



Offshore Design Section  
Engineering Services  
ISO – 9001:2008

**FUNCTIONAL  
SPECIFICATION FOR  
“SAFETY STUDIES”**

Spec. No.	5101
Rev. No.	3
Discipline	Mechanical
Page: 1 OF 32	

**FUNCTIONAL SPECIFICATION  
FOR  
“SAFETY STUDIES”**

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## CONTENTS

### 1.0 INTRODUCTION

- 1.1 Scope
- 1.2 Contractor's Responsibility
- 1.3 Abbreviations
- 1.4 Purpose of this Document
- 1.5 Mandatory Indian Statutory Requirements

### 2.0 OBJECTIVES

- 2.1 General
- 2.2 Scope of Safety Studies Works
  - 2.2.1 Detailed Design Phase
  - 2.2.2 Construction, Transportation, Installation and commissioning Phases
- 2.3 Safety Studies Schedule

### 3.0 GENERAL REQUIREMENTS

- 3.1 Quality and Design Integration
- 3.2 Safety Studies Validation
- 3.3 Assumptions Register
- 3.4 Risk Reductions Register
- 3.5 Progress and Weekly Status
- 3.6 Safety Handbook for Site

### 4.0 SAFETY STUDIES OUTLINE CONTENTS AND PROCESS

- 4.1 Safety Studies Methodology
  - 4.1.1 Field and Layout Review
  - 4.1.2 Coarse Quantified Risk Assessment
  - 4.1.3 Hazard Identification (HAZID) Workshops
  - 4.1.4 HAZOPs
  - 4.1.5 CHAZOP Control Hazards and Operability Study
  - 4.1.6 Safety Integrity Level Assessment
  - 4.1.7 Detailed Quantified Risk Assessment
  - 4.1.8 Critical Controls
  - 4.1.9 ALARP Workshops
  - 4.1.10 Escape, Evacuation & Rescue Analysis EERA)

### 5.0 DOCUMENTATION



## 1.0 INTRODUCTION

### 1.1 Scope

This document defines the minimum requirements for the Safety Studies to be conducted for all the aspects of the Contractor's Works. This includes the works associated with the new Platform and Risers & I/J Tubes. Contractor has to assess the effects of the modifications to the existing facilities. Effect of new facilities on the existing facilities shall be a part of the studies to be carried out by the contractor.

### 1.2 Contractor's Responsibility

It shall be the responsibility of the Contractor to conduct appropriate Safety Studies for the Works in accordance with this document.

The Contractor shall at all times be responsible for completing their component of the Safety Studies as per codes & standards. The Company's role shall be limited to review, approval and regulator interface. The Contractor shall be responsible for all aspects of their Safety Studies submission to the Company.

The Contractor shall work with the Company to ensure that an acceptable methodology dealing with each aspect of the Works is evolved.

The Safety Studies shall be completed by personnel with a track record of successfully completing similar studies for similar projects.

The Contractor shall be responsible for developing and stewarding the Safety Studies through the project, ensuring that the Safety Studies are as per codes & standards.

### 1.3 Abbreviations

The following abbreviations are used in this document:

ALARP	As low as reasonably practicable
BLEVE	Boiling Liquid Expanding Vapour Explosion
EPC	Engineering, Procurement and Construction
EPSC	European Process Safety Centre
ESD	Emergency Shutdown
FEA	Fire and Explosion Analysis
HAZID	Hazard Identification
HAZOP	Hazards and Operability Study
CHAZOP	Control Hazards and Operability Study
HSE	Health, Safety and Environment
IRPA	Individual Risk per annum
ISO	International Standards Organization
MAE	Major Accident Event



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<b>Page: 4 OF 32</b>	

ONGC	Oil and Natural Gas Corporation Ltd.
PLL	Potential Loss of Life
QRA	Quantitative Risk Assessment
RRM	Risk Reduction Measure
SIL	Safety Integrity Level

#### **1.4 Purpose of this Document**

This document indicates the minimum requirements for the Safety Studies to be conducted during the Works.

#### **1.5 Mandatory Indian Statutory/Regulatory Requirements**

This document has been prepared in accordance with International Standards. The EPC Contractor shall ensure that the Scope of Work is executed in accordance with all mandatory Indian Statutory requirements as a minimum.

The Safety Studies shall comply with all relevant legislation, national and international conventions, protocols, agreements, codes and standards; rules and regulations of the classification society. In addition, the Safety Studies shall demonstrate that the facilities have been designed and constructed to reduce the operating risk exposure to as low as reasonably practicable (ALARP). The safety studies shall be conducted in accordance with the requirements of this specification and the latest revision of the following codes and standards:

- IEC 61511 Functional safety-safety instrumented systems for process industry
- ISO 14690 Petroleum and natural gas industries- Health, safety & environmental management systems
- API RP 75 Recommended practice for development of a safety and environmental management program for offshore operations and facilities
- HSE manual of ONGC

#### **2.0 OBJECTIVES**

This document has the following objectives:

1. To provide guidance and expectations on Safety Studies methodologies, scope of work, workforce involvement and to ensure that critical controls are provided.
2. To define the demonstrable acceptable criteria that the Works are required to meet. In addition, the concept of ALARP shall be applied across the works. All steps shall be taken to reduce the risks to a level that is as low as reasonably practicable.

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Following contract award, a detailed Safety Studies Methodology and schedule shall be developed by the Contractor (see Section 4.1). The Safety Studies and schedule shall be kept updated throughout the project.

## **2.1 General**

The Safety Studies shall meet all Regulators requirements including methodology, completed Safety Studies and demonstration of ALARP.

The Contractor shall be responsible for completion of the Safety Studies applicable for the scope of work.

As a minimum, the Safety Studies shall address the following:

- The operating conditions, location and environment
- Operations and activities through all phases of work. These shall include, but not limited to design, fabrication, transportation, installation, commissioning and operation.
- Potential effects during simultaneous operations, if production continues, during certain stages of installation. This shall include considerations of shutdowns, operating procedures (e.g. Permit to Work), etc.
- The support services and operations necessary for normal and emergency operations.
- Interaction between the platforms within the process complex (process complex may consist of 2 or 3 platforms which are bridge connected.)

## **2.2 Scope of Safety Studies Works**

The Safety Studies shall be developed during the detailed design phase and continued into the installation and commissioning phases, and shall ensure that risk mitigation is introduced at the earliest possible time.

The Contractor shall develop a schedule for the completion of the Safety Studies.

The schedule shall include the Contractor's expectations of the Company resources.

The Safety Studies scope of work is described below. The Contractor shall be responsible for conducting Safety Studies that are acceptable to all stakeholders and therefore it shall ensure itself that the scope identified is acceptable.

