

JK Lakshmipat University Jaipur
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, May 2022
M. Tech. (HSEE), Semester II, 2021-22
B. Tech (CE), Semester VI

Roll No.....

IL2106: HEALTH, SAFETY, AND ENVIRONMENT AUDIT

Time: 3 hours

Max. Marks: 60

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Mention all the assumptions for your answers clearly.

Q. 1.1	Estimate the percentage loading of the induction motor with following data using input power method, line current method and slip method. Name plate details: Rated kW of Motor = 30 kW Rated Amps = 55 A Rated voltage = 415 V Name plate efficiency = 92% Name plate speed = 1440 rpm No. of poles = 4 Frequency = 50 Hz Operating Data: Measured speed = 1460 rpm Input load current = 45 A Operating voltage = 425 V Input power = 20 kW	10.0 (CO3)																											
Q. 1.2	During the performance evaluation of a DG set, the following parameters were noted: <table border="1"> <tr> <td>Capacity of DG set</td><td>1500</td><td>kVA</td></tr> <tr> <td>Test duration</td><td>36</td><td>minutes</td></tr> <tr> <td>Units generated</td><td>442</td><td>kWh</td></tr> <tr> <td>Average Power factor</td><td>0.92</td><td>pf</td></tr> <tr> <td>Length of diesel tank</td><td>90</td><td>cm</td></tr> <tr> <td>Width of diesel tank</td><td>90</td><td>cm</td></tr> <tr> <td>Height of the diesel tank</td><td>90</td><td>cm</td></tr> <tr> <td>Initial tank dip level (from top)</td><td>63</td><td>cm</td></tr> <tr> <td>Final tank dip level (from top)</td><td>79</td><td>cm</td></tr> </table> Calculate the following: 1. Diesel consumption (Litres) 2. Average load (kW) 3. Percentage Loading (%) 4. Specific power generation (kWh/Litre)	Capacity of DG set	1500	kVA	Test duration	36	minutes	Units generated	442	kWh	Average Power factor	0.92	pf	Length of diesel tank	90	cm	Width of diesel tank	90	cm	Height of the diesel tank	90	cm	Initial tank dip level (from top)	63	cm	Final tank dip level (from top)	79	cm	10.0 (CO5)
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Q. 2.1	List out the required information to be submitted under FORM-V in Environmental Statement for the financial year ending on 31st March of every year. How will you submit the Annual Environmental Statement for steel industry? Explain with the help of Form-V and assumed data	7.0 (CO1,2)																											

Q. 2.2	Suppose you are Safety officer in a large-scale construction industry, then how your organization become certified against ISO 45001? Illustrate the usual path and detailed methodology for your organization to become certified against ISO 45001.	7.0 (CO3,5)
Q. 2.3	Why carry out a carbon footprint? Conduct an organizational as well as product assessment w.r.t. Carbon footprint audit for a cement industry.	6.0 (CO2,3)
Q. 3.1	Develop the suitable aspect for the following audits viz water audits, carbon footprint audits, fire audit, electrical audit, process safety audit, energy audit and critically evaluate its outcomes for manufacturing of highly toxic and flammable substance.	06.0 (CO3)
Q. 3.2	Develop the procedure for audit entry/audit exit meeting, audit area familiarisation, and audit Observation Skills, audit discussion, audit conformity, audit uniformity and audit credibility.	04.0 (CO1)
	What happened at Bhopal in India in December 1984? The factory produced pesticides at a relatively isolated location. Initially, the operation was relatively low risk and was limited to formulating, packaging and distributing the pesticide. The business grew rapidly and necessitated the shipping of one of the key raw materials into the site. The major raw material was methyl-isocyanate (MIC), which is a particularly hazardous chemical. The business continued to grow and a decision was made to commence manufacturing of MIC at the site. The technology for the production plant was well established as the company already safely operated a similar plant successfully in the United States. The new plant was commissioned in 1981 using experienced personnel from the United States to train the local operators and oversee the start-up. The plant had multiple layers of protection to ensure that through design the plant was as intrinsically safe as possible. MIC is a highly reactive chemical which is at risk of thermal runaway if incorrectly stored and particularly if mixed with water. The MIC was stored in three tanks that were partially buried in the ground and had concrete insulation on the exposed sections to mitigate the solar gain from the sun. The MIC storage tanks also had emergency cooling coils and means of safely treating relief valve discharges and vented gases. The process design required that one tank was always empty, so that in the event of problems there was somewhere to safely dump excess MIC. On 2nd December 1984 (according to Kharbanda & Stallworthy), the pipework adjacent to one of the tanks was being washed out with water. The valves were known to leak, and so slip plates were inserted to prevent the risk of water entering the tank. Just before midnight, the new shift noticed that the pressure was rising in the tank. However, this was assumed to be because nitrogen was being added to the tank, but in any case, the operators knew the pressure gauges were faulty and didn't believe them. At 23:30 on 2nd December, the operators experienced irritation in their eyes, signifying an MIC leak, but as this happened from time to time, no action was thought to be necessary. The design of the system, in the event of thermal excursions, was that the temperature inside the MIC tanks would be controlled by the operation of internal cooling coils. Unfortunately, on 2nd December 1984, there was no refrigerant in the system, as it had been removed to be used elsewhere on the site. Because there were multiple layers of protection for the plant, this cooling system was not the only layer of protection, and this single error should not have resulted in a hazardous situation. The next layer of protection	

