Regulation DD-12.0: Risk Assessment Study

12.0 Risk Assessment Study

12.1 Guidelines for Conducting Risk Assessment (RA) Study

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Table 1 – Working Methods for Hazard Assessment

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12.0 Risk Assessment Study

12.0.1 Risk Assessment study shall be mandatory for all manufacturing & process industries, storage for flammable, combustible and other hazardous, dangerous chemicals, liquids, solids & gases, tank farms, spheres, bullets, liquid & gas storage tanks, boilers & pressure vessels, gas distribution systems, petrol, oil & chemical distribution systems / pipelines and other special facilities/project/industries etc.

12.0.2 Risk Assessment study shall be carried out by pre-qualified consultants of EHS-Trakhees-PCFC, and RA study shall be approved by EHS-Trakhees-PCFC prior to commencement of drawing submission for EHS-NOC for BP.

12.0.3 Risk Assessment consultants shall adhere to EHS-Trakhees-PCFC "Risk Assessment Guidelines" and shall include (but not limited to) the following points in Risk Assessment/Analysis Report, major aspects are as follows:

12.0.3.1 Manufacturing/operation/process/storage activities.

12.0.3.2 Machine/equipment detail and safety guards.

12.0.3.3 Factory/warehouse/facility building design/suitability for operation/activities.

12.0.3.4 Severity analysis/Fire & Explosion Index (F & EI) and Toxicity Index (TI).

12.0.3.5 Criteria for assessing maximum release quantity and separation distances/quantifying dispersion.

12.0.3.6 Direct comparison with actuarial data and other risk criteria, Process/Operation & Activities.

12.0.3.7 Fire & Toxic hazard identification.

12.0.3.8 Domino effect.

12.0.3.9 Scenario development.

12.0.3.10 Hazard and Operability Study (HAZOP).

12.0.3.11 Event trees / fault tree analysis.

12.0.3.12 Mapping areas of risk, risk contours and risk transect.

12.0.3.13 Probability analysis / the chances of fire and explosion.

12.0.3.14 Identification of environmental problems that are related to fire protection.

12.0.3.15 Risk reduction analysis (if the risk is not acceptable) systems & methods and recommendations to prevent and/or reduce them to the acceptable level(s).

12.0.3.16 Risk monitoring (if the risk is acceptable).

12.0.3.17 Case histories where appropriate.

12.0.3.18 Compliance with codes, procedures and regulations including manufacturing requirement & management under ASME code for boilers & pressure vessels.

12.0.3.19 Toxicity relationships & dense gas dispersion model.

12.0.3.20 Damage from fire and radiant heat

12.0.3.21 The TNT equivalence.

12.0.3.22 Primary and secondary blasts relationships.

12.0.3.23 Top event frequency estimation.

12.0.3.24 Design & construction procedures.

12.0.3.25 The scale that measures severity such as death, injuries, property damage, and areas reached by flames shall be specified.

12.0.3.26 Calculations specifying the severity measure used for a particular fire shall be included.

12.0.3.27 Active and passive fire protection measures shall be included.

12.0.3.28 Identification of environmental problems that are related to fire protection.

12.0.3.29 Maintenance Operations.

12.0.3.30 Occupational Health.

12.0.3.31 Education & Training of staff.

12.0.3.32 Fire Run Off water drainage provisions.

12.0.3.33 Emergency / Evacuation Plans (on site & off site plans including emergency actions, emergency reporting procedures, evacuation policy, exit maps, procedure for sheltering in place, procedure for people who remain in place, procedure for accounting for all personnel, rescue and medical tasks and emergency communication plan.)

12.0.3.34 Safe Access for Emergency Services.

12.0.4 The consultants shall be solely subject to the laws of the UAE for losses or damages in terms of life and property from design errors, implementation errors, deficiencies of inspections, failure to construct in compliance with the required standards, failure to comply with rules of professional ethics, failure to use knowledge and experience to the contracting entity, and similar reasons; and successively (severally) liable with the contractors where the consultants have undertaken control and inspection services on works. The consultants shall be caused to complete and compensate for any such losses or damages pursuant to the laws of the UAE / EHS-Fire section. EHS Department or any other departments of PCFC and their directors, officers and other concerned personnel shall not be held responsible or liable for any such losses or damages, errors, deficiencies and failures on the part of the consultants.

12.1 Guidelines for Conducting Risk Assessment (RA) Study

Risk Analysis should be based on the various hazard assessment methods outlined in Table 1 and should include (but not limited to) the following:

12.1.1 As a first step in Risk Assessment, PHA (Preliminary/Process Hazard Analysis) should be carried out followed by detailed examination by other known hazard analysis method such as HAZOP studies. The Risk Assessment Study should evaluate all possible risks arising within the premises/operations and/or off-site due to the operations and recommend necessary mitigation measures.