The Safety Studies shall cover all aspects of the Contractor's scope of work (the "Works"). This includes the works associated with the new Platform and any associated modifications to the existing facilities.

The Contractor shall implement the findings of the Safety Studies as applicable to his scope of work.



### 2.2.1 Detailed Design Phase

Initially the Safety Studies shall be developed in parallel with the detailed engineering phase of the project.

The Safety Studies shall demonstrate that the Works design is robust and that risk management has been incorporated throughout the design process.

The detailed design Safety Studies shall be completed and accepted by stakeholders (Company, regulators, etc.) prior to construction or installation. The contractor shall be responsible for the timely submission of deliverables to the Company to assist this process.

The deliverables that shall be produced by the Contractor shall include but are not limited to the following:

- Safety Studies Project Execution Plan and Schedule. This shall include project procedures such as Quality Assurance (including Management of Change) and Management of Assumption register, Management of HAZID Actions and Management of Risk Reduction Actions.
- Safety Studies Plan and Safety Studies Methodology documents for the project.
- Initial high level review of modifications to existing facilities to ensure no unacceptable risks are introduced.
- Hazards Identification workshops for the Works.
- Hazards Register and Hazards Identification documents with actions list. The Hazards Register shall be maintained and updated periodically through the project.
- Internal and external safety audits
- Coarse QRA with feedback sessions into the design process team at earliest timeframe. The coarse QRA report shall document the process, key assumptions, and results. The coarse QRA shall be robust and provide sufficient information to allow early design decisions on a risk based approach.
- Completion of the detailed Safety Studies:
  - Fire and Explosion Analysis
  - Gas and Smoke Dispersion Analysis
  - Non Process Hazards Analysis
  - Emergency Systems Review
  - Escape and Rescue Analysis
  - Quantitative Risk Assessment (Updated form Coarse QRA)
  - Impact analysis covering ship collision and drop objects
- Develop and maintain relevant documentation registers. These include but are not limited to:
  - Assumptions Register
  - Safety Studies Comments Register



- Complete and document the required HAZOPs for the detailed design phase. The HAZOP report should document process and outcomes. The contractor shall be responsible for closeout.
- Document demonstration of Critical Controls through use of Bowtie diagrams (or similar)
- Complete and document an ALARP workshop to identify potential risk reduction measures for the phase of the project. At this stage the emphasis would be on hardware changes. The ALARP sessions shall be workshop based.
- Develop and maintain a Risk Reduction Measures (RRMs) register for tracking of actions throughout the project. This shall be used for documenting the identification, tracking and closeout of actions.
- Documentation recording audits of the project closeout process for each of the HAZOP, HAZID and RRM actions.
- Complete and document a HAZID for the construction, installation, transportation and commissioning phases. The HAZID shall be used to identify Major Accident Event potential and shall put in place prevention/mitigation plans.

### **2.2.2 Construction, Transportation, Installation and Commissioning Phases**

During the construction, transportation, installation or commissioning phases of the project, modifications to the detailed design Safety Studies may be required and it is during this stage that Company Operations Personnel shall become increasingly involved.

Therefore during these phases the Safety Studies shall be updated as required.

In addition to the update of the detailed design Safety Studies, the following shall be conducted by the contractor during the construction, transportation and installation phases:

- Undertake and document any additional HAZOPs as required during the construction phase of the project. The contractor shall include any requirement for additional HAZOPs in their tender.
- Complete and document construction and installation phase HAZIDs. To be completed at appropriate stages prior to the activities
- Contractor shall prepare the HSE plan for the works. However any additional HAZOPS or HAZIDS requirement arise during these studies shall be taken care of and shall be a part of safety studies during final approval.
- Provide all documents in finalized form and submit to the Company.

### **2.3 Safety Studies Schedule**

The contractor shall produce a Project Execution Plan and Schedule for the Safety Studies. The schedule shall include all the elements discussed in Section 2.2 and as required by the Contractor. The Project Execution Plan and Schedule shall include due allowance for all elements to be completed by the company.



### 3.0 GENERAL REQUIREMENTS

#### 3.1 Quality and Design Integration

The Safety Studies shall be performed under a quality assurance system that is consistent with ISO 9001.

The Safety Studies shall be integrated with design activities so that the results of Safety Studies are incorporated into the design.

Thus the contractor shall ensure that the personnel performing the Safety Studies:

- Commence work as soon as possible after the start of the detailed design
- Have early attendance at all design meetings and reviews
- Facilitate and encourage the involvement of Company's operations personnel or representatives in workshops and reviews of the Safety Studies.
- Feed back lessons from previous Safety Studies
- Regularly report progress to Company
- Ensure that change control processes have been documented and followed

Accordingly a list for vital and essential elements along with a checklist shall be provided for monitoring and review. A list indicating all the types of materials used i.e. piping, pipeline, structural material etc., in a consolidated form with respect to discard date (i.e. life of concerned system/structure/member) for each material/structure/member/piping connection small bore lines etc. to be provided. Design factor so considered may be indicated in the introduction of such booklet/document. Similarly a separate list shall follow the equipments, tanks, compressors, pumps etc with respect to discard month/year. At each of such equipment/structure/ system adequate plate to be stamped.

#### 3.2 Safety Studies Validation

During the development of the Safety Studies, the contractor shall log and track the development of the design (drawing, reports and specifications etc.) using document control registers and the assumption registers. This shall ensure that Safety Studies are based on the latest design and are integrated with the latest design activity. An audit trail shall be available and checked at the completion of design phase and at the completion of the Works to verify that the Safety Studies are consistent with the current design.

To formally address validation for the Safety Studies, the Contractor shall perform the following key activities:

- Maintain a comments register to ensure and track consultation with Design Engineers, Company Personnel and Regulators. The comments register is to be tracked to closeout the same.





- Develop a Compliance Register to clearly demonstrate to a 3<sup>rd</sup> party how the Safety Studies complies with relevant legislation and associated guidelines

During the conduct of the Safety Studies, the Company reserves the right to undertake a technical audit of the contractor's work, its integration with design, delivery to regulator requirements, traceability, etc. Company shall provide due warning of the audits and the Contractor shall fully comply and assist Company by ensuring appropriate contractor's personnel are available for the durations of the audit. The Company shall issue an audit report and the Contractor shall respond and address any issues raised.

### 3.3 Assumptions Register

As part of performing the Safety Studies, a range of assumptions shall be made. These assumptions are key inputs to the calculation of risk and shall be recorded in an Assumption Register cross referenced to the appropriate Safety Study section.

As part of the conduct of the Safety Studies, the contractor shall develop a procedure to ensure that all relevant personnel review and approve the assumptions used in the Safety Studies on a regular and progressive basis. As new assumptions are added, the Assumption Register shall be updated and approved. Each individual assumption shall have a revision status so the addition and alteration of assumptions can be tracked clearly.

