Rules for the Alternative Design and Arrangements for Fire Safety

Effective from 1 January 2016

Emirates Classification Society (Tasneef)
Aldar HQ 19th Floor,
Al Raha Beach, Abu Dhabi, UAE
Abu Dhabi, United Arab Emirates

Phone (+971) 2 692 2333
Fax (+971) 2 445 433
P.O. Box. 111155
info@tasneef.ae

GENERAL CONDITIONS

Definitions:

"*Administration*" means the Government of the State whose flag the Ship is entitled to fly or under whose authority the Ship is authorized to operate in the specific case.

"IACS" means the International Association of Classification Societies.

"*Interested Party*" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"*Owner*" means the registered owner, the ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the specific Rules.

"Rules" in these General Conditions means the documents below issued by the Society:

(i) Rules for the Classification of Ships or other special units;
(ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
(iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
(iv) Guides to carry out particular activities connected with Services;
(v) Any other technical document, as for example rule variations or interpretations.

"*Services*" means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

"Ship" means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.

"*Society*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

Article 1

1.1. The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
(i) sets forth and develops Rules;
(ii) publishes the Register of Ships;
(iii) issues certificates, statements and reports based on its survey activities.

1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various G overnments.

1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are regulated by these general conditions, unless expressly excluded in the particular contract.

Article 2

2.1. The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

2.2. The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatement t. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

2.3. The Society exercises due care and skill:
(i) in the selection of its Surveyors
(ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

2.4. Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

Article 3

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of the specific scope of the Service requested by the Interested Party or on its behalf.

3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as p art of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificate on and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaworthiness,

structural integrity, quality or fitness for a particular purpose or service of any Ship, structure, material, equipment or machinery inspected or tested by the Society.

3.4. Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certification or other activity at the time of the check.

3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, the Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.

In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.

In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered.

Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the services rendered by the Society are described in the Rules applicable to the specific Service rendered.

Article 4

4.1. Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2. In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of late payment, interest at the legal current rate increased by 1.5% may be demanded.

4.3. The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.

For every termination of the contract, the fees for the activities performed until the time of the termination shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination.

With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any statutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

Article 5

5.1. In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

Therefore, except as provided for in paragraph 5.2 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

5.2. Notwithstanding the provisions in paragraph 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only). Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in paragraph 5.1 above.

5.3. Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

Article 6

6.1. These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

6.2. However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the

right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.
In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the right to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

Article 7

7.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorization of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of cl ass, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.
Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

7.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's clients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as de- fined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific property of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning Sys- tem. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

7.3. In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificates, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty to ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.
In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

Article 8

8.1. Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

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CHAPTER 4 - EXAMPLE FOR METHODOLOGY APPLICATION

Chapter 1 - INTRODUCTION

1 GENERAL

The statutory requirements of the SOLAS Convention and/or national safety regulations, as applicable, regarding fire protection, detection and extinction (hereinafter referred to as "fire protection statutory requirements") are no longer mandatory for the purpose of classification, except where Tasneef carries out surveys relevant to fire protection statutory requirements on behalf of the flag Administration. In such cases, fire protection statutory requirements are considered a matter of class and therefore compliance with these requirements is also verified by Tasneef for classification purposes at class surveys.

The aim of these Rules is to provide a methodology to perform engineering analyses of fire design and arrangements alternative to those contained in SOLAS Chapter II-2.

These Rules:

a) Specifies the procedures for the acceptance by Tasneef of the alternative design and arrangements (see Chapter 2),

b) indicate a detailed methodology to carry out the analysis required (see Chapter 3), and

c) provide useful examples of methodology application (see Chapter 4).

These Rules include:

1) requirements of the MSC/Circ. 1007 "Guidelines on alternative design and arrangements for fire safety", developed by the International Maritime Organisation (IMO) to provide further guidance on SOLAS Regulation II-2/17, printed in Italic type; in reproducing the above text in these Rules applicable for the purpose of classification, unless are purposely, the words "Administration" and "Guidelines" have been replaced by the words "Tasneef" and "Rules", respectively. The word "should", wherever mentioned, is to be understood as "is to" or "are to", as appropriate.
2) additional requirements of Tasneef, printed in Roman type.

2 DEFINITIONS AND ABBREVIATIONS

a) "IMO Guidelines" means the IMO MSC/Circ. 1007 "Guidelines on alternative design and arrangements" (see item 1 of Article 1)

b) "SOLAS" means the International Convention for the Safety of Life at Sea, 1974, as amended.

c) “FSS Code” means the IMO “International Code for Fire Safety Systems”.

3 APPLICATION

a) These Rules are applied by Tasneef, upon specific agreement with the flag Administration, when carrying out surveys relevant to fire protection statutory requirements on behalf of the flag Administration.
However, these Rules do not apply in cases of alternative designs approved by the Administration of the State whose flag the ship is entitled to fly.
When the Administration has issued specific regulations covering the requirements of these Rules, Tasneef may accept such regulations in lieu of those given in these Rules.

b) These Rules are intended for application of fire safety engineering design to provide technical justification for alternative design and arrangements to SOLAS Chapter II-2. The Rules serve to outline the methodology for the engineering analysis required by SOLAS Regulation II-2/17 "Alternative design and arrangements", applying to a specific fire safety system, design or arrangements for which the approval of an alternative design deviating from the prescriptive requirements of SOLAS Chapter II-2 is sought.

c) These Rules are not intended to be applied to the type approval of individual materials and components.

d) These Rules are not intended to serve as a stand-alone document, but should be used in conjunction with fire safety engineering design guides and other literature, examples of which are referenced in Chapter 3.

