International Diploma in Safety Engineering (IDSE)
Qualifi Endorsed Qualification

UNIT 2: Principles and Applications of Science and Technology in Safety

Total Time: 5:00 hours
Total Questions: 15

Total Marks: 150
Passing Marks: 75

- This is a closed book exam. The maximum marks for each question are 10.
- Answers may be illustrated by sketches or process flow diagrams where appropriate.
- This question paper & answer sheets must be returned to the invigilator after the examination.
- Support your answers with **logical arguments** and **examples**. Generic and Bookish answers will not be accepted by the examiners.
- All Questions are compulsory and must be answered to gain maximum marks
- Use bullet points for questions asking to **Outline** and make sure each bullet point has unique and valuable content. You must give examples for each bullet point to clarify your answer.

Part A
(Each Question carries 10 Marks)

1- You are working in a company which is involved in manufacturing and installation of telecom towers. Working at height has been assessed as the key process and you as safety engineer has been tasked by the management to devise engineering controls for the safety of people working at height.
Suggest 3 different engineering controls for work at height safety and also explain if they will reduce/eliminate likelihood or severity or both?

Sample Answer

1st Engineering Control

The Guardrail of suitable specifications must be installed on all working platforms. This will reduce the likelihood of fall from height. Similarly, a ladder cage of suitable specification must be installed around the ladder to reduce the risk of fall from height while climbing up or down.

2nd Engineering Control

Provide soft landing either through Safety nets or portable soft landing bags across the tower basement. This will although not eliminate/ reduce the likelihood of the hazard but it will significantly reduce the severity of hazards hence the risk.

3rd Engineering Control

Personal inflatable airbags with fall detection sensors could be used a s a measure to reduce the severity of hazard. These inflatable airbags will operate as soon as the sensor detects the fall and will reduce the impact on collision with ground. Such solutions are very costly and have limited uses so far but in future, they will be used for personal safety against fall from height alongwith other engineering controls.

Note: The candidates may suggest some other engineering controls which are either in practice within relevant industry sectors or under design. The answers are marked for the quality of answers and solutions and not the quantity or length of answers.

2- You are working in a surface treatment plant where number of chemical processes are carried out. Due to the presence of chemicals, there are airborne chemicals at the workplace which have lately caused ill health issues to the workforce. The management wishes to take measures to eliminate/ reduce ill health effects due to airborne chemicals.

Outline in a step by step process how will you carry out the control measures?

Sample Answer

First Step

The identification of chemicals and the ill-health effects they pose to the workers. This will include the legal limits of STEL and LTEL for all the airborne chemicals

Second Step

Measuring and Monitoring of airborne chemicals PPM values to make sure they are well behind the stipulated values as per STEL and LTEL. The selection consideration will be important for measuring and monitoring devices based on the quantity and type of airborne chemicals and extent of required controls.

Third Step

Based on initial 2 steps, the development of Control measures e.g. Engineering Controls (Ventillations) or Administrative Controls e.g. Awareness , Shift timings and personal dosiemeters etc.

Fourth Step

Data analysis and Evaluation i.e. based on the performance of first 3 steps, what actions need to be taken in order to make the whole process more effective. This may include additional measuring or monitoring devices and/or additional control measures. As there are no limits established for mixed exposure of airborne chemicals, same should be kept in consideration if all limits are complied ut still there are health issues within the workforce. Other factors which may somehow invalidate the legal limits are age, fatigue, alchoholism, gender and environmental conditiona like extreme temperatures, pressure etc.

3- Your company houses 2 boilers (Old/ repaired and modified) which are used to produce steam. During your visit as safety manager to the boilers site, you notice that boiler operations are manual. There is a pressure gauge installed on each boiler and once a threshold pressure is reached, an alarm rings and the operator adjusts the setting to bring down into the safe range. The situation is a matter of concern as it is dependent on the vigilance of the operator and may cause boiler explosion. You discussed the issue with the top management who tasked you to devise an engineering control through a sub-contractor.
Explain the features of proposed engineering control you wish to suggest which will reduce/eliminate the likelihood of the hazard.

Sample Answer

It is obvious from the question requirements that top management wishes an automatic pressure adjustments to avoid explosion as existing system requires continuous human intervention which may lead to human error and failure.