The Assumption Register shall be approved as a package prior to final submission of the Safety Studies to the Company.

### 3.4 Risk Reductions Register

It is expected that as part of the Safety Studies, Risk Reduction Measures (RRMs) shall be identified. RRMs may require evaluation to determine if they are valuable risk reduction proposals. Therefore, the contractor shall develop a method for:

- Documenting RRMs, identifying where they were identified, responsible persons for the closeout, timing of the closeout, etc. The method shall include a hierarchy of risk reduction.
- Tracking of the actions required for each RRM and signoff acceptance for that action. The action response shall be consistent with any methods developed as part of Section 5.
- Ensuring that all recommendations accepted are incorporated in the Works.

### 3.5 Progress and Weekly Status

The contractor shall provide weekly status reports outlining as a minimum:

- Progress of the Safety Studies as measured against the approved schedule.



- A work completed and two week look-ahead status report
- A month look-ahead for Company interface requirements
- List of safety compliance

### 3.6 Safety Hand Book for Site

With the coverage of 3.1 to 3.5, a handbook in condensed form indicating vital and essential aspects shall be kept at two important places of the work site and at central point for all time reference. Every such handbook shall have a checklist as a helpful monitoring tool.

## 4.0 SAFETY STUDIES OUTLINE CONTENTS AND PROCESS

The following sections provide a minimum expectation of the requirements for the Safety Studies to be conducted for the execution of work.

The primary components are:

- Safety Studies Methodology
- Safety Studies
- Critical Controls
- ALARP Implementation

A separate handbook required to be issued on ALARP levels and critical jobs falling in different ALARP areas as a helpful advanced planning tool. All pocket books/small handbooks indicating cross references are to be provided and to be made available with all senior level executives for supervisions/implementation checks.

The following sections provide guidance with respect to Company's expectations.

### 4.1 Safety Studies Methodology

The Safety Studies Methodology is required as an early stage contractor deliverable. It shall be reviewed and approved by Company prior to commencement of the Safety Studies.

The Safety Studies Methodology shall provide a clear and concise statement of the processes to be used. It shall be used as an input into the Safety Studies and shall define the deliverables to be generated.

The Safety Studies shall address all phases of the Works, including but not limited to transportation, installation, hookup, commissioning, normal operations, and maintenance operations.

The schedule for the Safety Studies and Safety Studies Methodology shall be submitted to the Company no latter than 30 days after Contract award.



The Safety Studies Methodology shall include (but not be limited to) the following and make due allowance for details in the following sections:

- Describe the overall process to be used in the Safety Studies
- Describe the process by which operator/workforce input shall be ensured
- Describe the HAZID and HAZOP process to be employed, resources required and closeout procedure. This shall include detailed description of Hazard Matrix (ISO 17776), its use and interpretation.

Note the Company may audit HAZOP closeout, however closeout shall remain the responsibility of the Contractor's design team.

- Describe the use of registers in the project such as Assumption Registers, Compliance Registers etc.
- Include Performance Criteria that the Safety Studies shall be using (for example, maximum thermal radiation levels, toxic gas levels, etc)
- Describe the consequence (such as Fire and Explosion Analysis) and other studies (such as Non Process or Emergency Systems Review) to be completed, methodology, software to be used, deliverables, etc.

Where software is to be used, the contractor shall provide a full description, validation of the results and a description of the input and output. Where possible, the Contractor shall make available to Company the software models.

- Describe a Quantitative Risk Assessment methodology detailing the QRA Rule Set to be used, software to be employed for integration of risk, sources of data, deliverables etc.
- Describe the details of Sensitivity Analysis to be completed as part of the QRA.
- Describe the implementation of Critical Controls
- Describe the identification of risk mitigation options, the application of ALARP and the tracking to closeout of RRM's.
- Drawings/Documents approved prior to HAZOP/HAZID shall be considered as “Drawings/Document approved for HAZOP/HAZID study.” Only after HAZOP/HAZID close out, drawings/documents are to be considered as approved for construction.

#### 4.1.1 Field and Layout Review

Following development of the Safety Studies Methodology, the contractor shall undertake a review of the proposed new platform location and layout. The purpose of this review shall be to confirm that new platform location and layout is acceptable from a risk/safety point of view. Also the proposed platform (if part of existing complex) does not yield excessive risks/interaction with the other platforms in the existing complex.



The Field and Layout review shall be submitted to the Company for review. Comments from this review shall be incorporated into the reviewed document and the Works (as required) without impacting the project schedule.

#### 4.1.2 Coarse Quantified Risk Assessment

To assist in the early identification of the facility risk profiles, a coarse QRA, shall be completed at the earliest opportunity after start of the detailed design with the results being provided back to the design team and the Company.

The initial coarse QRA shall utilize the same technique to be employed in the subsequent detailed QRA and Safety Studies.

The Contractor shall, as part of the Safety Studies Methodology, document the methodology to be employed in the coarse QRA and the assumptions made. The coarse QRA shall provide early risk information to feed into the detailed design and subsequent Safety Studies.

The Coarse QRA shall cover the scope of the Works.

#### 4.1.3 Hazard Identification (HAZID) Workshops

HAZID study shall be carried out for early identification of potential hazards and threats.

HAZID study shall be conducted by an agency of repute and the HAZID team shall be experienced multi – discipline team of relevant discipline engineers i.e. Safety, Process Design, Operation and Other disciplines (as required) , having sufficient knowledge to recognize and identify all the HSE issues, led by Team Leader/ Facilitator. Team Leader/ Facilitator shall have sufficient experience of conducting HAZID study & safety reviews for similar facilities.

4.1.3.1 DEFINITION: - Hazard Identification (HAZID) is a technique for early identification of Occupational Health Safety and Environmental (HSE) related Major Accident Events (MAE)/ Hazards of a project. This technique should be applied at the very outset of a new venture or during the early stages of a development. It is therefore likely to be the first formal Health Safety and Environment (HSE) related study for any new project. The major benefit of HAZID is that early identification and assessment of the critical HSE hazards provides essential input to project development decisions. This will lead to safer and more cost-effective design options being adopted with a minimum cost of change penalty.

##### a. Hazards

These are defined as having the potential to cause harm, including ill health and injury, damage to property, products or the environment, production losses or increased liabilities.



#### b. Threats

These are possible causes that could potentially lead to a hazard and produce an incident.

#### c. Incidents

These are defined as an unplanned event or chain of events, which have caused or could have caused injury, illness and or damage (loss), to assets, the environment, or third parties.

The primary means of documenting Major Accident Events (MAEs) and their associated hazards shall be Hazard Identification (HAZID) Workshops. Additional Hazard Identification may also occur throughout the project prompted by the analyses and reviews undertaken.

