

NPTEL CERETIFICATE EXAMINATION

HSE practices in offshore & petroleum industries- SET 1

- *This question paper contains three sections. Answer all sections.*
- *No codes and additional support material is allowed for reference.*
- *Any data missing, may be suitably assumed and stated.*
- *Use of calculators is permitted.*

Time: 3 hrs

Total Marks: 100

Section A: Each question carries one mark. Use appropriate key words to answer

1. According to environmental protection act, _____ % of mud or cuttings cannot be discharged into sea water. (50%)
a) 25% b) >50% c) 75% d) >75%
2. _____ and _____ are primary environmental issues resulting from oil and gas exploration & production. (Shelf eco systems and marine biological resources)
3. The toxicity of the surrounding medium that will kill half of the sample population in a specified period through exposure is _____ (Lethal Concentration- LC50)
4. _____ is a stable stability class as per Pasqual stability class (F class)
5. Maximum concentration of plume release occurs at _____ (release point)
6. Explain Dow fire & explosion index
The Fire and Explosion Index calculation is a tool to help determine the areas of greatest loss potential in a particular process. It also enables one to predict the physical damage that would occur in the event of an incident.
7. Fatality accident rate (FAR) is defined as _____ (ratio of # of fatalities to # of persons at risk)
8. Societal risk are expressed in as _____ (F-N curves)
9. As per Frank & Morgan model, the relative risk of the department with highest risk index is _____ (Zero)
10. The locations at which the process parameters are investigated for deviations is known as _____. (Node)
11. _____ keywords focus on design intent and _____ keywords focus on deviations (Primary, secondary)
12. _____ defines how the plant is expected to operate in the absence of deviations at the study nodes. (Design intent)

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13. _____ is a way in which the process conditions may depart from their design/process intent. (Deviation)
14. Main objective of Failure Mode and Effect Analysis is on _____ and not on _____. (Failure prevention; detection)
15. _____ is the minimum oxygen concentration below which combustion is not possible, with any fuel mixture. (Limiting oxygen concentration, LOC)
16. _____ is the calculation of quantitative relationships of the reactants and products in a balanced chemical reaction (Stoichiometry)
17. _____ is devoted to identification, evaluation and control of occupational conditions that cause sickness and injury. (industrial hygiene)
18. Most dangerous type of plume is _____ (fumigation)
19. Action taken to control or reduce risk is called _____. (Risk aversion)
20. Offshore reserve that is not economical to support installation of a permanent drilling and production platform is called as _____. (Marginal field)

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Section B: Each question carries TWO marks. Answer briefly

1. Discuss factors affecting dispersion of release gas or vapor

wind velocity

atmospheric stability

terrain conditions

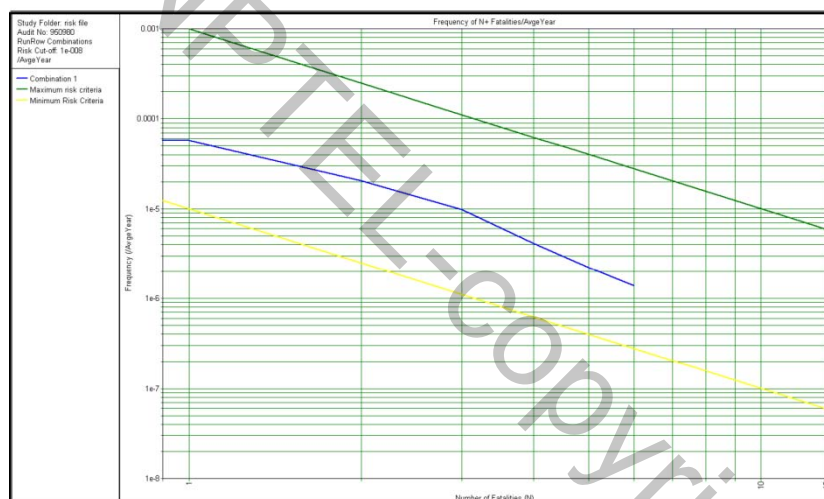
height of release above ground

initial momentum of release material

2. Define hazard

It is a situation that poses a level of threat to life, health, property, or environment

3. Discuss the F-N curve shown below using ALARP concept



FN curves show that the studied combination is well within the range of max and minimum permissible risk of the plant under consideration. However, even the minimum admissible risk is above the risk cut-off, which highlights the necessity of appropriate safety measures.