I would like to propose an engineering control which will eliminate the need for continuous human monitoring and intervention (Except routine maintenance activities). Based on the requirements, the features of control measures to eliminate the risk of explosion are as follows;-

1- An auto pressure relief valve to be installed on the boiler which purges the steam into the environment once pre-set temperature is reached. The pressure relief valve must be compatible with the system and calibrated. A claibration certificate will also be required from the subcontractor to ensure safety.
2- A redundant auto pressure relief valve must also be installed on the boiler for increased safety as in case, one pressure relief valve gets unserviceable, the redundant system will take over to avoid the explosion.
3- Both the pressure relief valves will be fitted with pressure guages so that the operators also have the visibility of the pressure being developed inside the boiler and to make sure that the pressure relief valve operated at a pre-set pressure.

Note: The Excessive Pressure is only 1 cause of boilers' explosion. There are many other causes like materials or design failure, Excessive heating, Weakening of boiler due to rusting etc. The above engineering control will only cater for the excessive steam pressure which is question's requirement.

4- LTEL of H2S gas is 10 ppm/ 8 hrs and STEL is 15ppm/ 15 min. Please analyse the following exposure data for employees and comment if **STEL** and **LTEL** limits are being complied or not? Also calculate the **TWA**.

Morning shift 0800 to 1600 hrs (8am to 4pm)

Time	8 to 9	9 to 9:40	9:40 to 10:15	10:15 to 11	11 to 1:00	1:00 to 1:45	1:45 to 4
Exposure	12 PPM	18 PPM	11 PPM	9 PPM	14 PPM	14.5 PPM	14 PPM

Sample Answer

There are 2 ways to calculate the TWA

1- Convert the timing into minutes

First Bracked 8-9= 60 Minutes
Multiply 60 Minutes with Exposure i.e. 12; 60 X12= 720

Similarly

2nd Bracket= 40X18= 720

3rd Bracket= 35 X 11= 385

4th Bracket= 45 X 9= 405

5th Bracket = 120 X 14= 1680

6th Bracket= 45 X 14.5= 652.5

7th Bracket =135 X 14= 1890

Now add all the answers

720+720+385+405+1680+652.5+1890= 6452.5

Now divide the above answer by 480 Minutes (8 Hours= 480 Minutes)

TWA= 6452.5/480= **13.44 PPM (Long Term Exposure Limit)**

LTEL value is more than legal limit (Not being complied)
STEL is within legal limit as 15 PPM was never exceeded in any 15 minutes continuous period.

2nd Method is to convert the time durations into hours (Instead of minutes)

First Bracked = 1 X 12= 12

2nd Bracket= 0.666X18= 12

3rd Bracket= 0.58X 11= 6.41

4th Bracket= 0.75 X 9= 6.75

5th Bracket = 2 X 14= 28

6th Bracket= 0.75 X 14.5= 10.875

7th Bracket =2.25 X 14= 31.5

Now add all the answers

12+12+6.41+6.75+28+10.875+31.5= 107.5

Now divide it with 8 hours

107.5/8= 13.43 (LTEL)

5- You have been tasked as investigation officer by the regulatory body subsequent to a boiler explosion at a factory. **Develop a checklist** of atleast 10 suitable questions you wish to ask the user agency to identify the root cause of collapse. Your checklist must be in the following format;

Sr#	**What to Ask (Look Into)**	**Why to Ask?(Look For)**

In such questions, What to Ask is required evidence which an investigation officer must have as objective evidence to establish the facts. Whereas “Why to Ask” are the causes of the accidents which the inviestigation officer may write down to ascertain if that specific reason of accident can be ruled out or not.

To answer such questions, write the generic reasons of failure/ collapse/ accident of the structure under investigation i.e. on extreme right column. Once you write down generic reasons which in your opinion have resulted in the accident then on the left column, establish which evidence you need to reach to conclusion.

“Why to Ask” i.e. the extreme left column are the reasons which prompt or alarm any safety engineer or investigation officer when they hear of some accidents. For example, you hear of a road accident, what generic reasons prompt your mind?

- Over speeding
- Unattentive Driving (Using phone while driving)
- Road Conditions e.g. slippery rain due to rain/ snowfall etc.
- Limited visibility due to Fog
- Unauthorized driving by non licensed person
- Driving while intoxicated
- Etc etc

So what do you do to reach to an answer about the cause of such accident? Definitly not all reasons can be true simultaneously so you seek evidences e.g.

To establish if overspeeding was significat contributory factor then you wish to check the speed of the vehicle before accident. This can be done eaither through vehicle tracking system (If installed) or the data fromGPS system of the Mobile phone of the driver/ any passenger.