It is anticipated that the following main HAZID workshop sessions shall be required. The Contractor shall be responsible for organizing, running and documenting the HAZID process.

- At the beginning of the detailed design, a detailed HAZID for the project. The Hazards Register developed shall be the basis upon which the subsequent Safety Studies are developed through the design stage.
- At the beginning of the construction phase of the project, an update and review of the initial HAZID shall be conducted, with an increased Company Operation input. The Hazards Register shall be updated for new Hazards and for additional operations input.
- In addition, a HAZID workshop session shall be conducted for the construction and installation phases in the project. This HAZID shall be completed in two parts, initially during the detailed design phase, followed by an update at the relevant time during the construction phase prior to installation. The HAZID shall identify issues associated with the construction and installation phases of the project and actions required to minimize risk.

All HAZID Workshops shall be structured review meetings that provide a systematic approach to the identification and screening of hazards. A multidisciplinary team shall provide the range and depth of expertise and knowledge necessary for a comprehensive review. Such personnel shall attend the workshop. MAEs identified during the workshops shall be assessed and screened using an approved Risk Matrix (ISO 17776) or other Company approved risk ranking system.

#### 4.1.3.2 The key objectives of the HAZID Workshops shall be to:

- Identification and awareness of potential hazardous events and how they may be contained by good design
- Identify MAEs capable of posing a serious and immediate risk to health and safety including flammable releases, toxic releases, non-process incidents, etc.



- Identify the hazards that cause, or contribute to causing, those MAEs (eg. Process upset, equipment failure, maintenance).
- Identify existing engineering or operational (eg. Procedural) controls and measures that are included in the design for prevention or mitigation
- Identify those controls that are safety critical to the identified MAE
- Where appropriate identify additional prevention and/or mitigation RRM for improvement to meet the ALARP concept.
- Identify further hazard assessment that may be required to be addressed during detailed design.

#### 4.1.3.3 DOCUMENTS REQUIRED

As a minimum following documents/ information may be considered as guide for carrying out the HAZID study:

- a) Process Flow Diagrams (PFD) containing material balance as minimum
- b) Development layout including field layout, well head layout, facility layout and hazardous area layout
- c) Process description including all planned operating cases
- d) Project description including all options, life cycle issues and planned plant flexibility
- e) Safety philosophy
- f) Preliminary operating philosophy and product take-off constraints
- g) Major inventory details/ equipment datasheets.
- h) Additional information from site visit reports, pictures etc., if available
- i) Material Safety Data Sheets/Bulletins, if available

#### 4.1.3.4 STUDY PROCEDURE

The study method is a combination of identification, analysis and brainstorming on the hazards identified. The checklist is divided into three main sections, which are as follows:

- A) External and Environmental Hazards
  - a1) Natural and environmental hazards
  - a2) Created (man- made) hazards
  - a3) Effect of the facility on the surroundings
  - a4) Infrastructure
  - a5) Environmental Damage
- B) Facility Hazards
  - b1) Control Methods/Philosophy
  - b2) Fire and Explosion Hazards
  - b3) Process Hazards
  - b4) Maintenance Hazards
  - b5) Construction/Existing Facilities
- C) Health Hazards



The intention of the study is to identify and describe potential HSE hazards. It will also recognise continuous releases from the installation and their effects on the environment. This will include all emissions not associated with an incident but as part of the design intent. The hazards and continuous emissions will be further evaluated as a normal part of the later development of the project.

#### 4.1.3.5 PRIORITISATION

During the study the Team may use a general qualitative system to give a simple priority rating to the risks (high, medium or low) associated with the hazards identified. An example of such system is given in Corporate Risk Matrix (attached). This would combine an estimation of the HSE consequence of an incident or a continuous emission with its likely probability. Failure effects are classified according to their severity as follows:

**Low: Acceptable without required further action.**

Failure affects which would not significantly reduce the installation's safety and which would involve actions by operators that are well within their capabilities. Minor failure consequences may include for example a slight reduction in safety margins or functional capabilities. Examples include small unignited condensate release from process equipment.

**Medium: Acceptable but must be managed at ALARP**

Failure effects which reduce the capability of the installation or the ability of the operators to cope with adverse operating conditions to the extent that there would be, for example, a significant reduction in safety margins or functional capabilities, a significant increase in operator work load or in conditions impairing operator efficiency, possibly leading to minor injuries.

Examples include the formation of un-ignited clouds from releases at process equipment, pool fires from small condensate releases.

**High: Unacceptably high, action must be taken immediately to lower the risk.**

a) Failure consequences which reduce the capability of the installation or the ability of the operators to cope with adverse operating conditions to the extent that there is:

- A large reduction in safety margins or;
- Physical distress or excessive work- load such that the operators cannot be relied upon to perform their task accurately or completely. Or the work load is such that a combined operation, maintenance and construction work cannot be fully and safety controlled by the Site Management, or;
- Serious or fatal injury to any number of occupants, damage to the site facilities, a pollution risk, or;
- Conditions arising which requires a controlled de-manning of the site.

Examples include jet fires from ignited releases at process equipment.





- b) Failure effects which require emergency evacuation of personnel from the site, or possibly leading to fatal injuries, extensive damage to or loss of the site facilities, or major pollution.

Examples include large gas cloud over the gas plant with subsequent explosion.

All the hazards identified during HAZID Workshops shall be recorded and described in the project Hazard Register. The Hazard Register shall be maintained throughout the project by the contractor and shall provide a primary input to the Safety Studies as well as recording their outputs. The register shall also allow tracking and closeout of actions.

At the end of the study a report to be produced which discusses the findings of the study and details the critical issues and the action to be taken. All the study recommendations shall be implemented by the contractor without any implication on schedule and cost to Company. For proper recording and reporting of Project Safety Management, a corrective Action on Recommendation Form shall be developed for future tracking and a Close Out Report indicating the actions taken against each recommendations emerged during study.

#### 4.1.4 HAZOP

Hazard and Operability (HAZOP) studies are valuable as a design tool and in a role of supplementing the Safety Studies and are to be carried out on all final updated Piping and Instrumentation Diagrams (P&IDs) during engineering. The HAZOP study shall cover all the lines and equipment that are modified and have been installed newly as per P&IDs.

The contractor shall arrange and conduct HAZOP study through an agency of repute and be responsible for the completion of the HAZOPs and ensuring the identification of MAEs and other issues are carried from the HAZOPs to other Safety Studies.

For each HAZOP study, contractor shall arrange a third party chairman for facilitating the HAZOP study with sufficient experience of conducting HAZOP study & safety reviews for similar facility and shall be independent of the Contractor's design/project team. Resume of HAZOP chairman shall be submitted to the COMPANY and shall also be participated by the relevant discipline engineers of the contractor.