Chapter 2 - DOCUMENTATION TO BE SUBMITTED TO Tasneef

1 LIST OF THE DOCUMENTATION

The following information should be provided to Tasneef for approval of the alternative design or arrangements:

a) scope of the analysis or design;
b) description of the alternative design(s) or arrangements(s), including drawings and specifications;
c) results of the preliminary analysis, to include:
  1) members of the design team (including qualifications);
  2) description of the trial alternative design and arrangements being evaluated;
  3) discussion of affected SOLAS Chapter II-2 regulations and their functional requirements;
  4) fire hazard identification;
  5) enumeration of fire hazards;
  6) selection of fire hazards; and
  7) description of design fire scenarios;
d) results of quantitative analysis:
  1) design fire scenarios:
    – *critical assumptions;*
    – *amount and composition of fire load;*
    – *engineering judgements;*
    – *calculation procedures;*
    – *test data;*
    – *sensitivity analysis; and*
    – *time-lines;*
  2) performance criteria;
  3) evaluation of trial alternative designs against performance criteria;
  4) description of final alternative design and arrangements;
  5) test, inspection and maintenance requirements; and
  6) references.

2 DOCUMENTATION TO BE MAINTAINED ON BOARD

2.1

Item 2.2 does not contain requirements applicable by Tasneef for the purpose of these Rules; it has been reproduced for reference purposes only.

2.2

Documentation of approval by the Administration and the following information should be maintained on board the ship at all times:

a) scope of the analysis or design, including the critical design assumptions and critical design;
b) features;
c) description of the alternative design and arrangements, including drawings and specifications;
d) listing of affected SOLAS Chapter II-2 regulations;
e) summary of the results of the engineering analysis and basis for approval; and
f) test, inspection and maintenance requirements.

3 REPORTING APPROVAL FORMS AND CERTIFICATES

3.1

Items 3.2, 3.3 and 3.4 do not contain requirements applicable by Tasneef for the purpose of these Rules; they have been reproduced for reference purposes only.

3.2

When the Administration approves alternative design and arrangements for fire safety, pertinent technical information about the approval should be summarised on the reporting form given in Appendix A and should be submitted to the International Maritime Organisation for circulation to the Member Governments.

3.3

When the Administration approves alternative design and arrangements on fire safety, documentation should be provided as indicated in Appendix B.

3.4

A reference to the approved alternative design and arrangements should be included in the appropriate SOLAS certificate.

Chapter 3 - METHODOLOGY

1 DEFINITIONS

1.1 Alternative design and arrangements

Alternative design and arrangements means fire safety measures which deviate from the prescriptive requirement(s) of SOLAS Chapter II-2, but are suitable to satisfy the fire safety objective(s) and the functional requirements of that chapter. The term includes a wide range of measures, including alternative shipboard structures and systems based on novel or unique designs, as well as traditional shipboard structures and systems that are installed in alternative arrangements or configurations.

1.2 Design fire

Design fire means an engineering description of the development and spread of fire for use in a design fire scenario. Design fire curves may be described in terms of heat release rate versus time.

1.3 Design fire scenario

Design fire scenario means a set of conditions that defines the fire development and the spread of fire within and through ship space(s) and describes factors such as ventilation conditions, ignition sources, arrangement and quantity of combustible materials and fire load accounting for the effects of fire detection, fire protection, fire control and suppression, and fire mitigation measures.

1.4 Functional requirements

Functional requirements explain, in general terms, what function the ship should provide to meet the fire safety objectives of SOLAS.

1.5 Performance criteria

Performance criteria are measurable quantities stated in engineering terms and obtained from prescriptive regulations (see Note 1) to be used to judge the adequacy of trial designs.

Note 1: Reference is made to SOLAS Chapter II/2.

1.6 Prescriptive based design or prescriptive design

Prescriptive based design or prescriptive design means a design of fire safety measures which comply with the prescriptive regulatory requirements set out in Parts B, C, D, E or G of SOLAS Chapter II-2.

1.7 Safety margin

Safety margin means adjustments made to compensate for uncertainties in the methods and assumptions used to evaluate the alternative design, e.g. in the determination of performance criteria or in the engineering models used to assess the consequences of fire.

1.8 Sensitivity analysis

Sensitivity analysis means an analysis to determine the effect of changes in individual input parameters on the results of a given model or calculation method.

2 ENGINEERING ANALYSIS

2.1

The engineering analysis used to show that the alternative design and arrangements provide the equivalent level of safety to the prescriptive requirements of SOLAS Chapter II-2 should follow an established approach to fire safety design. This approach should be based on sound fire science and engineering practice incorporating widely accepted methods, empirical data, calculations, correlations and computer models as contained in engineering textbooks and technical literature (see also Appendix C).

2.2

Examples of acceptable approaches to fire safety engineering are listed below:

1) The SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings, Society of Fire Protection Engineers and National Fire Protection Association, 1999.

2) ISO/TR 13387-1 through 13387-8, "Fire safety engineering", International Standards Organisation, 1999. Other fire safety engineering approaches recognised by the Administration may be used. See Appendix C for guidance and a list of additional technical literature.

3) Tasneef Research Report TR 2002/20- IRP, "Design Guide for Performance-Based Fire Engineering Analysis of Ships", 2002.

3 DESIGN TEAM

3.1

A design team acceptable to Tasneef should be established by the Owner, Builder or Designer and may include, as the alternative design and arrangements demand, a representative of the Owner, Builder or Designer, and expert(s) having the necessary knowledge and experience in fire safety, design and/or operation as necessary for the specific evaluation at hand.

3.2

The level of expertise that individuals should have to participate in the team may vary depending on the complexity of the alternative design and arrangements for which approval is sought. Since the evaluation, regardless of complexity, will have some effect on fire safety, at least one expert with knowledge and experience in fire safety should be included as a member of the team.

3.3

The design team should:

1) communicate with Tasneef for advice on the acceptability of the engineering analysis of the alternative design and arrangements throughout the entire process;
2) conduct a preliminary analysis to develop the conceptual design in qualitative terms, as specified in item 4 below. The results of the preliminary analysis are to be documented in a report, as specified in item 1 of Chapter 2, to be submitted to Tasneef for approval before the quantitative analysis is started.
3) conduct a quantitative analysis to evaluate possible trial alternative designs using quantitative engineering

analysis. From this step the final alternative design and arrangements are selected and the entire quantitative analysis is documented in a report, as specified in item 1 of Chapter 2, to be submitted to Tasneef for approval.