Similarly, you keep on collecting evidences to establish or rule out any cause/s.

Lets attempt the question now;

Sample Answer

Sr#	What to Ask (Look Into)	Why to Ask?(Look For)
1	Inventory log	Pressure relief valves were not installed
2	Calibration records	Pressure relief Valves were not calibrated
3	Inspection and testing of the pressure relief valves found from accident site	Pressure relief valves were unserviceable due to mechanical problems
4	Interview with the operators about the usuall process.	Pressure relief valves manually adjusted by operators and a wrong pressure relief setting were adjusted due to human error
5	Modification records, Maintenance Log book. Inspection of boiler debris collected from accident site	Unauthorized modification was carried out on the boiler which weakened its structure

6	Manufacturer documents. Installation Date. Operating hours and comparison with operators shift hours.	Boiler was being used beyond its serviceable life period as recommended by the designer/ manufacturer
7	Maintenance log. Spare purchase and consumption records. Scaling inside fire tubes and within boiler shell collected from the accident site	Recommended Maintenance was not carried out
8	Interview with the operators to check the level of control they had e.g. manual settings etc. and any complaints regarding operations	Tampering with safety devices by the Operators for any reason including False Alarms/ Arsenal etc
10	The market repute and accident history of the manufacturer's products. The certifications of manufacturer and the manufacturing and testing standrds	Design Failure

Part B
(Each Question carries 10 Marks)

6- **Outline** the selection consideration for monitoring and measuring devices for a workplace having airborne chemical?

Sample Answer

- Environmental condition in which the measuring or monitoring equipment is to be used
- Type of hazardous substance against which the detection system is required e.g. CO, H^2S or SO^2 gases etc.
- Workplace conditions e.g. requirement of spark proof system to be used in a flammable conditions
- Detection range requirement e.g. 0-50 PPM or 0-100 PPM or 0-1000 PPM etc.
- Any requirement of resolution of the displaying. 10.0 or10.00 or 10.000 etc.
- Response time for sensors to alarm immediately. This will be required where possibility of sudden release of toxic gases is present
- The compatibility with Alarm system
- The competence of the people who are supposed to use, operate & maintenance & any specific training requirement.
- Calibration frequency & any specific equipment training or competency requirement for the calibration
- The Accuracy, reliability & repeatability of the equipment
- Requirement of being tamper- proof & ruggedness

7- **Explain** various mechanical properties of materials and identify which properties are desired in the materials and which properties are not desired?

Sample Answer

(Given in the Unit 2 book in detail).

- Tensile Strength
- Compressive Strength
- Shear Strength
- Maleability
- Ductility
- Hardness
- Brittleness
- Toughness
- Elasticity
- Pasticity

8- **Explain** why studying various forms of energy is important from occupational safety and health perspective. Give suitable examples?

Sample Answer

Various forms of energy exist in the nature e.g. Electrical Energy, Kinetic Energy, Radiation Energy, Potential Energy, Thermal Energy, Chemical Energy, Nuclear Energy and Gravitational Energy Etc.

But why is it important for an OHS Practitioner, Safety Engineer or Advisor to study and understand various forms of energy? I shall explain this in subsequent paragraphs.

The first and most significant thing is to understand the features of various forms of energy and their behaviors which can influence the health and safety performance of the workers. Similarly the potential risks when one form of energy is converted to another form of energy. For example, Sodium Na) causes fire if put in water. The behaviour of Sodium (Na) is due to its intrinsic chemical energy. Similarly a compressed spring has potential/mechanical energy. If this energy is not released properly before carrying out the maintenance activities then the potential energy of the spring will converted into kinetic energy and can pose severe safety risk to the operators.

The second important thing is the perception about the energy. Most forms of energy are not visible/ noticeable e.g. you cannot be sure with your naked eye if a circuit is energized or not. Similarly, one cannot see radiation or gravitational energy. Most of the time, the available form of energy poses a severe risk to health and safety of personnel because they may not detect their presence with 5 senses. So any such energy will be called a “hazardous energy”

A safety engineer and practitioner must be aware of the factors which can influence the conversion of one form of energy to another undesired form in a given condition. For example, a suspended load has a gravitational energy and the safety team must have taken Safety control measures accordingly but imagine if a strong wind starts to swing the load i.e. gravitational energy plus kinetic energy. The result can be crane toppling or collision of load with adjacent structures etc. In the same context, chemical energy of inflammables can be converted into thermal energy if the work conditions give rise to the factors like ignition source availability etc.