It is anticipated that two HAZOPs shall be required. The scheduling of the HAZOPs shall be the responsibility of the contractor and these shall be included in the Safety Studies Schedule (see Section 2.3).

- A Preliminary HAZOP during the detailed design. This may also act as a design review.

This shall be conducted as early as practical in the detailed design phase on first issue key process and instrumentation drawings to maximize impact. Note that a detailed HAZOP shall also be required later in the design.





The HAZOP shall be led by an experienced HAZOP leader and minutes collected via a HAZOP package that allows tracking and closeout of each action.

- A detailed HAZOP to be conducted on all completed elements during the detailed design prior to Approval for Construction.

Designers, HSE engineers, Company representatives and regulators (as appropriate) should attend the HAZOP.

The HAZOP shall be led by an experienced HAZOP leader and minutes collected in via a HAZOP package that allows tracking and closeout of each action. Any incomplete actions (i.e. that are required to be completed at a later stage of the project) shall be approved by the project manager and highlighted.

The HAZOPs shall be completed in a manner that is consistent with industry standard approach. The contractor shall, as part of the Safety Studies Methodology, describe the HAZOP process. The HAZOP minutes shall be collated in an approved package that allows closeout interface by the project.

The contractor shall provide the name and brief description of the computer software proposes to use for recording and reporting deliberations of HAZOP study. Software of international repute shall be used.

Based on the study, recommendations for mitigation/reducing the hazards and ease of operability shall be firmed up and report shall be produced and submitted to the Company.

HAZOPs shall be conducted in accordance with:

- IEC 61882 – Hazard and Operability studies – Application guide; and
- EPSC-HAZOP : Guide to Best Practice

Contractor shall submit a HAZOP study procedure for review by the company at least 4 weeks prior to the commencement of the HAZOP study. The procedure shall contain following information:

- HAZOP Methodology
- Team composition
- HAZOP Timings & schedule
- Proposed list of nodes
- List of reference documents

The HAZOP study notes shall be recorded in the format called “WORKSHEET”, where each deviation is considered, every possible consequences are recorded and actions where necessary are recored and where not necessary, the reasons are stated. All



action items are to be numbered so as to enable clear identification of the cause and consequences of potential hazards.

For each HAZOP study system, a format called “COVER SHEET” is to be prepared to explain in detail the systems considered for HAZOP study P&IDs number, line number and design intention etc.

A separate list of recommendations shall be made giving reference to HAZOP study work sheet. Also, this list will be divided into two parts for hardware change, software change and operating instruction as per the implection of the recommendations.

The HAZOP study report will cover the following section in general.

- 1- Introduction
- 2- Executive summary
- 3- Description of facilities
- 4- Approach/methodology
- 5- Team composition and period
- 6- List of P&IDs
- 7- Description of nodes
- 8- P&IDs with nodes marked-up
- 9- HAZOP study worksheets.
- 10- Conclusion/Recommendations (sub divided as hardware change software change, operating instruction, verification/check, P&ID depiction, etc.)

HAZOP study report shall be submitted by contractor in hard form alongwith electronic copy of report on CD.

#### **IMPLENENTATION OF HAZOP STUDY RECOMMENDATIONS**

- a) All HAZOP study recommendations shall be implemented at site and shall also be incorporated in all the relevant documents by the contractor without any implication on schedule and cost to Company.
- b) Contractor is required to prepare a HAZOP study Close Out Report indicating the actions taken against each recommendations emerged during the HAZOP study. The report shall be submitted to the Company.

#### **4.1.5 CHAZOP - Control Hazards and Operability Study**

Control Hazards and Operability Analysis (CHAZOP) is a highly structured hazards identification tool for instrument control systems.

This methodology to be used to identify potential flaws and weaknesses of instrument control and computer systems by reviewing how the system deviates from design intents. It should be used for proposed and existing Safety Critical Software and Instrument Control Systems. It should supports the risk analysis requirement in IEC 61508, Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems



The following procedure needs to be followed as minimum guidelines for the study and the minimum deliverables from this study. :

1. Break system into manageable sections (Nodes).
2. Prepare list of Guidewords, Parameters and Operations to be examined.
3. For each Node create Deviations.
4. List and record causes for each Deviation.
5. List and record Consequences for each Cause.
6. List and record Safeguards or Controls that may prevent either the Cause or the Consequence.
7. Implementation of the recommendations and any required statutory clearances will be contractor's responsibility without any time and cost impact to company. The contractor shall prepare and submit the “Action Taken Report” on the recommendations.

#### **4.1.6 Safety Integrity Level Assessment**

The Contractor shall undertake a Safety Integrity Level (SIL) assessment for all safety related electrical/electronic/programmable electronic/pneumatic systems.

SIL study shall be carried out by third party of exceptional repute. Contractor shall submit the third party experience list and resume of persons who would be associated with the study and shall be independent of the Contractor's design/project team.

The SIL study shall start immediately after all the required documents are available.

The SIL assessments shall be conducted in accordance with:

- IEC 61508 – Functional Safety of Electrical/Electronic/Programmable Electronic Safety Related Systems
- IEC 61511 – Safety Instrumented system for the process industry sector
- ANSI/ISA-S84.01 – Application of Safety Instrumented Systems for the Process Industries

The classification methodology comprises “Classification of IPF dangerous failures” (failures when a genuine demand exists). Classification of IPF (Instrument Protective Functions) dangerous failures takes into account:

- Demand rate (W)
- Exposure time parameter (F)
- Probability of avoiding the hazardous event parameter (P)
- Consequences related to personnel health and safety (S)

Following are considered while determining personnel health and safety consequences:

- Potential for human injury if the IPF fails upon occurrence of a hazardous situation
- Exposure of personnel in the area affected by the hazardous situation
- Possibility of the potential casualties avoiding/escaping the hazarding situation.



- Consequences related to production and equipment loss (economic loss) (L)
- Consequences related to environmental impact (E)

Following documents are to be considered for the SIL study:

- Process description
- Equipment Layout
- P&IDs
- Cause & Effect matrices
- HAZOP Study report

The SIL assessments shall:

- Evaluate the SIL/reliability requirements for each safety related electrical/electronic/programmable electronic system; and
- Verify that the proposed system configuration shall achieve these SIL/reliability requirements.

The contractor shall, as part of the Safety Studies Methodology, describe the SIL assessment process.

At the end of the study, a report shall be generated. The report will comprise the conclusions of the study and include SIFs classified and their description, SIL assigned (with applicable reasoning), causes, protection layers, hazardous scenario and suggestions/recommendations for mitigating the effects of the hazards.

