve shall be the standard for E-119 or the ISO equivalent. The duration of the tests shall be as specified below.

4.3.2 Each test specimen shall be 300-350 mm wide to allow for the differences in the spacing of Longitudinal supporting members. The length of each test specimen shall be the length of the maximum span to be seen in service, plus 200 mm. Four test specimens shall be prepared as described above: two of the proposed FRP gratings and two of a similar steel grating that would be used in the same location constructed to the applicable regulations and standards (steel gratings rated at a minimum of 4.5 kN/m² (94 lbf/ft²) uniform loading with a 1.67 factor of safety are acceptable).

4.3.3 The pre-loaded test shall consist of the following:

- i) One steel grating specimen and one FRP grating specimen shall be placed adjacent to one another in the furnace, simply supported on two I-beams with a minimum flange width of 100 mm at an elevation of at least one half of the furnace height, or a minimum of 300 mm above the burners;
- ii) The specimens shall be placed on the I-beams such that 100 mm of each side of the specimen rests on each of the two I-beams;
- iii) A static load represented by a 40 kg mass shall be placed in the center span of the test specimens;
- iv) The 40 kg mass load shall consist of a steel container filled with sand, the base of which shall be square with an area of 0.9 m²;
- v) Arrangements shall be made to measure the deflection at the center of the span of each of the loaded specimens during the test, with a degree of accuracy of ± 5 mm.
 - vi) The two specimens shall be subjected to the time-temperature curve specified in the ASTM E-119;
- vii) Deflection of the two loaded test specimens shall be measured throughout the duration of the fire test, and the average furnace temperature shall be recorded when each of the two specimens has deflected a distance of L/10 (failure point) from the horizontal, where L is equal to the maximum unsupported span of the specimens; and
- viii) The test will be considered successful if the difference between the average furnace temperature at the time of failure of the steel grating and the average furnace temperature at the time of failure of the FRP grating is less than 100°C (180°F).

4.3.4 The post-loaded test shall consist of the following:

- i) One steel grating specimen and one FRP grating specimen shall be placed adjacent to one another in the furnace, simply supported on two I-beams with a minimum flange width of 100 mm at an elevation of at least one half of the furnace height;
- ii) The specimens shall be placed on the I-beams such that 100 mm of each side of the specimen rests on each of the two I-beams;
- iii) The two specimens shall be subjected to the time-temperature curve specified in the ASTM E-119 for a duration of 60 minutes;
- iv) At the end of the 60 minutes, the specimens will be allowed to cool and shall then be subjected to a static load represented by the 40 kg mass specified in the pre-loaded test above, placed in the center span of the test specimens; and
- v) The test will be considered successful if the FRP grating specimen is intact at the end of the test and does not collapse under the 40 kg mass load.

5. Structural Fire Integrity Matrix

Location	Service	Fire Integrity
Machinery Spaces	Walkways or areas which may be used for escape, or access for firefighting, emergency operation or rescue	L1 ⁽¹⁾
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	L3
Cargo Pump Rooms	All personnel walkways, catwalks, ladders, platforms or access areas	L1
Cargo Holds	Walkways or areas which may be used for escape, or access for firefighting, emergency operation or rescue	L1
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	None required
Cargo Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	None required ⁽²⁾
Fuel Oil Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	None required ⁽²⁾
Ballast Water Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	None required ⁽³⁾
Cofferdams, void spaces, double bottoms, pipe tunnels, etc.	All personnel walkways, catwalks, ladders, platforms or access areas	None required ⁽³⁾
Accommodation, service, and control spaces	All personnel walkways, catwalks, ladders, platforms or access areas	L1
Lifeboat embarkation or temporary safe refuge stations in open deck areas	All personnel walkways, catwalks, ladders, platforms or access areas	L2
Open Decks or semi-enclosed areas	Walkways or areas which may be used for escape, or access for firefighting, emergency operation or rescue	L3 ⁽⁴⁾
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	None required

Footnotes:

- 1 If the machinery space does not contain any internal combustion machinery, other oil-burning, oil-heating, or oil-pumping units, fuel oil filling stations, or other potential hydrocarbon fire sources, and has not more than 2.5 kg/m² of combustible storage, gratings of L3 integrity may be used in lieu of L1.
- 2 If these spaces are normally entered when underway, gratings of L1 integrity shall be required.
- 3 If these spaces are normally entered when underway, gratings of L3 integrity shall be required.
- 4 Vessels fitted with deck foam firefighting systems require gratings of L1 integrity for foam system operational areas and access routes.

6. Other Authorized Uses

6.1 The BKI Surveyor may authorize the use of FRP gratings without Main Office approval in applications where structural fire integrity of the FRP gratings is not a concern, provided they meet the applicable fire retardance, flame spread and smoke generation requirements set forth in Appendix 3.3.2, 3.3, and 3.4. Applications where the use of FRP gratings have been authorized in the past, without any structural fire integrity requirements, include the following:

- i) Sea chest coverings;
- ii) Small sundeck awnings and supports;
- iii) Lifeboat bilge flooring;
- iv) Electrical control flooring;
- v) Pipe guards on deck, in cargo holds, and in engine rooms;
- vi) Removable guards over hawse holes, anchor hawse pipes, and scuppers;
- vii) Personnel barriers, such as protection for electrical panels; and
- viii) Ship staging and work platforms (Occupational Safety and Health Administration (OSHA) requirements may also apply).