4) approval documentation, specifications and a life-cycle maintenance program. The alternative design and arrangements are to be clearly documented and approved by Tasneef, and a comprehensive report describing the alternative design and arrangements and required maintenance program is to be kept on board the ship. An operations and maintenance manual is to be developed for this purpose. The manual is to include an outline of the design conditions that are to be maintained over the life of the ship to ensure compliance with the approved design.

3.4

The fire safety objectives in SOLAS Regulation II-2/2 and the purpose statements listed at the beginning of each individual regulation in Chapter II-2 should be used to provide the basis for comparison of the alternative design and arrangements to the prescriptive regulations.

4 PRELIMINARY ANALYSIS IN QUALITATIVE TERMS

4.1 Definitions of scope

4.1.1

The ship, ship system(s), component(s), space(s) and/or equipment subject to the analysis should be thoroughly defined. This includes the ship or system(s) representing both the alternative design and arrangements and the regulatory prescribed design. Depending on the extent of the desired deviation from prescriptive requirements, some of the information that may be required includes: detailed ship plans, drawings, equipment information and drawings, fire test data and analysis results, ship operating characteristics and conditions of operation, operating and maintenance procedures, material properties, etc.

An example of "Definitions of scope" is provided in item 2.1 of Chapter 4.

4.1.2

The regulations (see Note 1) affecting the proposed alternative design and arrangements, along with their functional requirements, should be clearly understood and documented in the preliminary analysis report (see item 4.4). This should form the basis for the comparative analysis referred to in item 5.4. In particular it is necessary to define the performance criteria upon which the comparative analysis will be based. Although the quantitative definition of performance criteria is to be done within the quantitative analysis (see item 5.3), within the preliminary analysis it is required that they are outlined to the extent necessary to fully clarify their theoretical background, validity and applicability to the case under analysis.

Note 1: Reference is made to SOLAS Chapter II/2.

4.2 Development of fire scenarios

Fire scenarios should provide the basis for analysis and trial alternative design evaluation and, therefore, are the backbone of the alternative design process. Proper fire scenario development is essential and, depending on the extent of deviation from the prescribed design, may require a significant amount of time and resources. This process can be broken down into four areas:

1) identification of fire hazards;
2) enumeration of fire hazards;
3) selection of fire hazards; and
4) specification of design fire scenarios.

4.2.1 Identification of fire hazards

This step is crucial in the fire scenario development process as well as in the entire alternative design methodology. If a fire hazard or incident is omitted, then it will not be considered in the analysis and the resulting final design may be inadequate. Fire hazards may be identified using historical and statistical data, expert opinion and experience, and hazard evaluation procedures. There are many hazard evaluation procedures available to help identify the fire hazards including HAZOP, PHA, FMEA, "what-if", etc. As a minimum, the following conditions and characteristics should be identified and considered:

1) pre-fire situation: ship, platform, compartment, fuel load, environmental conditions;
2) ignition sources: temperature, energy, time and area of contact with potential fuels;
3) initial fuels: state (solid, liquid, gas, vapour, spray), surface area to mass ratio, rate of heat release;
4) secondary fuels: proximity to initial fuels, amount, distribution;
5) extension potential: beyond compartment, structure, area (if in open);
6) target locations: note target items or areas associated with the performance parameters;
7) critical factors: ventilation, environment, operational, time of day, etc.; and
8) relevant statistical data: past fire history, probability of failure, frequency and severity rates, etc.

Without prejudice concerning the techniques selected by the design team, it is noted that, for this step, techniques such as HAZOP, FMEA and "what-If" are suitable for the identification of hazards relevant to a space containing industrial equipment, whereas for accommodation spaces (cabins, lobby, etc.) hazard identification can be carried out by means of a Preliminary Hazard Analysis (PHA) (see the example in item 2.3 of Chapter 4).

4.2.2 Enumeration of fire hazards

All the possible outcomes which may result from each fire hazard identified above are to be grouped into one of three incident classes: *localised, major, or catastrophic. A localised incident consists of a fire with a localised affect zone, limited to a specific area. A major incident consists of a fire with a medium affect zone, limited to the boundaries of the ship. A catastrophic incident consists of a fire with a large affect zone, beyond the ship and affecting surrounding ships or communities. In the majority of cases, only localised and/or major fire incidents need to be considered. Examples where the catastrophic incident class may be considered would include transport and/or offshore production of petroleum products or other hazardous materials where the incident affect zone is very likely to be beyond the ship vicinity. The fire hazards should be tabulated for future selection of a certain number of each of the incident classes.*

Examples of "enumeration of fire hazards" are provided in item 2.3 of Chapter 4.

4.2.3 Selection of fire hazards

The number and type of fire hazards that should be selected for the quantitative analysis is dependent on the complexity of the trial alternative design and arrangements. Starting from all of the fire hazards, identified events evolutions should be traced out and reviewed for selection of a range of incidents. In determining the selection of fire hazards, frequency of occurrence does not need to be fully quantified, but it can be utilised in a qualitative sense. The selection process should end with the identification of a range of incidents which cover the largest and most probable range of enumerated fire hazard outcomes.
Because the engineering evaluation relies on a comparison of the proposed alternative design and arrangements with prescriptive designs, demonstration of equivalent performance during the major incidents should adequately demonstrate the design's equivalence for all lesser incidents and provide the commensurate level of safety. In selecting the fire hazards it is possible to lose perspective and to begin selecting highly unlikely or inconsequential hazards. Care should be taken to select the most appropriate incidents for inclusion in the selected range of incidents.