Implementation of the recommendations and any required statutory clearances will be contractor's responsibility without any time and cost impact to company. The contractor shall prepare and submit the “Action Taken Report” on the recommendations.

#### 4.1.7 Detailed Quantified Risk Assessment

The scenarios identified in the HAZID Workshop shall be developed in the detailed Quantified Risk Assessment to cover the range of potential MAE (Major Accident Events) outcomes.

Quantified Risk Assessment study shall be carried out by third party of exceptional repute. Contractor shall submit the third party experience list and resume of persons who would be associated with the study and shall be independent of the Contractor's design/project team.

Contractor shall submit “QRA procedure” prior to start of study.

Quantitative Risk assessment study shall include:



- Identification of events from units and storage area, which could result in loss producing consequences, such as Fire and Explosions Analysis (FEA), Gas and Smoke Dispersion Analysis, toxic release and Non process Hazards Analysis.
- Analysis of the consequences involved
- Plotting of effect zones of various failure scenarios on the plot plan to predict the magnitude and severity of their impact in terms of damage to property and injury to personnel.
- Assessment of risk to installations and individuals within and outside the facility from all situations envisaged
- Estimate of the number of casualties and fatalities
- Recommendations for overall improvement of safety based on the above evaluation
- Recommendations for preventing loss-producing incidents.

The Safety Studies shall document MAEs in terms of:

- Based on these studies, determine the adequacy of the controls for the identified MAEs in a workshop forum or ALARP (As low as reasonably practicable) session. The outcome would be potential RRM's consequence of MAEs and their impact on the facility. The outcome shall be tracked and incorporated into safety studies.
- Assessment of the controls available to prevent an MAE or mitigate its consequences should it occur.
- Integration into a quantitative risk assessment (QRA) that shall allow ranking of the identified MAEs and demonstration of the risk levels-with particular reference to Individual Risk levels for exposed personnel.
- Using these Studies, document the critical MAEs in the form of bowtie diagrams (or similar). The bowtie diagrams shall assist in the identification of the controls in place, the need for additional controls and performance standards required.

The requirements of these are detailed in the following sections.

### CONSEQUENCE STUDIES

The assessment of applicable MAEs shall be completed by undertaking the following:

- Fire and Explosion Analysis – for ignited hydrocarbon and non-hydrocarbon scenarios
- Gas and Smoke Dispersion Analysis-including un-ignited and toxic gas scenarios, including combustion products
- Non Process Hazards Analysis- associated with all non process type hazards

The outcome from these studies shall be taken forward to the Emergency Systems Review, Escape and Rescue Analysis and Quantitative Risk Assessment.



- For the Fire and Explosion Analysis and Gas and Smoke Dispersion Analysis, the following shall be included:
    - Definition of the flammable inventories, including location, linkages, etc.
    - Definition of the system properties for each flammable inventory (e.g. volume, mass, pressure, temperature, etc)
    - The realization of the identified process hazards, including:
      - Toxic release
      - Flash fire
      - Vapour cloud explosion
      - Jet fire
      - Pool fire
      - Boiling liquid expanding vapour explosions (BLEVE)
      - Toxic combustion products
    - The consequences of these outcomes shall be quantified in terms of the potential impact. This may be on personnel, equipment/emergency systems and emergency response operations.
- Therefore effects shall be modelled in terms of:
- Potential for flame engulfment or impingement
  - Heat radiation levels
  - Explosion overpressures
  - Toxic concentrations
- For the non process hazards identified in the HAZID, assess the potential for impact on personnel and the potential for escalation to a hydrocarbon release, emergency systems and evacuation and rescue systems.

The non process hazards would be identified in the HAZID and include issues such as:

- Transportation (for example helicopter, vehicle transport to service facilities, etc)
- Offshore Marine activities
- Dropped Objects
- Extreme Weather conditions
- Third Party sources of interference

As part of the Safety Studies Methodology, the contractor shall be responsible for developing the criteria to be used in the Safety Studies (i.e. impairment criteria for personnel and equipment). The criteria shall be reviewed and agreed with Company prior to use.

The contractor shall develop the appropriate methodology for completing the consequence analyses. As a minimum, the contractor shall ensure:



- That all consequence modeling software and techniques are to an approved standard. Any software modeling tools used shall be validated and where not covered by pre-existing confidentiality requirements, the models made available to the Company
- All process data used in the consequence studies shall be sourced from the engineering teams and logged and recorded as Assumptions for purposes of traceability.
- All acceptance criteria are documented and traceable
- All data sources used for risk based information shall be quoted and the data sources provided as part of the Assumptions Register
- All assumptions shall be recorded and approved as part of the Assumptions Register

#### EMERGENCY SYSTEM REVIEWS

Based on the consequence analysis and the criteria developed as part of the Safety Studies Methodology, the effectiveness of systems and features for preventing or mitigating consequences shall be assessed. Systems and features to be considered include (but are not limited to):

- Fire and gas detection systems
- Emergency Shutdown (ESD) and blow down systems
- Active fire protection system (e.g. deluge valve, ring main, monitors, fire hydrants and foam facilities)
- Plant layout and separation distances
- Equipment design
- Emergency response

The review of the Emergency Systems shall include consideration of the following:

- Emergency systems critical for each MAE
- Potential impairment of emergency systems due to the MAE.
- Redundancy/ fail safe nature of the emergency systems
- Duration that Emergency Systems are required to remain functional for

#### ESCAPE AND RESCUE ANALYSIS

The contractor shall examine the potential for impacts on the designated escape, safe muster, evacuation and rescue facilities and systems provided.

In the event of an MAE, those personnel surviving the initial incident shall be able to escape from the facilities in a safe and controlled manner and where appropriate be promptly rescued and taken to a place of safety.

The assessment shall include but not be limited to:

- Estimation of evacuation times





- The vulnerability and frequency of impairment of the facility escape routes
- The vulnerability and frequency of impairment of the muster areas
- The vulnerability and suitability of the evacuation systems
- The effectiveness of Emergency Response systems

## **QUANTIFIED RISK ASSESSMENT**

The objective of the QRA is to assist the overall process in determining the:

- Relative ranking of the identified MAEs and there contribution to the facility risk profiles
- Facility worker Individual Risk Per Annum (IRPA)
- Risk posed by the facility on all worker groups through PLL
- Based on the above results, discuss the implications and major contributors to the facilities risk profile and where applicable identify potential risk reduction measures

The risk quantification process shall be based on accepted methodology (such as the development of event and fault trees). While this Safety Studies Plan does not dictate the methods for QRA to be used, the following guidelines shall be considered:

- Where proprietary packages for the integration of risk are used, the package must have independent validation and the input files must be made available to the Company at the completion of the Safety Studies.
- All inputs used in a proprietary package and the methods employed in the integration of risk must be clear and documented in the Assumptions Register. Independent validation of calculations used in the proprietary packages must be possible.
- If an event tree analysis is used there must be sufficient supporting documentation to enable independent check of the logic and assumptions used in the event tree development.