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Appendix 4

References, Codes and Standards

The latest edition of the following codes and standards are applicable and referenced in these Rules.

Reference	Title
API RP 2A-WSD	Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design
API RP 2D	Operation and Maintenance of Offshore Cranes
API RP 14C	Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms
API RP 14E	Design and Installation of Offshore Production Platform Piping Systems
API RP 14F	Design and Installation of Electrical Systems for fuel and floating offshore Petroleum Facilities for unclassified and class 1, division 1 and division 2 locations.
API RP 14FZ	Design and Installation of Electrical Systems for fixed and floating offshore petroleum Facilities for unclassified and Zone 0, Zone 1 and Zone 2 locations
API RP 14G	Fire Prevention and Control on Open Type Offshore Production Platforms
API RP 14J	Design and Hazards Analysis for Offshore Production Facilities
API RP 17A	Design and Operation of Subsea Production Systems
API RP 55	Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide
API RP 500	Classification of Location for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2
API RP 505	Classification of Location for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2
API RP 520	Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries
API Std. 521	Pressure-Relieving and Depressuring Systems
API RP 554	Process Instrument and Control
API Spec 2C	Offshore Cranes
API Spec 6A	Specification for Wellhead and Christmas Tree Equipment
API Spec 6FA	Fire Test for Valves
API Spec 12K	Specification for Indirect-Type Oil Field Heaters
API Spec 12L	Specification for Vertical and Horizontal Emulsion Treaters
API Spec 16C	Choke and Kill Systems
API Spec 16D	Specification for Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment
API Spec 17D	Design and Operation of Subsea Production Systems-Subsea Wellhead and Tree Equipment
API Std 607	Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats
API Std 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API Std 616	Gas Turbines for the Petroleum, Chemical, and Gas Industry Services
API Std 617	Axial and Centrifugal Compressors and Expander-compressors for Petroleum, Chemical and Gas Industry Services
API Std 618	Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services
API Std 619	Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries
API Std 620	Design and Construction of Large, Welded, Low-Pressure Storage Tanks
API Std 660	Shell-and-tube Heat Exchangers
API Std 661	Air Cooled Heat Exchangers for General Refinery Service
API Std 2000	Venting Atmospheric and Low-Pressure Storage Tanks
API RP 2030	Application of Fixed Water Spray Systems for Fire Protection in the Petroleum and Petrochemical Industries

Reference	Title
ASME B31.3	Process Piping
ASME B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
ASME B31.8	Gas Transmission and Distribution Piping Systems
ASME Sec II, Part A, B, C, D	Materials
ASME Sec V	Nondestructive Examination
ASME Sec VIII, Div 1	Rules for Construction of Pressure Vessels
ASME Sec VIII, Div 2	Alternative Rules - Rules for Construction of Pressure Vessels
ASME Sec IX	Welding and Brazing Qualifications
ASME Sec X	Fiber-Reinforced Plastic Pressure Vessels
ASTM D635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D2444	Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tub (Falling Weight)
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E140	Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness
ASTM E695	Standard Method for Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading
IEC 60331	Test for Electric cables under fire conditions
IEC 60332-3-10	Tests on electric and optical fiber cables under fire conditions: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus
IEC 60034	Rotating Electrical Machines
IEC 60079-2	Electric Apparatus for Explosive Gas Atmosphere
IEC 60092	Electrical Installations in Ships
IEC 60269	Low Voltage Fuses
IEC 60947-2	Low Voltage Switchgear and Controlgear
IEC 61508	Functional Safety of E/E/PE Safety-related Systems
IEEE 45	Recommended Practice for Electrical Installations on Shipboard
IEEE Std 242	Recommended Practice for Protection and Coordination of Industrial & Commercial Power Systems
IMO FTP Code	Fire Test Procedures
IMO MODU Code	Code for the Construction and Equipment of Mobile Offshore Drilling Units
IMO MSC Circ 582	Guidelines for the Performance and Testing Criteria, and Surveys of Low-Expansion Foam Concentrates for Fixed Fire-Extinguishing Systems
IMO MSC Circ 670	Guidelines for the Performance and Testing Criteria, and Surveys of High-Expansion Foam Concentrates for Fixed Fire-Extinguishing Systems
IMO MSC Circ 848	Revised Guidelines for the Approval of Equivalent Fixed Gas Fire-Extinguishing Systems, as Referred to in SOLAS 74, for Machinery Spaces and Cargo Pump Rooms
IMO Res. A.653(16)	Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling and Deck Finish Materials
IMO Res. A.754(18)	Recommendation on Fire Resistance Tests for “A”, “B” and “F” Class Divisions
IMO Res. MSC 61(67)	International Code for Application of Fire Test Procedures
ISO 75	Plastics - Determination of Temperature of Deflection Under Load
ISO 9001	Quality Management Systems - Requirements
ISO 10418	Petroleum and Natural Gas Industries -- Offshore Production Installations -- Analysis, Design, Installation and Testing of Basic Surface Process Safety Systems
ISO 10497	Testing of Valves - Fire Type-testing Requirements
ISO 15540	Ships and Marine Technology - Fire Resistance of Hose Assemblies - Test Methods
ISO 15541	Ships and Marine Technology - Fire Resistance of Hose Assemblies - Requirements for the Test Bench