4.2.4 Specification of design fire scenarios

Based on the fire hazards selected, the fire scenarios to be used in the quantitative analysis should be clearly documented. The specification should include a qualitative description of the design fire (e.g. ignition source, fuel first ignited, location, etc.), description of the vessel, compartment of origin, fire protection systems installed, number of occupants, physical and mental status of occupants and available means of escape. The fire scenarios should consider possible future changes to the fire load and ventilation system in the affected areas. The design fire(s) will be characterised in more detail during the quantitative analysis for each trial alternative design.

4.3 Development of trial alternative designs

At this point in the analysis, one or more trial alternative designs should be developed so that they can be compared against the developed performance criteria. The trial alternative designs should also take into consideration the importance of human factors, operations and management as reflected in Part E of SOLAS Chapter II-2. Management procedures may play a large part in increasing the overall level of safety.
Examples of "performance criteria" are indicated in item 2.2 of Chapter 4.

4.4 Preliminary analysis report

4.4.1

A report of the preliminary analysis should include clear documentation of all steps taken to this point, including identification of the design team, their qualifications, the scope of the alternative design analysis, the functional requirements to be met, the description of the fire scenarios and trial alternative designs selected for the quantitative analysis.

4.4.2

The preliminary analysis report should be submitted to Tasneef for approval prior to beginning the quantitative analysis. The key results of the preliminary analysis should include:

1) *a secured agreement from all parties to the design objectives and engineering evaluation;*
2) *specified design fire scenario(s) acceptable to all parties; and*
3) *trial alternative design(s) acceptable to all parties.*

5 QUANTITATIVE ANALYSIS

5.1

The quantitative analysis is the most labour intensive from a fire safety engineering standpoint. It consists of quantifying the design fire scenarios, developing the performance criteria, verifying the acceptability of the selected safety margins and evaluating the performance of trial alternative designs against the prescriptive performance criteria.

5.2

The quantification of the design fire scenarios may include calculating the effects of fire detection, alarm and suppression methods, generating time-lines from initiation of the fire until control or evacuation and estimating consequences in terms of fire growth rate, heat fluxes, heat release rates, time history of toxic gas temperatures, time history of boundary temperature, flame heights, smoke and toxic gas generation, etc. This information will then be utilised to evaluate the trial alternative designs selected during the preliminary analysis.

5.3

Risk assessment may play an important role in this process. It should be recognised that risk cannot ever be completely eliminated. Throughout the entire performance based design process, this fact should be kept in mind. The purpose of performance design is not to build the fail safe design, but to specify a design with reasonable confidence that it will perform its intended function(s) when necessary and in a manner equivalent to or better than the prescriptive fire safety requirements of SOLAS Chapter II-2.

5.4 Quantification of design fire scenarios

5.4.1

After choosing an appropriate range of fire incidents, quantification of the fires should be accomplished for each of the incidents. Quantification will require specification of all factors (human behaviour, fire detection, alarm and suppression methods, etc.) that may affect the type and extent of the fire hazard. The fire scenarios should consider possible future changes to the fire load and ventilation system in the affected areas. This may include calculation of heat release rate curves, time history of toxic gas temperatures, time history of boundary temperature, flame height, length and tilt, radiant, conductive and convective heat fluxes, smoke production rate, pool fire size, duration, time-lines, etc. References on suggested example correlation and models that may be of use are listed in Appendix C. It should be noted that when using any of these or other tools, the limitations and assumptions of these models should be well understood and documented. This becomes very important when deciding on and

applying safety margins. Documentation of the alternative design should explicitly identify the fire models used in the analysis and their applicability. Reference to the literature alone should not be considered as adequate documentation. The general procedure for specifying design fires includes fire scenario development completed during the preliminary analysis, time-line analysis and consequence estimation which is detailed below.

5.4.2

For each of the identified fire hazards, a range of fire scenarios should be developed. Because the alternative design approach is based on a comparison against the regulatory prescribed design, the quantification can often be simplified. In many cases, it may only be necessary to analyse one or two scenarios if this provides enough information to evaluate the level of safety of the alternative design and arrangements against the required prescriptive design (see item 3 of Chapter 4).

5.4.3

A time-line should be developed for each of the fire scenarios developed beginning with fire initiation. Time-lines should include one or more of the following: ignition, established burning, fire detection, fire alarm, fire suppression/control system activation, personnel response, fire control, escape times (to assembly stations, evacuation stations and lifeboats as necessary), manual fire response, untenable conditions, etc. The time-line should include fire size throughout the scenario, as determined by using the various correlations, models and fire data from the literature or actual fire tests.

5.4.4

Consequences of various fire scenarios should be quantified in fire engineering terms. This can be accomplished by using existing correlation and calculation procedures for determining fire characteristics such as heat release rate curves, flame height, length and tilt, radiant, conductive and convective heat fluxes, etc. In certain cases, live fire testing and experimentation may be necessary to properly predict the fire characteristics. Regardless of the calculation procedures utilised, a sensitivity analysis should be conducted to determine the effects of the uncertainties and limitations of the input parameters.

5.5 Development performance criteria

5.5.1

Performance criteria are quantitative expressions of the fire safety objectives and functional requirements of SOLAS. The required performances of the trial alternative designs are specified numerically in the form of performance criteria. Performance criteria may include tenability limits such as smoke obscuration, temperature, height of the smoke and hot gas layer in a compartment, evacuation time or other criteria necessary to ensure successful alternative design and arrangements.

5.5.2

Each of the regulations in SOLAS Chapter II-2 states the purpose of the regulation and the functional requirements that the regulation meets. Compliance with the prescriptive regulations is one way to meet the stated functional requirements. The performance criteria for the alternative design and arrangements should be determined taking into consideration the fire safety objectives, the purpose statements and the functional requirements of the regulations.
An example of a performance criterion drawn directly from the regulations in SOLAS Chapter II-2 is provided in item 2.2 of Chapter 4.

5.5.3

If the performance criteria for the alternative design and arrangements cannot be determined directly from the prescriptive regulations because of novel or unique features, they may be developed from an evaluation of the intended performance of a commonly used acceptable prescriptive design, provided that an equivalent level of fire safety is maintained.