12.1.2 A detailed evaluation of regular/irregular operations, activities, tasks and main installations, including physico-chemical characteristics of materials being stored/handled/processed, quantitative data on amounts, volumes, production/storage conditions etc. should be carried out.

12.1.3 Site suitability with regard to wind, flooding, neighboring facilities/locality, Residential, Religious, School and Hospital etc.

12.1.4 FAULT TREE and EVENT TREE analysis should be carried out to provide a graphic description of the accident sequences associated with plant operations and storage.

12.1.5 Evaluate/Clarify risks (Frequency, Severity and Probability) using accepted Risk Assessment Technique and Criteria leading to determination of risks to be eliminated or controlled.

12.1.6 Accident Consequence Analysis and its effects on human, environment and nearby installations and site should be analyzed.

12.1.7 Provide for clarification of risks and identification of those to be eliminated or controlled.

12.1.8 Evaluate Fire & Explosion hazard using F & EI Index.

12.1.9 Evaluate Fire Protection System, Alarm System and Ventilation.

12.1.10 Hazardous Area Classification

12.1.11 Effects of emergency situations/major environmental events such as lightning, flooding, acts of mischief or sabotage should be analyzed.

12.1.12 Evaluate occupational health hazards & environmental risks involved in process and operations.

12.1.13 For all of the above, measures should be developed and recommended for technical and organizational protection to bring down risks AS LOW AS REASONABLY PRACTICABLE (ALARP).

12.1.14 Develop ON SITE & OFF SITE emergency action plan in co-ordination with PCFC – EHS Fire Dept.

12.1.15 Wherever a risk/operation/situation cannot be managed feasibly, it shall be the duty of the consultant to highlight the same in the report.

12.2 Outline for Risk Assessment Study Report

Risk (incorporating Health, Safety & Environment risks) Assessment study report should contain the following information as a minimum. In practice, the depth of the information required on each guideline topic given below will vary according to the circumstance of the individual facility.

It is important that the names of personnel who conducted the RA study be mentioned in the report.

Background and objective.

Information on hazardous substances (e.g. substance name monitoring method, hazards, composition of process etc.).

Documentation and summary of Codes, Standards and Recommended Practices which have been consulted during the design stage of the project.

Information on the installation (e.g. location, plot plan, process/flow diagram, personnel on site, local land used and population distribution etc.).

Information on details of the plant and machinery including sketches (sectional view) of machinery and schematic of the process involved.

Information required on management system (e.g. responsible person and Quality Control for safety training etc.).

Information on major accidents (identification of potential major hazard events, process flow diagram, prevention and control systems, emergency procedure meteorological conditions, numbers at risk etc.).

Prior to final approval of the Risk Assessment Study report, a technical presentation to EHS. Management should be carried out if required.

After completion of the project, Risk Assessment consultant shall conduct site visit to verify compliance/ implementation of RA recommendations and accordingly submit the Statement of Compliance to EHS.

TABLE 1

WORKING METHODS FOR HAZARD ASSESSMENT

METHOD	PURPOSE	AIM	WORKING PRINCIPLE
1. Preliminary/Process hazard analysis 2. Matrix diagrams of interactions 3. Use of checklist	1. Identification of hazards	1. Completeness of safety concept	Use of "thinking aids"
4. Failure effect analysis 5. Hazard & operability study	2. Identification of possible failure and it's consequences	2. Designs modification of system	2. Use of "searching aids" in schematic documents
6. Accident sequence analysis (inductive) 7. Fault tree analysis (deductive)	3. Assessment of hazards according to their occurrence frequency	3. Optimization of reliability and availability of safety systems	3. Graphic description of failure sequences and mathematical calculation of probabilities
8. Accident consequence analysis	4. Assessment of accident consequences	4. Mitigation of consequences and development of optimum emergency plans	4. Mathematical modeling of physical and chemical process

12.3 Specific Fire Protection Requirements to be Addressed

12.3.1 Fire hazard identification.

12.3.2 Severity Analysis/Fire & Explosion Index (F & EI) and Toxicity Index (TI). (Refer to TABLE 2)

12.3.3 Mapping areas of risk / risk contours

12.3.4 Direct comparison with actual data and other risk criteria.

12.3.5 Criteria for assessing maximum release quantity and separation distances / quantifying dispersion.

12.3.6 Scenario development.

12.3.7 Probability analysis / the chances of fire and explosion.

12.3.8 Risk monitoring (if the risk is acceptable).

12.3.9 Identification of environmental problems that are related to fire protection.

12.3.10 Risk reduction analysis (if the risk is not acceptable) systems & methods and recommendations to prevent and/or reduce them to the acceptable level(s).