References	Title
ISO 19921	Ships and Marine Technology - Fire Resistance of Metallic Pipe Components with Resilient and Elastomeric Seals - Test Methods
ISO 19922	Ships and Marine Technology - Fire Resistance of Metallic Pipe Components with Resilient and Elastomeric Seals - Requirements Imposed on the Test Bench
MARPOL 73/78-Annex I	Regulations for the Prevention of Pollution by Oil
NACE MR0175/ISO 15156	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production
NEMA MG-1	Rotating Electric Machinery
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 11	Standard for Low-Expansion Foam
NFPA 12	Standard for Carbon Dioxide Extinguishing Systems
NFPA 13	Installation of Sprinkler Systems
NFPA 15	Standard for Water Spray Fixed Systems
NFPA 17	Standard for Dry Chemical Systems
NFPA 20	Standard for Installation of Stationary Pumps
NFPA 30	Flammable and Combustible Liquids Code
NFPA 37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 77	Recommended Practice on Static Electricity
NFPA 96	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA 496	Standard for Purged and Pressurized Enclosed for Electrical Equipment
NFPA 780	Standard for Installation of Lightning Protection Systems
SOLAS, 1974 Chap II-2	IMO - Consolidated text of the International Convention for the Safety of Life at Sea
UL 248	Low Voltage Fuses
UK DOE/NPD	Interim Hydrocarbon Fire Resistance Test for Elements of Construction for Offshore Installation
USCG PFM 1-98	Policy File Memorandum on the Fire Performance Requirements for Plastic Pipe per IMO Resolution A.753(18)
USCG PFM 2-98	Policy File Memorandum on the Use of Fiber Reinforced Plastic (FRP) Gratings and Cable Trays

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Appendix 5

System Requirement for Floating Installations

Shipshaped Hull

**Semisubmersible, TLP or
DDCV (Spar) based Hull**

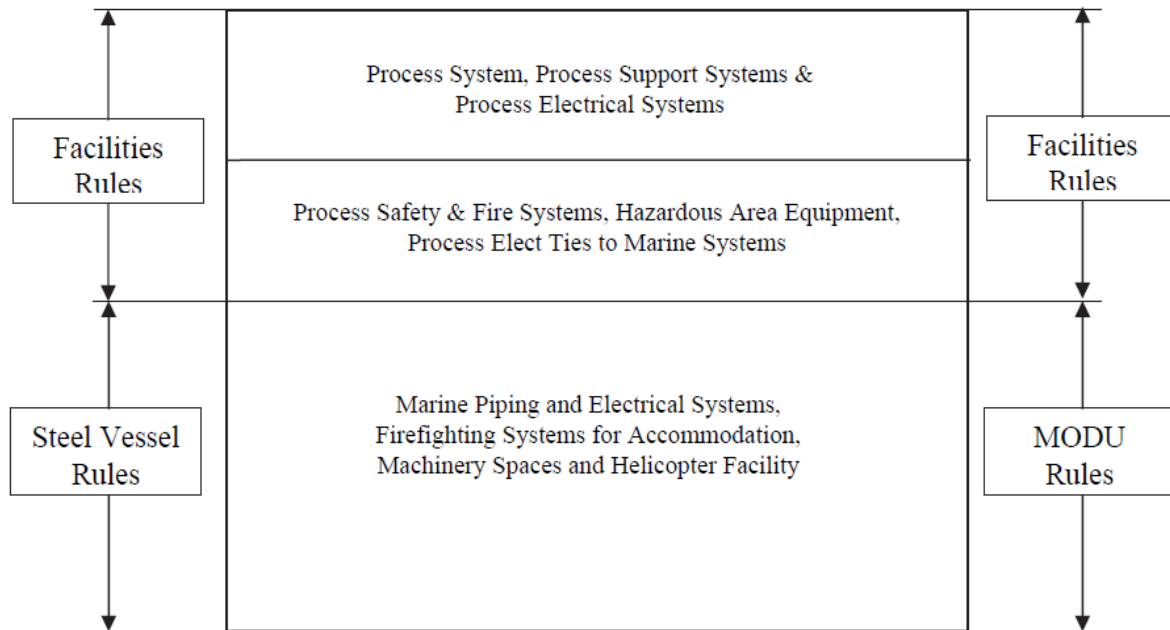


Fig. 1. System Requirement Chart

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