5.5.4

Before evaluating the prescriptive design, the design team should agree on what specific performance criteria and safety margins should be established. Depending on the prescriptive requirements for which the approval of alternative design or arrangements is sought, these performance criteria could fall within one or more of the following areas:

1) *Life safety criteria - These criteria address the survivability of passengers and crew and may represent the effects of heat, smoke, toxicity, reduced visibility and evacuation time.*
2) *Criteria for damage to ship structure and related systems - These criteria address the impact that fire and its effluents might have on the ship structure, mechanical systems, electrical systems, fire protection systems, evacuation systems, propulsion and manoeuvrability, etc. These criteria may represent thermal effects, fire spread, smoke damage, fire barrier damage, degradation of structural integrity, etc.*
3) *Criteria for damage to the environment - These criteria address the impact of heat, smoke and released pollutants on the atmosphere and marine environment.*

5.5.5

The design team should consider the impact that one particular performance criterion might have on other areas that might not be specifically part of the alternative design. For example, the failure of a fire barrier may not only affect the life safety of passengers and crew in the adjacent space, but it may result in structural failure, exposure of essential equipment to heat and smoke, and the involvement of additional fuel in the fire.

5.5.6

Once all of the performance criteria have been established, the design team can then proceed with the evaluation of the trial alternative designs.

5.6 Evaluation of trial alternative designs

5.6.1

All of the data and information generated during the preliminary analysis and specification of design fires should

serve as input to the evaluation process. The evaluation process may differ depending on the level of evaluation necessary (based on the scope defined during the preliminary analysis), but should generally follow the process illustrated in Fig 1.

5.6.2

Each selected trial alternative design should be analysed against the selected design fire scenarios to demonstrate that it meets the performance criteria with the agreed safety margin, which in turn demonstrates equivalence to the prescriptive design.

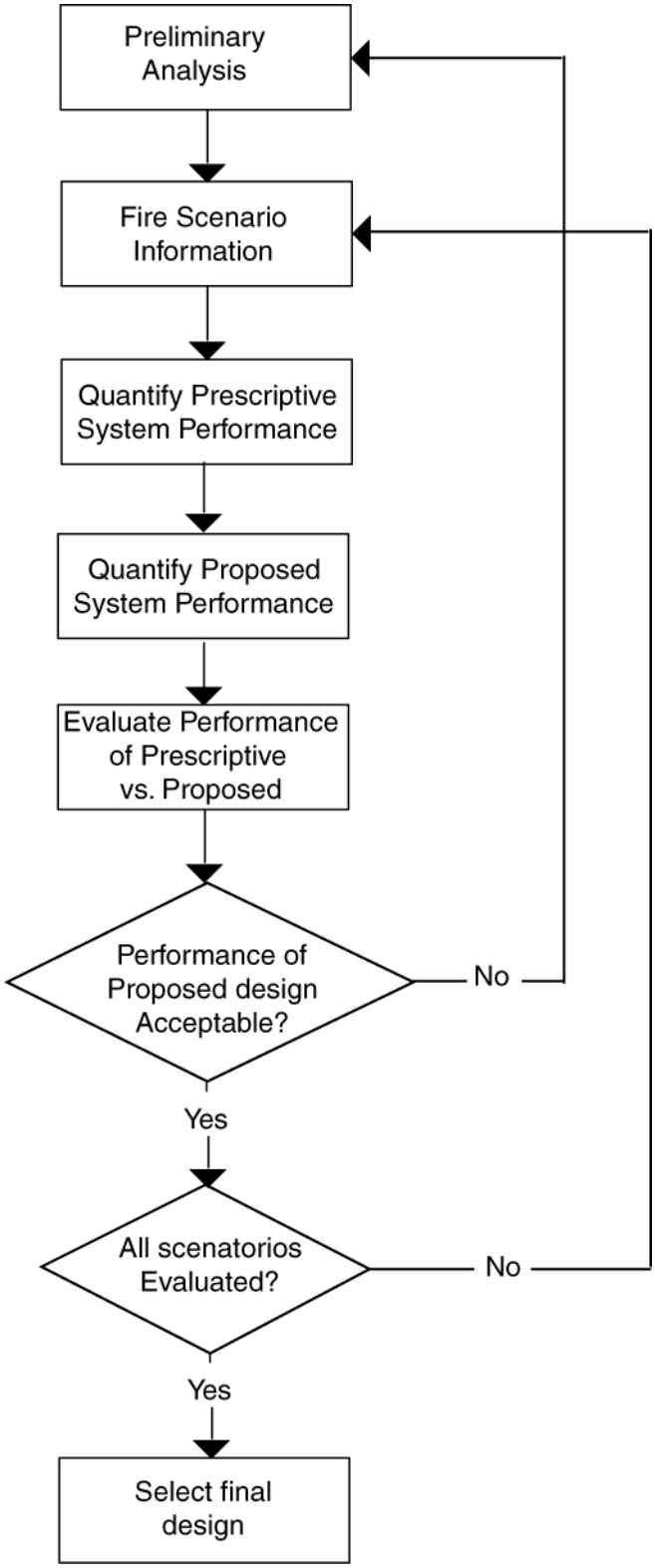
5.6.3

The level of engineering rigour required in any particular analysis will depend on the level of analysis required to demonstrate equivalency of the proposed alternative design and arrangements to the prescriptive requirements. Obviously, the more components, systems, operations and parts of the ship that are affected by a particular alternative design, the larger the scope of the analysis.

5.6.4

The final alternative design and arrangements should be selected from the trial alternative designs that meet the selected performance criteria and safety margins.

Figure 1: Alternative design and arrangements process flowchart



1 FOREWORD

The following examples of Preliminary Analysis are provided in order to explain how these Rules are to be applied.
Note: Details of calculations needed to demonstrate the Qualitative Analysis are omitted in these examples.