4. What is the difference between Incident and Accident?

An incident is an unplanned, undesired event that hinders completion of a task and may cause injury or other damage. An accident is a undesired event or sequence of events causing injury, ill-health or property damage. All incidents do not propagate to an accident, if we are able to contain the unplanned, undesired event.

5. What is hazard evaluation?

Hazard identification along with risk assessment together is known as hazard evaluation

6. Difference between full recording and recording with exception

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Recording with exception - Earlier HAZOP are carried out only for potential deviations with negative consequences, as it was used for internal purposes and handwritten. It is assumed that deviations not included are presumed to be satisfactory.

Full recording - Over period of time it was observed the need for recording all deviations irrespective of their potential. Each keyword applied to the system in the HAZOP report has to be clearly stated. Even statements like no cause could be identified or no consequences arose from the cause recorded are to be reported.

7. What is a weak link and what methods is used to detect them?

Weak Link: It is the one having the highest chance of failure. A detailed analysis of the components in the weak link are carried. The components if needed has to be redesigned such that the failure rate decreases to ALARP.

One of the method used to identify the weak link is FMEA.

8. What is a toxicant and how do they enter human body?

Toxicant denote substances introduced into the environment by human activity which have adverse affect on the biological organisms

Toxicants enter body through inhalation, dermal adsorption, ingestion, injection

9. Define the terms toxic dose, lethal dose, effective dose

Lethal dose: The response of the interest is death or lethality; such a dose is called lethal dose

Effective dose: The response to the toxicant is very minor but reversible; such a dose is called effective dose

Toxic dose: the response to the toxicant causes an undesirable response, which is not lethal but irreversible is called toxic dose

10. What is fire triangle? Explain its significance is safety assurance

Fire triangle is a simple diagram representing the necessary ingredients for



most fires

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If any arm of the fire triangle is not available, fires cannot take place. Therefore in order to dose fires it is necessary to eliminate any one ingredient of the fire triangle.

11. Write short notes on Inerting and purging

Both inerting and purging are mechanisms by which either oxygen or fuel concentration is reduced to a level lower than the target value. Usually, this is 4% lesser than the limiting oxygen concentration. Nitrogen is commonly used for purging process.

12. Write a brief note on BLEVE

BLEVE is boiling liquid vapour cloud explosion. This is caused due to the instantaneous release of large amount of vapour through narrow opening under pressurized condition.

13. What do understand by rule-based regime in safety practices?

Rule-based regime consists of legislators who set the safety rules. They emphasize compliance rather than outcomes. Main disadvantage is that they are slow to respond. They give less emphasis on continuous improvement and work-force involvement.

14. What is a toxicant?

Toxicant is a chemical or physical agent, including dust, fibres, noise and radiation. They can enter human body through ingestion, inhalation, injection and dermal absorption.

15. List a few factors that are considered while framing environmental management policy

These factors include i) possibilities of alternate sources of energy; ii) natural condition; iii) ecological factors; and iv) techno-economic factors.

16. How do oil spill occur?

Hydrocarbons are released continuously in marine environment due to natural oil seepage from sea floor. In addition, oil spill occurs due to collision of vessels, leak from drilling stack, faulty connections of risers etc. They include physical transport, dissolving and emulsification of chemicals, oxidation and decomposition of microbial waste and microbial degradation.

17. What safety measures are followed while discharging drilling waste in sea?

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Through ecological monitoring, pollution of seawater that occurs from drilling waste can be monitored. Further, biological monitoring is helpful in measuring molecular and cellular effects under low levels of impact, which are not capable of measuring by chemical analysis.

18. Write a brief note on FMECA

FMECA abbreviates for Failure Mode Effect and criticality analysis. In addition to listing of failure modes of a given mechanical/electric system, FMECA also highlights the critical effect of those failure mode on overall performance of the chosen system.

19. What do you understand by acceptable risk?

Acceptable risk refers to permissible level of consequences, which are as low as reasonably practical. As offshore exploration process is not risk-free operation, international standards allow a minimum level of risk under exploration and production operations, as long as mitigating this risk level is not too expensive.