9- **Explain** the working principle of a screw jack and how it can be used to lift heavy loads by a single person?

Sample Answer

As we know the basic machines like pulley, lever, screw etc. can create mechanical advantage and are used to lift heavy loads with small force. But we have also studied that energy cannot be created nor destroyed. So how can we lift heavy load by using small force exerted by humans?

We have read the formula for work i.e.

Work done = Applied Force X Distance travelled. (Equation No. 1)

- Work done is the lifting of car through screw jack i.e. 1 ton vehicle lifting to a specific height e.g. 6 Inches
- Applied Force is the force being exerted by the person who is using a screw jack
- Distance travelled is the total linear rotation of the handle (For example the person rotated the jack handle 30 times and the dia of the handle is 18 Inches (Radius= Dia/2= 18/2=9 Inches)

We now put this data into the equation No 1

1000 Kg X 6 Inches= Force Required X 30 (Rotations of handles)X 2 π r

Note**:** π=Pi=3.14 r = Radius of jack handle
(2 π r is formula to calculate the linear distance i.e. the distance operator hand moved while rotating screw jack 30 times with a handle of 9 Inch Radius)

6000= Force RequiredX 30 X2 X3.14 X9
6000= Force Required X 1695.6
Rearrange the equation

Force Required= 6000/1695.6
Force Required= 3.54 Kg

D=So 3.54 Kg force will be exerted by operator on the jack handle (9 Inch Radius) to lift 1000 Kg load at height of 6 Inches in 30 handle rotations.

So there are 2 variables which can influence the required force for lifting heavy objects;

1- The dia of the handle. If you increase the jack handle dia, it will need less force to lift the same car at same height in same 30 rotations of handle
2- Number of Handle Rotations if doubled e.g. 30 to 60 then half force will be required to lift same load at same height. But how the number of rotataions can be changed? Number of rotations are influenced by the pitch of the screw. Pitch is the distance between 2 consecutive threads. If you reduce the distance between threads (Threads are more close to each other) then the

screw jack capacity will increase. Similarly when you increase the pitch (Increase distance between threads), the capacity of the screw jack will decrease.

So the mechanical advantage of the screw jack can be calculated by

1- Dia of the handle (More dia more load lifting capacity)
2- Pitch of screw threads (Less the pitch, more will be lifting capacity)

Note : The reponse given in green will also be accepted. But better more explanation is provided

10- **Outline** the reasons and contributory factors for material failures?

(Given in the Unit 2 book in detail; Page 94-95 Element 3).

11- **Outline** the control measures for working on **live** electrical equipment?

Sample Answer

As we know that Lock Out/ Tag Out (LOTO) will not be possible once working on a live electrical equipment. Such situations usually arise during maintenance and troubleshooting of the electrical equipment once they are required to be operating on electricity and at the same time, operators perform their checks. Such activities have high potential risks as a small error or negligence can risk the precious lives. So the control measures should be commensurate with the severity of potential risk.

1- Any such activities must be administered through Permit to Work with additional supervisory controls who must be continuously monitoring the activities from safety perspective.
2- Emergency response arrangements must be in place to provide the rescue and recovery immediately
3- Only well trained and experienced operators should have authorization to perform such activities.
4- The operators must be provided with Standard Operating Procedure and the supervisors must intervene if they observe any SOP requirements are being violated intentionally or unintentionally
5- The operators must wear suitably rated PPE's as recommended in the SOP
6- The tools must be inspected prior to use to ensure they are properly electrically insulated.
7- The access equipment to and from the electrical equipment must be intrinsically safe and present no fall hazards. Similarly, the access equipments must also be of suitable insulation against the electricity
8- If practically and operationally feasible, then GFCI (Ground Fault Circuit Breaker) must be used in the circuit to reduce the risk of electrocution
9- Proper signage must be used to discourage unauthorized person coming close to the work site.
10- The operators must be advised to avoid distractions like using mobile phones during the activity as it can reduce the attention on the job and its potential risks.

12- **Outline** the product designers' limitations to eliminate OHS hazards from the tools & equipments?