	was a pressure relief system, which was designed to allow overpressure to be relieved and the MIC gas released to be diverted to a flare stack, where it could be burned off safely. By midnight on 2nd December 1984, both the temperature and pressure in the tank had risen to such a level that the relief valve lifted. Unfortunately, on that day, the flare system was <i>undergoing maintenance</i> and a section of <i>the flare header between</i> the MIC tanks and the flare stack had been <i>removed</i>, rendering this <i>protection system inoperable</i>. Fortunately, the designers had <i>provided an alternative safe route</i> to dispose of rogue gas emissions. This involved using a <i>scrubbing tower</i>, through which the MIC gases could be rendered harmless by scrubbing the gas with caustic soda. Unfortunately, in the early hours of 3rd December 1984, <i>the caustic scrubbing tower</i> was not in operation, and the <i>fugitive MIC gases</i> from the relief valve discharge passed straight through the tower and were discharged from a vent at the top of the column. Approximately 30 tons of highly toxic MIC gas was discharged from the tower vent. Fortunately, the designers had considered the risk of toxic gas releases at the plant and had <i>installed a water spray curtain</i> around the perimeter to absorb and dilute any escaping gas. Unfortunately, the water <i>sprays were limited in height to 6 metres</i>, because it had been designed to only contain gas emissions that occurred at ground level. On 3rd December 1984, the emissions occurred from the top of the tower vent, approximately 30 metres above the ground, and so the water curtain had no effect whatsoever and the gases passed over the top. The consequences of the incident were aggravated by the fact that a shanty town had grown up around the plant to provide homes for the workers, and so a large number of people were exposed to the MIC fumes. Two thousand five hundred people died immediately as a result of the incident, and it is currently believed that around <i>8500 may have died</i> as a direct result, although the number of victims also continues to rise as a result of long-term health effects. The <i>number of injury claims arising</i> directly from the incident was in excess of half a million, and the tragic event at Bhopal is considered to be the world's worst chemical incident. There are very many learning messages that arise from Bhopal, but for the purposes we shall focus on process safety learning. The simple facts are that a plant of very similar design had been operating safely in the United States for many years. Although there are things that could have been improved in the design and operability of the Bhopal plant, if the plant had functioned as designed, it is unlikely that this catastrophic incident would have occurred. The design incorporated multiple layers of protection, but for various reasons these layers of protection were rendered inoperable and no one seemed to have noticed. When the chips were down and the protection was needed, it was not available.	
Q. 3.3	Analysis the level of compliance of HSE policy at the Union Carbide Corporation Bhopal by applying the principle of process safety 3Ps.	04.0 (CO4)
Q. 3.4	Develop a good HSE audit system to prevent such disasters in the future by applying the principle OHSAS 18001 and ISO45001.	06.0 (CO5)

All the best!