20. List a few software used for risk assessment

CMO compliance, Spiramid, Integrum, Rivo

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Section C: Each question carries 5 marks. Answer in detail. Draw figures, wherever necessary to support your answer

1. What are different stages involved in ecological monitoring

Stages of ecological monitoring are:

- Identification of potential hazards
- Qualitatively assess the biological responses
- Cause-effect relationship
- Assess the total impact on the marine environment
- Corrective measures

2. List impacts caused by drilling operations

Drilling process discharges drilling muds and cuttings onto the ocean floor which contains hazardous materials disturbing the marine ecosystem.

- The oil based drilling waste contains non bio-degradable material by 95% even after six months.
- The drilling waste based on fatty acids lose their organic fraction due to microbial and physiochemical decomposition.
- Drill cuttings increase turbidity & smothering of benthic organisms

3. What are isopleths? How are they constructed? How are they useful?

A line on a map connecting points having equal concentration is called isopleths. The steps involved are:

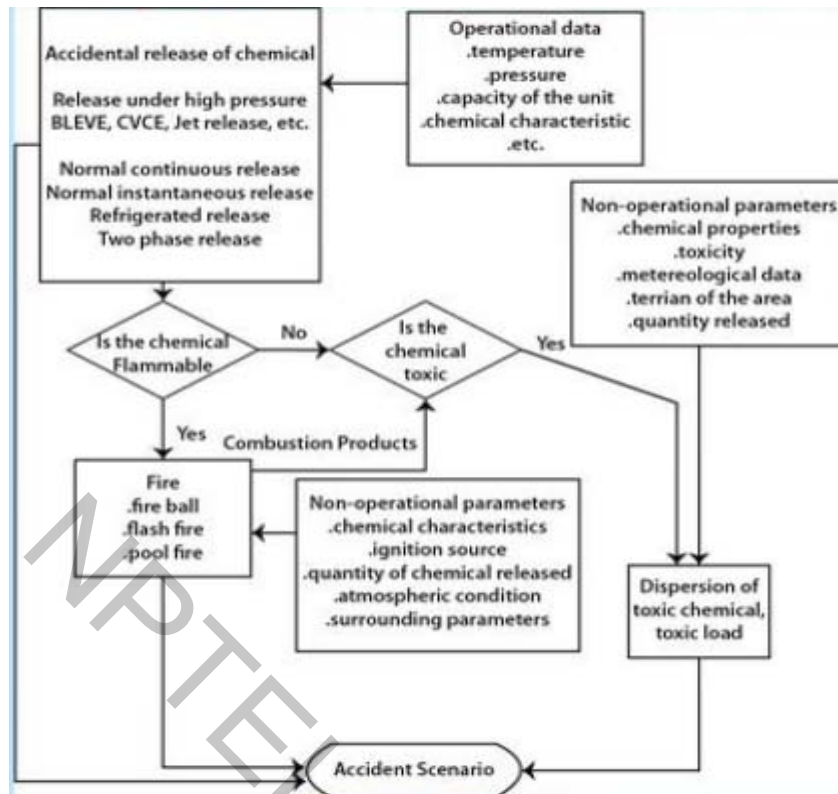
- Step 1: Determine the concentrations along the centre line at fixed points in the downward wind direction
- Step 2: Find the off-centre distance to isopleths at each point
- Step 3: Plot the isopleths offsets for both the directions at each point
- Step 4: connect the points

They are useful to estimate the dispersion concentration, knowing the direction of release and point of release (in terms of its coordinates)

4. How accident scenario is developed for analysis?

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5. Calculate the risk ranking for each department using Frank and Morgan model?

Exposure Dept.	Hazard score	Control score	Property value (x10 ³)	Business interruption (x10 ³)	Composite score	
					Personnel	Exposure dollars
A	250	310	2900	1400	900	5200
B	75	240	890	1200	650	2700
C	180	185	1700	720	1600	3400
D	150	240	1200	900	1900	2800
F	90	150	800	1050	2100	6300
G	100	200	750	450	850	8000