Sample Answer

Ideally all products should be intrinsically safe for use in all type of environments but it rarely is the case. Not all products can be used in all type of work environments. Similarly, There is a breakeven in foolproofing and maintenance requirements. The following are some of the limitations of the designers when they design a new product;

- The first and foremost limitation is the cost of production. If the designer puts extensive safety features in a product, the cost becomes very high and it becomes difficult for the manufacturer to market at competitive price.

- The designers' skill and knowledge is another limitations. Not all the designers are equally skilled so it is very likely that not all the potential risks are considered while designing a product.

- The availability of technology for designing products is another limitation for the designers. They could only used the available softwares and hardwares for initial prototyping purposes. Similarly, the design softwares too have some limitations as they cannot 100% simulate the actual operation environment

- A balance between foolproofing/ tamperproofing and required maintenance must be made by the designers as without a maintenance friendly product, they may not be marketed effectively

- Due to the versatile nature of work sites and the different work environments, the designers may not consider all of them to save the cost. For example, Dust Proofing, Chemicals Proofing, Rain Proofing, Extreme Temperature Proofing etc.

- Due to the complexity involved in the manufacturing processes, it restrict the designers to design the products which could be produced using certain easy, simple an dcost effective manufacturing processes.

- Designers are humans. So human error in designing cannot be ruled out. Even the best design team of Boeing may not produce effective results due to human limitations.

- The choice of intrinsically safe and manufacturing friendly materials sometimes becomes limited. For example, the aircraft designers have to breakeven between the required mechanical properties of the materials and their weight.

13- **Explain** how "Earthing" can be effective against the risk of electrocution?

Sample Answer

The earthing is a method used to save precious human lives from electrocution across the world. The earthing is the process of attaching a good conductor wire to any electrical equipment from one end and attaching the other end to the earth (a specially build points which are placed deeper in earth for good conductivity. Normally saline solutio is added in the earthing pit to increase the conductivity). The level of protection from Earthing can be as required. The conductor on earthing pit is checked for resistance value in ohm (symbol Ω). The lesser the value of ohm, the better is the earthing effectiveness.

How earthing works: As we understand that the current will pass through the medium which offers the lowest resistance in its path. For example if the earthing value of a given site is 1 Ω and this is connected to an equipment with faulty current through a copper conductor. If a person touches the equipment, it will create a path from equipment to the ground. But as the resistance value of earthing is lower, maximum current will flow through earthing and only a small current will pass through the person. This will be because the person may have dry skin, wearing rubber shoes or the floor has some current resistance rug or carpet resulting in resistance value overall e.g. 10 Ω. So the current will prefer 1 Ω lesser resistance through earthing instead of 10 Ω higher resistance through human.

In case the earthing is not effective or not installed, the whole current will pass through the person with severe electrocution. So from the discussion, we understand that earthing reduces the risk of electrocution.

14- **Outline** the **"Factors"** you will consider in a Fire Risk Assessment?

Sample Answer

- The number of people occupying a premises in peak working hours because the risk assessment should cater for the required measures
- Presence of vulnerable people in the workplace e.g. Disabled, Pregnant women who need help for evacuation during a fire emergency
- Presence of member of public e.g. a shopping mall or 3rd party contractors' workers/ suppliers etc.
- General safety awareness/safety culture of the occupiers of the premises or employees of the organizations so that the measures should be made fool proof accordingly if required.
- Any past fire related incidents at the workplace. (this will also include the organizations incident reporting system effectiveness)
- Availability of trained personnel to assume the responsibilities related to fire prevention
- The effectiveness of existing control measures to ensure if additional controls are needed or not.
- The cost implication for proposed control measures as budget allocation from top management will be sought for implementation of controls.
- Legal requirements related to fire control to ensure Fire Risk Assessment complies with regulatory requirements.
- Size of the building & no of stories of the building. This should include the building material & also means of escape from the building.
- Nature & scope of the organization/premises with respect to the fire hazard
- Non Routine activities e.g. a special farewell gathering or some maintenance activities which require the staff to work at
- Any Distant working locations and confined space etc.

15- **Explain** how car seat belt works during the collision and saves you?