12.3.11 Hazard and Operability Study (HAZOP)

12.3.12 Event trees

12.3.13 Case histories where appropriate

12.3.14 Compliance with codes, procedures and regulations including manufacturing requirement & management under ASME code for boilers & pressure vessels.

12.3.15 Toxicity relationships

12.3.16 Damage from fire and radiant heat

12.3.17 The TNT equivalence

12.3.18 Primary and secondary blasts relationships

12.3.19 Top event frequency estimation

12.3.20 Design & construction procedures

12.3.21 Maintenance Operations

12.3.22 Education & Training of staff

12.3.23 Emergency / Evacuation Plans (on site & off site plans)

12.4 Guideline Notes

12.4.1 The scale that measures severity such as death, injuries, property damage, and areas reached by flames shall be specified.

12.4.2 Calculations specifying the severity measure used for a particular fire shall be included.

12.4.3 Active and passive fire protection measures shall be included.

12.4.4 The consultants shall be solely subject to the laws of the UAE for losses or damages in terms of life and property stemming from design errors, implementation errors, deficiencies of inspections, failure to construct in compliance with the required standards, failure to comply with rules of professional ethics, failure to use knowledge and experience to the contracting entity, and similar reasons; and successively (severally) liable with the contractors where the consultants have undertaken control and inspection services on works. The consultants shall be caused to complete and compensate for any such losses or damages pursuant to the laws of the UAE.

12.5.5 EHS-Fire Dept/AHJ, EHS Dept or any other departments of PCFC and their directors, officers and other concerned personnel shall not be held responsible or liable for any such losses or damages, errors, deficiencies and failures on the part of the consultants.

TABLE - 2

FIRE & EXPLOSION INDEX (F&EI) SYSTEM

MATERIAL FACTOR (MF)

The Material Factor (MF) is derived from the following table:

	$N_r = 0$	$N_r = 1$	$N_r = 2$	$N_r - 3$	$N_r = 4$
$N_f = 0$	1	14	24	29	40
$N_f = 1$	4	14	24	29	40
$N_f = 2$	10	14	24	29	40
$N_f = 3$	16	16	24	29	40
$N_f = 4$	21	21	24	29	40

The MF for Combustible Dusts; Combustible Solids; Warehousing/Storage of Goods; Manufacturing, Construction and Other Occupancies are derived from separate tables.

GENERAL PROCESS HAZARDS (GPH)

General process Hazards are factors that play a primary role in determining the magnitude of a loss incident. The items viz. (i) Chemical Processes (ii) Storage, Handling, Transfer and Manufacturing (iii) Confinement (iv) Access (v) Drainage (vi) Total General Hazards Factor are investigated as contributing hazards.

SPECIFIC PROCESS HAZARDS (SPH)

The items viz. (i) Quantities of Materials Involved (ii) Pressure Conditions (iii) Toxic Materials Involved (iv) Explosion Potential/ Flammable Range & (v) Total Specific Hazards Factor that indicate existence of specific conditions as a major contributing factor in fire and explosion incidents are investigated.

FIRE AND EXPLOSION INDEX (F&EI)

The F&EI calculation is calculated by giving credit for both general and specific process hazards to the materials involved. The formula used is:

F&EI = MF x (1 + GPH) x (1 + SPH)

The resulting F&EI values are ranked into four categories:

01 - 45	Light Hazard
46 - 60	Moderate Hazard
61 - 95	High Hazard
96 - up	Severe Hazard

FIRE & EXPLOSION INDEX SYSTEM

TOXICITY INDEX (TI)

TOXICITY NUMBER: The toxicity number (Th) is derived from the NFPA health factor Nh (NFPA 704, 325M or 49). Nh is an integer number ranging from 0 to 4. The five degrees of hazards are related to the protective equipment normally available to fire fighters.

Nh	Th
0	0
1	50
2	125
3	250
4	325

PENALTY FACTOR: The Penalty Factor (Ts) is the second toxicity parameter used to determine the TI. The Ts value is derived from the 'Threshold Limit Values (TLV).

The TLV-values are drawn up by the American Conference of Governmental Industrial Hygienists. TLV represents a Time Weighted Average (TWA) air concentration to which workers can be exposed during a normal working week without ill effects. TLV is often indicated as a TWA-value, both are the same.

The penalty factor is determined from the table below:

Threshold Limit Values (TLVs)	Penalty Factor (Ts)
< 5	125
5-50	75
> 50	50

TOXICITY INDEX (TI)

The Toxicity Index is then calculated from Th and Ts plus the hazard factors of Fire & Explosion Index (F&EI). The TI is found from the following formula:

$$TI = \frac{Th + Ts\ (1 + GPH + SPH)}{100}$$

The resulting TI values are ranked into three categories:

1-5	Light
6-9	Moderate
10-up	High