



**University of Petroleum & Energy Studies  
School of Business, Dehradun  
MBA POWER MANAGEMENT  
END SEM EXAM-APRIL 2018  
HSE FOR POWER INDUSTRY MBPG 932**

**TIME: 3 HRS**

**MAX MARKS; 100**

**SECTION-A**

**(2x10=20 Marks)**

**Q.1 Briefly write:**

- I. PHA -----
- II. HAZOP is -----
- III. ALARP is -----
- IV. QRA is-----
- V. P&IDs -----
- VI. BACT is -----
- VII. STP -----
- VIII. FTA is -----
- IX. IITS is -----
- X. ERICPD -----

**SECTION-B, ATTEMPT ALL QUESTIONS**

**(4x5= 20 Marks)**

Q.2. Write Short Notes on:

- SAFETY DISTRICT
- BLEVE

Q.3 Define an incident. What are direct & indirect costs of an accident?

Q.4 EMS is on top priority for all type of industries. Highlight the benefits & Key principles of EMS.

Q.5 Share your knowledge on various work permit systems used to avoid accidents in various organizations.

Q.6 Safety audit is an important study for most of the hazardous industries. Describe different types of safety audit conducted for any industry.

**SECTION -C, ATTEMPT ANY TWO QUESTIONS****(15x2= 30 Marks)**

- Q.7 Generation of solid waste depends upon life style of that particular region. What do you mean by solid waste? What are different techniques available to manage solid waste?
- Q.8 Risk assessment at various stages of plant life can help in reduction of major accidents. Discuss objectives of risk assessment and components of risk assessment.
- Q.9 Disaster like Bhopal can be avoided, if disaster management plan is properly framed and rehearsed. What is disaster management plan? Describe categories of emergency with elements of a major emergency management plan.

**SECTION D – CASE STUDY****(1x30= 30Marks)**

- Q.10a. Find out major causes of the disaster in current case study.
- Q.10.b What is learning as safety officer from this accident?

**THE BHOPAL GAS TRAGEDY**

The Bhopal pesticide plant where took place this fatal accident was built in 1970's and was owned and operated by Union Carbide India Limited (UCIL), an Indian company in which Union Carbide Corporation of US held just over half of the stock. Indian financial institutions and thousands of private investors in India held the rest of the stock. Union Carbide India Limited (UCIL) was established in 1934, when Union Carbide Corporation (UCC) became one of the first U.S. companies to invest in India

Between 1977 and 1984, UCIL, located within a crowded working class neighborhood in Bhopal, under license from the Madhya Pradesh Government produced pesticides for use in India to help the country's agricultural sector increase its productivity and contribute more significantly to meeting the food needs of one of the world's most heavily populated regions. Methyl isocyanate (MIC) was produced at the Bhopal plant by reacting monomethylamine and phosgene in the plant's MIC production unit. The refined MIC was then transferred to a separate MIC storage area where it was stored in two horizontal, mounded, 15,000-gallon, and stainless-steel tanks. A third storage tank was kept empty for emergencies and for off-specification material waiting reprocessing. The MIC was used to make SEVIN carbaryl and several other carbamate pesticides. The MIC was processed into SEVIN carbaryl pesticide in the SEVIN unit. The MIC was transferred in one-ton batches to a charge pot in the SEVIN unit using nitrogen pressure. A nitrogen pressure of at least 14 psig in the MIC storage tank was necessary to move the material from the storage area to the SEVIN unit charge pot at a reasonable rate. From there, each batch

would be reacted with alpha-naphthol to make SEVIN carbaryl. below is presented the reaction producing carbaryl.

### **THE DISASTER**

On the early morning of the 3rd December 1984, water inadvertently entered the MIC storage tank, where over 40 metric tons of MIC was being stored. The addition of water to the tank caused a runaway chemical reaction, resulting in a rapid rise in pressure and temperature. The heat generated by the reaction, the presence of higher than normal concentrations of chloroform, and the presence of an iron catalyst, produced by the corrosion of the stainless steel tank wall, resulted in a reaction of such momentum, that gases formed could not be contained by safety systems. As a result, MIC and other reaction products, in liquid and vapor form, escaped from the plant into the surrounding areas.

### **AFTER - EFFECTS**

#### **LIFE AND PROPERTY**

The heavier-than-air MIC gas mixture when released into the air rolled along the ground through the surrounding streets and spread around. The transportation system in the city collapsed and many people were trampled trying to escape. There was no warning for people surrounding the plant as the emergency sirens had been switched off. The effect on the people living in the shanty settlements just over the fence was immediate and devastating. Many died in their beds, others staggered from their homes, blinded and choking, to die in the street. Many more died later after reaching hospitals and emergency aid centers.

The majority of deaths and serious injuries were related to pulmonary edema, but the gas caused a wide variety of other ailments. Signs and symptoms of methyl isocyanate exposure normally include cough, dyspnea, chest pain, lacrimation, eyelid edema, and unconsciousness. These effects might progress over the next 24 to 72 hours to include acute lung injury, cardiac arrest, and death.

Information on the exact chemical mixture was never provided by the company, but blood and viscera of some victims showed cherry-red color characteristic in acute cyanide poisoning. A series of studies made five years later showed that many of the survivors still suffered from one or several of the following ailments: partial or complete blindness, persistent respiratory problems, gastrointestinal disorders, impaired immune systems, post traumatic stress disorders, and menstrual problems in women. A rise in spontaneous abortions, stillbirths, and offspring with genetic defects was also noted.

According to the state government of Madhya Pradesh, approximately 3,800 people died initially and several thousand other individuals experienced permanent or partial disabilities.

Greenpeace cites 20,000 total deaths as its conservative estimate till date from the harmful effects.

According to the Bhopal Medical Appeal, around 500,000 people were exposed to the leaking chemicals. Approximately 20,000, to this date, are believed to have died as a result; on average, roughly one person dies every day from the effects. Over 120,000 continue to suffer from the effects of the disaster, such as breathing difficulties, cancer, serious birth-defects, blindness, gynecological

complications and other related problems. It is believed that 50,000 people are unable to work because of their debilitating ailments.

Union Carbide, on their Bhopal Information Center website, maintain that “approximately 3,800 died”, while 40 people have permanent disabilities and 2,800 have “partial disabilities”.

The International Campaign for Justice in Bhopal, however, claim that these figures are derived from an affidavit submitted to the Indian Supreme Court on 12th July 1990. This affidavit was apparently based on only roughly 15% of medical evaluations; the Indian Supreme Court would hear, in 1991, that 495,000 people had been classified as injured (22,000 permanently disabled, 3,000 seriously, and another 8,500 temporarily disabled). Even today, according to the campaign, evaluation continues: 15,000 death claims and more than 560,000 injury claims have so far been granted. The campaign also suggest that “official figures only tell part of the story”, as many injury and death claims have been “denied arbitrarily”. It is also difficult to demarcate which deaths can be attributed to the incident directly.

The Indian Council for Medical Research reported that, in 1988 alone, approximately 2,500 extra deaths had occurred in places affected by the disaster. The factory was closed down after the accident.