As part of the Safety Studies Methodology, relevant QRA “rulesets” shall be developed. The rulesets shall govern issues such as the frequency of the initiating event and the various probabilities required to calculate the frequency of an outcome (such as a fatality) associated with each MAE. The rulesets shall include but not be limited to:

- Potential for a release (using a Parts Count or similar method)
- Size of release and probability split by hole size
- Probability of ignition
- Population distribution
- Probability of fatality impact
- Probability of equipment damage given an impact
- Reliability of emergency systems
- Probability of a specific outcome such as a dropped load or helicopter crash with appropriate reference
- Potential for escalation





- Probability of successful mitigation systems
- Potential human factor issues

As a minimum following documents/ information/ services/ assistance may be considered as guide for carrying out the study:

- Description of the facilities.
- Material balance showing stream composition & operating parameters (Pressure, Temperature, flow and other physical properties)
- Process Flow Diagrams
- Piping & Instrumentation Diagram
- Major inventory storage details like material stored, quantity and dimensions of equipment
- Equipment / instruments data sheets for the facilities under scope of studies
- Meteorological Data for the past 10 years
- Soft and hard copy of the overall plot plan depicting all major units and adjacent facilities
- Isometric diagrams
- Area map / key plan showing adjacent facilities
- Population details within and around the facility
- Traffic data of ships within and adjacent to the facility.

The contractor shall provide the name and brief description of the computer software proposes to use for study. Software of international repute shall be used.

At the end of the study, a report shall be generated. The report will comprise the conclusions of the study and include suggestions / recommendations for mitigating the effects of the hazards.

Implementation of the recommendations and any required statutory clearances will be contractor's responsibility without any time and cost impact to company. The contractor shall prepare and submit the “Action Taken Report” on the recommendations.

#### 4.1.8 Critical Controls

Following completion of the Safety Studies and QRA, the contractor shall, as an outcome, document the controls identified in the assessment of an MAE and where appropriate identify critical controls.

It is anticipated that the contractor shall, for the significant risk contributors identified in the QRA, develop Bowtie diagrams (or similar). The Bowtie diagrams for the significant MAEs shall assist in the understanding of the controls and their importance to the MAE. The Bowtie diagrams shall be used in the communication of the Safety Studies outcomes as part of the ALARP process. The Bowtie diagrams should:

- Provide a pictorial representation of the hazards that can cause an MAE occurring



- Detail the barriers (control measures) that prevent the occurrence of the MAE
- Show the mitigating systems that minimize all the potential consequences of the MAE (e.g. fire, gas release, explosion, etc)
- Facilitate the identification of safety critical controls

Bowtie diagrams are a means of displaying the number of control and mitigating measures available, in order to assist in determining whether the existing systems are adequate and that the risk of the MAE occurring is ALARP or whether further measures are required.

- During the early state of the construction phase of the project an update ALARP review shall be conducted including an increased Company Operator input. At this stage, any additional risk reduction measures shall be worked, with particular focus on the operational aspects of the project.

Attendees shall be drawn from design engineering, construction, maintenance and operations, plus other interested parties as necessary. For all MAEs identified in the HAZID and subsequently assessed, the team shall review the following information:

- QRA output documenting the ranking and contribution of MAEs
- The HAZID Register sheet for the MAE, updated to show any adjustment in assessed risk as a result of the Safety Studies
- Supporting data on the control and mitigating systems

#### 4.1.9 The ALARP workshops shall:

- Assess the risk associated with each MAE
- Determine whether the risk associated with each MAE is ALARP
- Determine whether the existing control and mitigating measures are adequate
- Confirm safety criticality of control measures
- Apply brainstorming to propose additional measures. These shall be recorded in the Risk Reduction Register for action.

#### 4.1.10 Escape, Evacuation & Rescue Analysis (EERA)

For Escape, Evacuation and Rescue Analysis (EERA) study, contractor shall arrange a third party. The party shall have done similar study independently or through subsidiaries ( not through technical support of any other party on MOU/technical collaboration) for at least one offshore oil & gas complex and one rig with a capacity of minimum 50 persons in India or internationally in last 10 years. The project manager for the study shall have 10 years experience in offshore facilities safety and risk management services. The party shall be independent of the Contractor's design/project team.



#### 4.1.10.1 Objectives of EERA

As stated by the Prevention of Fire and Explosion and Emergency Response (PFEER) Regulations the assessment of EER Systems should be performed as may be appropriate and should include.

Identification of the various events which could give rise to:-

- A major accident involving fire and explosion and
- The need for EER to avoid or minimize exposure to a major accident
- The evaluation of likelihood and consequences of such events.

The establishment of appropriate performance to be attained by anything provided by measures to:-

- Ensure effective EER to avoid / minimize exposure to major incident.
- Protecting personnel from a major accident involving fire of explosion.
- The selection of appropriate measures.

Escape, Evacuation & Rescue Analysis (EERA) shall be carried out by third party of exceptional repute and shall meet the following requirements. Contractor shall submit the third party experience list and resume of persons who would be associated with the study and shall be independent of the Contractor's design/project team.

- The party shall have done similar study independently or through subsidiaries (not through technical support of any other party on MOU / technical collaboration) for at least one offshore oil & gas complex and one rig with a capacity of minimum 50 persons in India or internationally in last 10 years.
- The approach for the study shall be HAZOP based and include the goals & guide words stated in the methodology.
- The project manager shall have 10 years' experience in offshore facilities safety and risk management services.
- The deliverables shall include those stated in scope.

#### 4.1.10.2 Scope of Work

##### 4.1.10.2.1 The Purpose

The purpose of this activity is to review escape routes for the offshore platforms/rigs based on credible events from the fire and explosion analyses to ensure that:

- There are adequate means of events.
- Egress is not prevented from each area upon realization of the most extreme credible event in that particular area.



- Assess the ability to recover injured personnel in the event of an incident based on typical personnel distributions.

The Escape, Temporary Refuge, Evacuation and Rescue Analysis will also be used to establish the adequacy of the overall layout. The results of the Escape, Temporary Refuge, Evacuation and Rescue Analysis will be available to be incorporated into the overall Unit layout design. Layout considerations might include.

- Ignition sources
- Limited human factors considerations
- Escape, evacuation and rescue
- Reduction of overpressure from explosion.

