

**UNIVERSITY COLLEGE LONDON**

University of London

**EXAMINATION FOR INTERNAL STUDENTS**

For The Following Qualification:–

*Coll Dip*

**Chemical Eng E876: Advanced Safety and Loss Prevention**

COURSE CODE : **CENGE876**

UNIT VALUE : **0.50**

DATE : **21-MAY-04**

TIME : **10.00**

TIME ALLOWED : **3 Hours**

*Answer FOUR questions only with no more than TWO questions from each SECTION. Only the first FOUR answers will be marked. Answers to questions in sections A and B to be presented in SEPARATE ANSWERBOOKS.*

*ALL questions carry a total of 25 MARKS each, distributed as shown [ ]*

## **SECTION A**

- 1.
- i) What are the key elements of successful health and safety management? [5]
  - ii) To achieve a positive health and safety culture it is necessary to gain the commitment and involvement of all staff. Briefly describe the factors that contribute to the development of safety culture [20]
- 2.
- i) What is the purpose of investigating accidents and reporting them? [4]
  - ii) What are the steps taken or action plan necessary to carry out a thorough investigation? [10]
  - iii) A load of 900 tonnes of 98% formic acid on a ship for transport from the United Kingdom to the USA took 35 days. The formic acid was off-loaded and the tank washed using hot seawater for about one hour followed by a cold fresh water wash for about 30 minutes. The tank manhole was opened and a crewman wearing breathing apparatus entered to remove the remaining water in the tank. The crewman quickly got into difficulties, another crewman also wearing breathing apparatus entered the tank to rescue the first crewman. The second crewman also got into difficulties in the tank and when both were eventually removed they were found to be dead.

The investigation revealed the following:

1. Both crewmen died of carbon monoxide poisoning with saturation level in the haemoglobin of the blood well above the normally considered fatal concentration.
2. Although tank ventilation had been started, the actual tank ventilation time is not known. However, no samples of air were taken for analysis for formic acid or oxygen.
3. Formic acid decomposes to carbon monoxide and water. The decomposition rate increases with an increase in temperature or concentration.
4. Carbon monoxide is reported fatal at levels between 0.5 – 1%.
5. Hot seawater is unlikely to have caused additional catalytic decomposition due to quick dilution of the formic acid.
6. Carbon monoxide is about 5%vol soluble in formic acid and is capable of a certain amount of supersaturation.

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**2. cont'd**

7. The crewmen wore demand valve type, without positive pressure, breathing apparatus. The crewmen who died had heavy growth of beard and almost certainly drew in the carbon monoxide atmosphere through the beard rather than through the demand valve of his breathing set.

What are the conclusions that can be drawn from the investigation? [11]

**3.**

'What if' reviews and Hazop studies are safety analysis methods that can be applied to a facility or a project. Briefly outline the features of each technique for selecting the most appropriate method for hazard identification. [5]

Describe the advantages and limitations of each technique. [20]

**SECTION B**

**4.**

- i) The risks associated with an industrial process may be broadly defined as:

- a) acceptable
- b) tolerable
- c) intolerable

What are the appropriate and necessary responses of management and the safety authorities to each category? [12]

- ii) British offshore safety legislation, specifically the Prevention of Fire and Explosion, and Emergency Response Regulations – PFEER, requires five “appropriate measures” to be formally adopted to ensure the safety of offshore workers. What are they? [13]

**5.**

- i) a) Define the acronym 'ALARP' [3]

b) To what does ALARP refer? [4]

c) What are the relevant criteria in determining ALARP? [8]

ii)

a) Explain the purpose of a permit-to-work system. [4]

b) What are the main factors that should be considered before the issue of a permit for entry into a vessel? [6]

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6.

- i) With the aid of a simple block diagram, explain the basic concept of safety assessment of process plant. [5]
- ii) Outline nine important factors that control the risk giving rise to accidents in the process plant. [5]
- iii) A continuous flow reactor is protected against overpressure using two pressure switches acting on an ESDV placed at the feed inlet. For this process:

- a) draw a suitable process and instrumentation flow diagram and calculate the overall system availabilities based on using either a 1002 or 2002 voting system for the pressure switches given the following data:

	Failure rate ( $\text{yr}^{-1}$ )	Proof test interval (yr)	
Pressure switches	$1 \times 10^{-2}$	2.5	
ESDV	$5 \times 10^{-3}$	5	

[10]

- b) based on your findings in (a) above, given the choice, comment on the rationale justifying using either 1002 or 2002 voting systems for the operation of the pressure switches. [5]

**END OF PAPER**