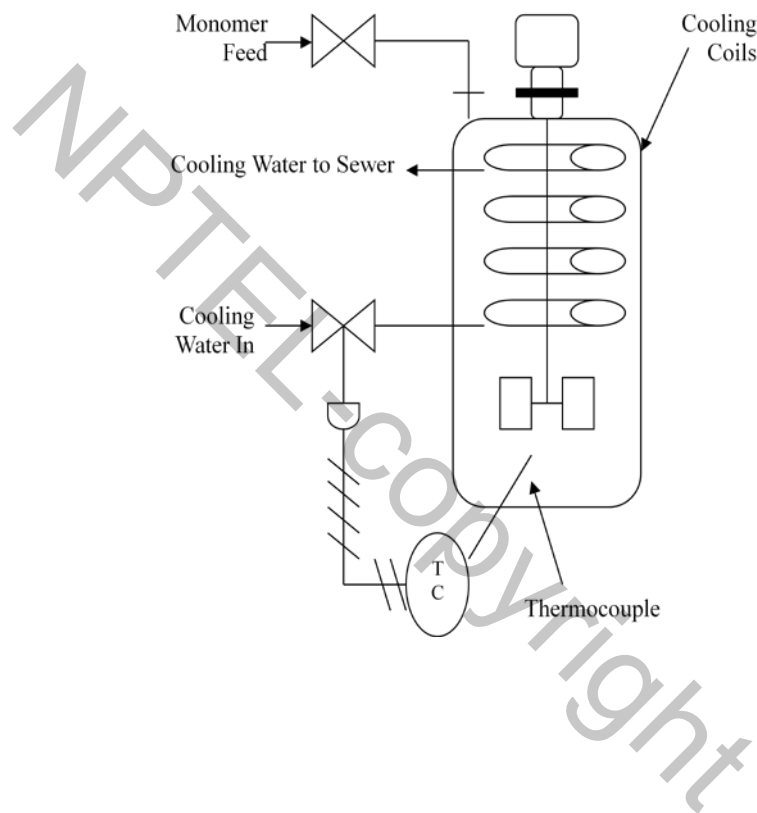
Risk index	Relative risk	% risk index	Composite risk	Risk ranking
60	-105	20.59	1070.59	4
165	0	0.00	0.00	6
5	-160	31.37	1066.67	3
90	-75	14.71	411.76	1
60	-105	20.59	1297.06	5
100	-65	12.75	1019.61	2

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6. Perform HAZOP Study to reactor system shown below

DESCRIPTION: The reaction is exothermic. A cooling system is provided to remove the excess energy of reaction. In the event of cooling function is lost, the temperature of reactor would increase. This would lead to an increase in reaction rate leading to additional energy release. The result could be a runaway reaction with pressures exceeding the bursting pressure of the reactor. The temperature within the reactor is measured and is used to control the cooling water flow rate by a valve.



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Guide Word	Deviation	Causes	Consequences	Action
NO	No cooling	Cooling water valve malfunction	Temperature increase in reactor	Install high temperature alarm TAH
REVERSE	Reverse cooling flow	Failure of water source resulting in backward flow	Less cooling, possible runaway reaction	Install check valve
MORE	More cooling flow	Control valve failure, Operator fails to take action on alarm	Too much cooling, reactor cool	Instruct operators on procedures
AS WELL AS	Reactor product in coils	More pressure in reactor	Off-spec product	Check maintenance procedures and schedules
OTHER THAN	Another material besides cooling water	Water source contaminated	May be cooling ineffective and effect on the reaction	If less cooling, TAH will detect. If detected, isolate water source

7. Carryout an FMEA study for centrifugal pump with components mechanical bearing, seal, shaft and impeller.

S No	Components	Failure mode	Failure effect	Comments
1	Mechanical seal	Leaking though seal	1. Fluid leakage 2. Losses of pumping efficiency	Periodic maintenance and replacement as per schedule
2	Bearing	Worn out: shaft and seal broken	1. Excessive pump vibration 2. Increased In shaft radial movement 3. Eventual pump shutdown	
3	Shaft	Corroded	1. Vibration 2. Possible bearing damage 3. Eventual coupling failure	1. Using non corrosive material and corrosion-resistant paints
4	Impeller	Worn out: decreasing pump capacity	1. Pump low efficiency 2. Vibration 3. Reduce in suction power	

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8. Draw flammability diagram for ethane (C₂H₆) for the following data in Table 1.

Table 1: Flammability limits and LOC of Ethane

Flammability in air	LFL: 3.0% UFL : 12.4%
Flammability in oxygen	LFL: 3.0% UFL : 66.0%
LOC	11%