2 EXAMPLE OF PRELIMINARY ANALYSIS

2.1 Example of scope of analysis

The scope of the actual analysis uses A-0 instead of A-15 deck between cabins of category 7.
In addition, "Guidelines on a simplified calculation for the total amount of combustible materials per unit area in accommodation and service spaces" MSC/Circ.1003 (Circular not mandatory), which specify maximum values for the total mass of combustible materials per unit area of ship spaces, are also considered.
These Guidelines indicate 15 kg/m^2 for accommodation spaces with a minor fire risk and 35 kg/m^2 for accommodation spaces with a moderate fire risk as maximum values of combustible materials per unit area.
Examples of Rules not fulfilled:

a) Regulation 9 of SOLAS Chapter II-2
b) Regulation 3.40 of SOLAS Chapter II-2.

2.2 Performance criterion (qualitative)

2.2.1 Performance criterion for fire

The proposed performance criterion to assess the equivalence between prescriptive and alternative cabins is the loss of thermal containment of barriers, which indicates fire propagation outside the cabin of origin through the deck.
As far as thermal containment is concerned, the following SOLAS Requirements apply:

a) class A deck is required to contain fire and smoke for 1 hour
b) class A-15 deck is required to "not rise more than 139 °C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180 °C above the original temperature, within 15 minutes".

With regard to a), the Ingberg (Ref. S.H. Ingberg, "Tests of the Severity of Building Fires", Quarterly of the National Fire Protection Association, Vol. 22, No. 1, July 1928) criterion is applied. This criterion states that the thermal energy absorbed by the alternative design deck during 1 hour is to be less than or equal to that absorbed by the prescriptive design deck. The thermal energy absorbed during a period of time is calculated by integrating the temperature-time deck curves.
These curves are obtained as results of numerical simulations which also allow analysts to verify compliance with b).

2.2.2 Performance criterion for smoke

No example is provided.

2.3 Examples of fire scenario development

This example is relevant to the Preliminary Hazards Analysis (PHA) for a cabin on a passenger ship.
It indicates the main points that are to be fulfilled during PHA.

a) Hazard identification
   List of potential ignition sources:
   - open flames (cigarettes, including match and lighter)
   - short-circuits
   - faulty electrical cables or equipment
   - table lamp
   - arson.

   When they come into contact with a flammable material, these ignition sources could cause an Ignition Event which, depending on the type of mitigation and suppression systems present in the cabin, could lead to a fire incident.
b) Hazard enumeration
   A classification of Fire Hazards may be provided taking into account the dimensions of the area impaired by the fire. As far as the cabin is concerned, all the fire hazards belong to the "localised" or "major" categories.
c) Selection of Fire Hazards
   Historical and statistical analyses show that the most hazardous situation inside a cabin is due to an open flame (cigarette) that comes into contact with bed furniture.
   This Ignition Event has been selected as the starting point of the sequence of events that leads to a fully developed fire.
d) Specification of design fire scenario
   This step should provide a detailed description of the layout, furniture, and active and passive fire protection equipment of the compartment on fire.
   1) Details of the cabin
      The cabin considered in the analysis belongs to category 7 of the SOLAS spaces classification; it has a total boundary (walls, deck and ceiling) area of approx. 34 m^2 and a total amount of combustible materials of 35 kg/m^2.
      The structural fire protection category of cabin partitions, ceilings and decks is determined by the category of the adjacent spaces (Ref. SOLAS, Chapter II-2, Tables 9.1 and 9.2).
   2) Proportion of time under occupation
      The proportion of time under occupation for a passenger cabin is assumed to be approximately 50%.
   3) Remote detection methods
      Smoke detectors are located in the cabin for the early detection of a fire. The maximum distance between detectors is not to exceed 11 m with a maximum distance from the bulkheads/partitions of 5.5 m (Ref. 2.4.2.1, Ch 9 of FSS Code). Typically, this means that only one detector is required in each standard cabin (passenger and crew).
      Since toilet rooms are considered as low fire risk spaces, smoke detectors are not required.
      The shutdown of ventilation fans and closing of dampers are normally manual.
   4) Remote suppression methods
      Sprinklers - or equivalent high pressure water fog systems - are placed in an overhead position on the cabin ceiling and spaced in a suitable pattern to maintain an average water application rate of not less than 5 litres/m^2/min. over the nominal area covered by each sprinkler diffuser (Ref. 2.5.2.3, Ch 8 of FSS Code).

Additionally, water hoses and hydrants are served by up to three fire-extinguishing centrifugal pumps located in separate compartments (e.g. auxiliary room) and having independent sea suctions and power supplies.
Hydrants are located within the technical spaces of cabins (located between cabin toilet unit and corridor), redundant on every deck/Main Vertical Zone.

5) Ventilation
All cabins are equipped with an HVAC (Heating, Ventilation and Air Conditioning) system. Typically 3 to 6 air changes per hour are considered, normally providing 100% fresh air without recirculation.
Inlet: through air diffusers in the ceiling (with incorporated air temperature control)
Outlet:
   - through toilet door and exhaust ducts in the toilet ceiling, or
   - through grills in the cabin door, or
   - through ducts underneath the toilet to the adjacent corridor

Fire dampers and shut-off dampers are installed on HVAC ducts, although not for single cabins but for groups of cabins, typically controlled by the Air Conditioning Units within the Air Conditioning Stations.
This implies that the dispersion of smoke to locations remote from a fire via the ventilation trunking would be totally eliminated by the closing of dampers.
In addition to the HVAC system inside each cabin, another source of fresh air may be the following: 1 entrance door of 1,14 m^2.

6) Communication and alarm
The General Alarm (GA) system comprises bells/sirens. A selector switch enables the GA to be sounded only in the crew areas, if desired.
The Public Address (PA) loudspeaker system serves all corridors, passenger spaces, crew living quarters and cabins.
The loudspeakers are used to give instructions during an emergency.

PA stations, from where announcements may be made, are located in the wheelhouse, Broadcasting Centre and other selected points (e.g. Chief Steward's Office).