#### 4.1.10.2.2 The Activities

- Review and develop the overall layout of the escape and evacuation system for the unit with regard to ignition sources, smoke, gas, toxic fumes, human factors, occape, evacuation and reduction of explosion overpressure.
- To review and develop the overall layout of the escape ad evacuation system to reduce risks to persons and the environment in major accident events upon the Unit to an acceptable level and/or applicable industry standards of design practice.
- Development of EERA document/manual including Safe Operating practice and Emergency operations bring out the following :
  - Basis of EERA
  - Evacuation pathways and layout
  - Sequence of actions
  - Operational command and control during emergency (Emergency organization and Responsibilities) etc.
- Adequacy check of life saving Appliances, evacuation and rescue facilities.

Broadly the following activities that need to be performed:

- Identify those events which may necessitate escape, evacuation and rescue of personnel.
- Identify escape route locations and define escape routes for typical population distributions on the vessel.
- Generate a matrix of escape routes that define the routes from each populated area. This will be achieved by dividing the platform/rig into section that have to be traversed to facilitate egress.
- Identify temporary refuge (TR) and alternative muster area locations.



- Define egress threatening scenarios.
- Based on the defined egress routes prepare a matrix of blocked egress routes for egress threatening hazards.
- Compare the required egress routes to facilitate an evacuation with those blocked by the various egress routes threatening hazards the ability to escape from populated areas to the main deck or alternative muster area.
- Assess the ability to safely recover injured personnel based on the remaining egress route permitting access to the affected areas.
- Combine the likelihood of the egress route threatening scenarios from the Fire Risk Analysis and the egress route impairment and calculate the frequency of egress route impairment. Use a risk ranking process to propose mitigation measures for those events contributing most to the egress impairment frequency.
- Systematically address the effects of accidental events on the adequacy and availability of the EER system to perform their intended functions on the platform.
- To carry out an EERA workshop with user groups for appraisal of the evaluation of existing facilities, discussion and finalization of the recommendations.

#### 4.1.10.2.3 The Methodology

EERA study will be performed using a goal analysis methodology. The work scope includes the followings:

Goal Analysis – The objects of the goal analysis is to confirm the adequacy of the EER facilities and arrangements and identify any area of weakness. There are seven (7) EERA goals which will be assessed in the EERA.

Goal 1 (Alarm) – All personnel are made aware in a timely manner that an accident has occurred.

Goal 2 (Escape) – All personnel are able to escape to muster station without undue risk.

Goal 3 (Muster) – The temporary refuge can remain habitable for sufficient time to enable mustering communications and controlled evacuation if required.

Goal 4 (Decision to Evacuate) – All personnel are made aware in a timely manner of the decision to abandon the installation.

Goal 5 (primary Means of Evacuation) – Suitable means of evacuation is provided to allow personnel to abandon the facility without undue risk.



Goal 6 (Secondary Means of Evacuation) – Alternate means of evacuation is provided should the primary the primary mode of evacuation be impaired.

Goal 7 (Rescue) – Adequate means exists to rescue personnel and transport them to a safe location.

An evacuation time analysis – The objective of the evacuation time analysis is to assess if the muster area and evacuation facilities are able to endure fire and explosion events for the period required for the POB to evacuate.

The methodology to be employed for this study should primarily be as follows:

- Review the findings of the HAZID exercise and identify those events likely to require escape temporary refuge evacuation and rescue of personnel.
- Assess the consequences of each hazardous event to determine whether flames, smoke, gas or oil releases, physical damage or any other factors impede the operator's ability to escape from the area of the incident.
- Assess the area attached by heat, smoke, flames or gas and assess the effect of wind direction. Do these factors prevent personnel from reaching the evacuation points directly from the work place?
- Check if the movement of personnel is threatened assess the duration of the hazardous event.

Estimate the probability that:

- Personnel in the area of the event can reach the evacuation point.
- Personnel who cannot reach the evacuation point have an alternative escape (and evacuation) route available to them.

#### **4.1.10.2.4 EERA to estimate Impairment frequencies of Residual Accident Events :**

The Escape Evacuation should sum up the impairment frequencies of the Residual Accidental Events which will address the specified safety in the defied hazards groups.

#### **4.1.10.2.5 EERA to be evaluated on Performance Based Criteria with respect to prevailing international bench mark index and practices.**

The elements of Performance based criteria are

- a) Design adequacy of Escape, Evacuation and Rescue Mechanism to meet the eventually.
- b) Performance
- c) Reliability
- d) Availability



#### 4.1.10.3 Deliverables

An easily comprehensible comprehensive Escape Evaluation and Rescue Analysis Report consisting of but not limited to the following

- Identification of Major Accident Events.
- Identification of Escape Routes and evacuation facilities for population on the platform/rigs.
- Adequacy check of existing refuge areas, escape routes, evacuation facilities, Life Saving appliances and rescue facilities.
- Details of blocked escape routes.
- Recommendations for improvement of escape and rescue facilities.

Report should

- Summarize adopted methodology.
- Activities to be undertaken to improve TEMPSC Evacuation.
- Critical analysis of the Operability of evacuation and Escape Methods under Various Accident Circumstances.
- Probability of Evacuation Success
- Improving Survival Times
- Reducing recovery times.

##### 4.1.10.3.1 As a minimum following documents/ information to be considered as guide for carrying out the study:

- Process Design Basis
- Number of personnel on the platform/rigs.
- PFD
- P&ID
- Equipment Layout
- Escape Route Plan

Any other related studies leading to the EERA study is to be carried out by the bidder.

The approach for the study shall be HAZOP based and include the goals & guide words stated in the methodology.

#### 5.0 DOCUMENTATION

All the Safety Studies conducted by the contractor shall be fully documented and submitted to the Company for review. On review comments if any, shall be incorporated and reissued to the Company.



Detailed calculations shall not be issued to the Company for review. However the Company may audit/review any calculations performed as part of the Safety Studies. Any findings from these audits/reviews shall be implemented by the Contractor.

Following completion (including Company review and comment incorporation) of the Safety Studies, a comprehensive dossier comprising all information (including reports, calculations, drawings and registers) shall be provided to the Company.

### Corporate Risk Matrix

Consequence					Increasing Probability			
Severity Rating	People	Asset	Environment	Reputation	A	B	C	D
					Has occurred in E&P industry	Has occurred in operating company	Occurred several times a year in operating company	Occurred several times a year in location
0	Zero injury	Zero damage	Zero effect	Zero impact	Manage for continued improvement (LOW)			
1	Slight injury	Slight damage	Slight effect	Slight impact				
2	Minor injury	Minor damage	Minor effect	Limited impact				
3	Major injury	Local damage	Local effect	Considerable impact				
4	Single fatality	Major damage	Major effect	Major national impact	Incorporate risk reducing measures (MEDIUM)		Fail to meet screening criteria (HIGH)	
5	Multiple fatalities	Extensive damage	Massive effect	Major international impact				

Note: Table gives an indication of risk tolerability in general terms