2.4 Development of trial alternative designs

Alternative designs considered in this example are:

a) A1: cabin of category 7 with A-0 class deck boundary and a total amount of combustible material for unit area of 35 kg/m^2.
b) A2: cabin of category 7 with A-0 class deck boundary and a total amount of combustible material for unit area of 25 kg/m^2.

3 EXAMPLE OF QUANTITATIVE ANALYSIS

The following is an example of Quantitative Analysis for a passenger ship cabin.

3.1 Quantification of design fire scenarios

Fire incident probability evaluation

a) As far as the probabilistic quantification of scenarios is concerned, the evolution of the fire from the Ignition Event to a developed fire (Incident) can be evaluated by means of an Event Tree Analysis.
Table no .1 lists the knots of the Event Tree developed for a cabin (see Fig 2).
b) Consequence of scenario evaluation
The method for carrying out consequence evaluation is based on the Heat Release Rate (HRR) curves for each of the cabin(s) (prescriptive, A1, A2).
The HRR curves are constructed based on a methodology used for civil buildings (Ref. "Competitive steel buildings through Natural Fire Safety Concept" Project, 1994-1998).
In view of its use for ship spaces, the methodology is adapted as follows:
   1) the total energy (area of the HRR curve) is calculated based on the total fire load;
   2) the effects of the sprinkler and forced ventilation are accounted for.

Fig 3 shows two HRR curves:

- the broken line HRR is relevant to a scenario without forced ventilation shutdown and with the sprinkler unavailable;
- the unbroken line is relevant to a scenario with forced ventilation prevented and the sprinkler available.

Table 1: List of the events in the Event Tree

Code	Event	Description
EI	Ignition Event	
A	Rapid self termination	Fire self terminates in the first instants subsequent to ignition
B1	Manual detection	People awake in the space are able to detect fire
B2	Automatic detection	Equipment is able to detect fire
C1	Forced ventilation shutdown	Forced ventilation shutdown
C2	Natural ventilation prevented	Whether door and/or windows are open/closed
D1	Local manual suppression	People in the space are able to extinguish fire
D2	Automatic suppression	Fixed equipment is able to extinguish fire
D3	On board manual suppression	People external to the space (fire brigade on board) are able to extinguish fire

Figure 2: Cabin Event Tree

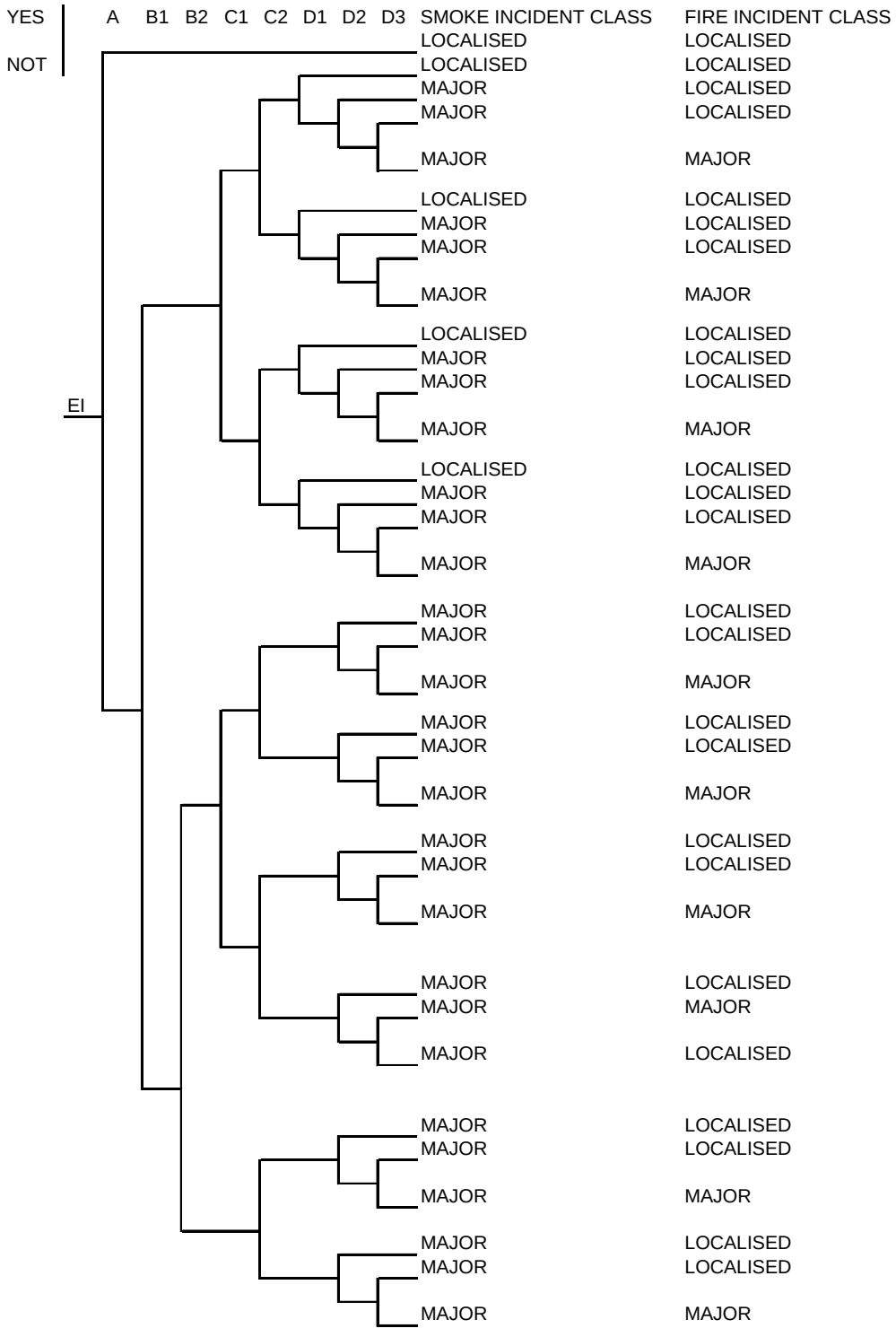
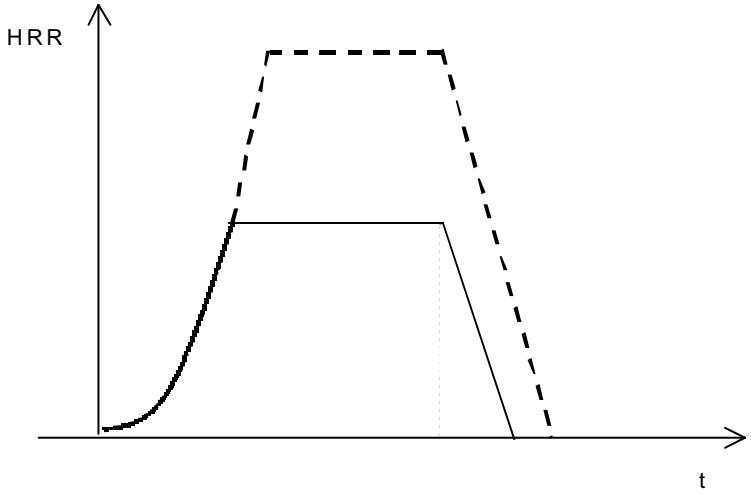


Figure 3: HRR qualitative curves



Appendix A - FACSIMILE OF REPORT ON THE APPROVAL OF ALTERNATIVE DESIGN AND ARRANGEMENTS FOR FIRE SAFETY

REPORT ON THE APPROVAL OF ALTERNATIVE DESIGN AND ARRANGEMENTS FOR FIRE SAFETY

The Government of …….. has approved on …… an alternative design and arrangement in accordance with the provisions of Regulation II-2/17.5 of the International Convention for Safety of Life at Sea (SOLAS), 1974, as amended, as described below:

Name of ship .....

Port of registry .....

Ship type .....

IMO Number .....

1) *Scope of the analysis or design, including the critical design assumptions and critical design features:*

2) *Description of the alternative design and arrangements:*

3) *Conditions of approval, if any:*

4) *Listing of affected SOLAS Chapter II-2 regulations:*

5) *Summary of the result of the engineering analysis and basis for approval, including performance criteria and design fire scenarios:*

6) *Test, inspection and maintenance requirements:*

Note 1: Appendix A is not applied by Tasneef for the purpose of these Rules; it has been reproduced for reference purposes only.

Appendix B - FACSIMILE OF DOCUMENT OF APPROVAL OF ALTERNATIVE DESIGN AND ARRANGEMENTS FOR FIRE SAFETY

DOCUMENT OF APPROVAL OF ALTERNATIVE DESIGN AND ARRANGEMENTS FOR FIRE SAFETY

Issued in accordance with the provisions of Regulation II-2/17.4 of the International Convention for Safety of Life at Sea (SOLAS), 1974, as amended, under the authority of the Government of..... by…….
(name of State) (person or organisation authorised)

Name of ship .....

Port of registry .....

Ship type .....

IMO Number .....

THIS IS TO CERTIFY that the following alternative design and arrangement applied to the above ship has been approved under the provisions of SOLAS Regulation II-2/17.

1. *Scope of the analysis or design, including the critical design assumptions and critical design features:*

2. *Description of the alternative design and arrangements:*

3. *Conditions of approval, if any:*

4. *Listing of affected SOLAS chapter II-2 regulations:*

5. *Summary of the result of the engineering analysis and basis for approval, including performance criteria and design fire scenarios:*

6. *Test, inspection and maintenance requirements:*

7. *Drawings and specifications of the alternative design and arrangement:*

Issued at …….. on …….

……..
(signature of authorised official issuing the certificate)

(Seal or stamp of issuing authority, as appropriate)

Note 1: Appendix B is not applied by Tasneef for the purpose of these Rules; it has been reproduced for reference purposes only.

Appendix C - TECHNICAL REFERENCES AND RESOURCES

a) *Item 2 of Chapter 3 states that the fire safety engineering approach should be "based on sound fire science and engineering practice incorporating widely accepted methods, empirical data, calculations, correlations and computer models as contained in engineering textbooks and technical literature." There are literally thousands of technical resources that may be of use in a particular fire safety design. Therefore, it is very important that fire safety engineers and other members of the design team determine the acceptability of the sources and methodologies used for the particular applications in which they are used.*

b) *When determining the validity of the resources used, it is helpful to know the process through which the document was developed, reviewed and validated. For example, many codes and standards are developed under an open consensus process conducted by recognised professional societies, codes making organisations or governmental bodies. Other technical references are subject to a peer review process, such as many of the technical and engineering journals available. Also, engineering handbooks and textbooks provide widely recognised and technically solid information and calculation methods.*

c) *Additional guidance on selection of technical references and resources, along with lists of subject-specific literature, can be found in:*

   1) *The SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings, Society of Fire Protection Engineers and National Fire Protection Association, 1999.*
   2) *ISO/TR 13387-1 through 13387-8, "Fire safety engineering", International Standards Organization, 1999.*

d) *Other important references include:*

   1) *SFPE Handbook of Fire Protection Engineering, 2 nd Edition, P. J. DiNenno, ed., The Society of Fire Protection Engineers, Boston, MA, 1995.*
   2) *Fire Protection Handbook, 18 th Edition, A. E. Cote, ed., National Fire Protection Association, Quincy, MA, 1997.*
   3) *Custer, R.L.P., and Meacham, B.J., Introduction to Performance-Based Fire Safety, Society of Fire Protection Engineers, USA, 1997.*
   4) *NFPA 550, Guide to the Use of the Fire Safety Concepts Tree, National Fire Protection Association, 1995.*
   5) *"Competitive steel buildings through Natural Fire Safety Concept" Project, 1994-1998.*
   6) Tasneef Research Report TR 2002/20- IRP, "Design Guide for Performance-Based Fire Engineering Analysis of Ships", 2002.