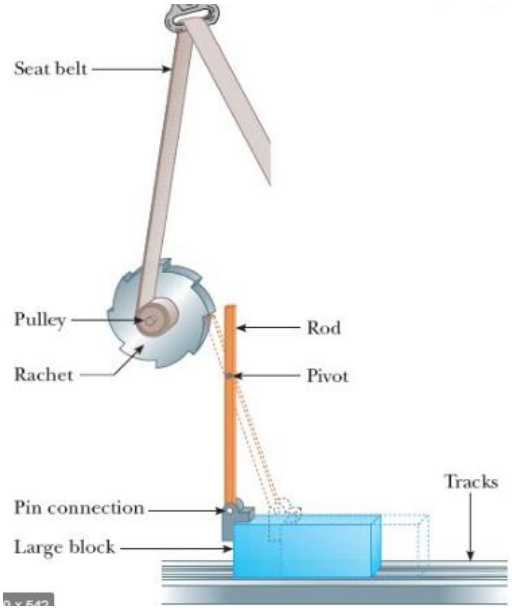
Sample Answer

You often have noticed that once you pull the seat belt abruptly, it gets locked. Same thing happens when a vehicle stops or decelerates abruptly as a result of collision. The seat belt gets locked at its position and does not allow free movement of the seat belt wearer.

But what actually happens is interesting as the Principle of Inertia, Principle of Centrifugal force and/or Principle of Gravitational force are used in order to design a seat belt which will operate during the collision.

- Principle of Inertia

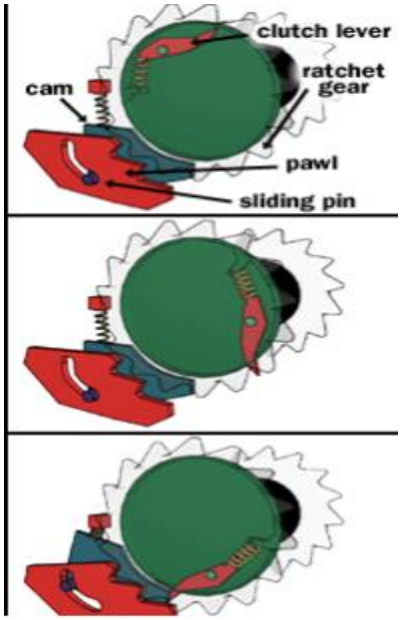
Imagine what will happen if you have placed a ball on rear side of the car and the car collides or you apply hard brakes? The ball will move forward in the direction of motion as per the principle of inertia. Similarly, inside a car seat belt system, there is locking mechanism which gets engaged as soon as the car collides which restricts further extension of the seat belt and restrains the wearer from free movement. A simple diagram shown below explains this principle;



- Principle of Centrifugal force

Principle of centrifugal force alone or in combination with the principle of inertia is used to restrain the seat belt extension in case of collision.

A centrifugal clutch is used in this type of mechanism which gets engaged with the lock once the revolution speed abruptly increases in case of vehicle collision. A simple diagram explains the process;



- Principle of Gravitational Force

The gravitational principle is used to engage a lock to restrain further extension of seat belt in case the vehicle gets toppled. The small steel ball inside the car seat belt mechanism remains in its position a slong as the vehicle is running smoothly. As soon as there is some collision, abrupt braking or vehicle toppling, the steel balls moves and presses the lock which engages the seat belt spool and restricts it from further extension.
A picture below shows the process

Note: To clarify it further, the candidates must watch youtube videos by writing “How the car seat belt works” in youtube search and watch 3-4 relevant videos for further understanding.

Explain how physical nature if chemical substances at the workplaces can affect the type and extent if control measures?

Student Response

Chemicals have different physical forms, solid, liquid, gas, etc. it is very important to identify the physical nature of the chemical so, the appropriate control measures can be allocated. For example, if the hazardous chemical (toxic) we have in our workplace is in a gaseous state, then based in its physical nature we can set many control measures against it like, having adequate ventilation using air mover to disperse the gas if released (engineering control). Since the main route of entry of gases is inhalation having gas testers to check the concentration of this hazardous gas and having SCBA to be worn by the employees if this gas released (PPE control). So here we have the prevention and the protection needed to overcome the hazard of a hazardous GAS.

Another example, if the hazardous chemical is in liquid form. Then the control measures will be a slightly different. We may use engineering controls that isolate or separate the workers from this hazardous chemical by having adequate storage and separation of incompatible materials. Also, since the main entry here is skin contact PPEs that cover employees' hands and bodies shall be used to prevent exposure. Also, chemical containment arrangements must be in place to control the hazardous liquid if accidentally spilled.

Review by examiner: The answer is Good But candidate did not give single example of chemical who is in both liquid and gas state for clarity e.g. Caustic soda is available is solid, liquid and also flakes form. The candidate also did not cover the "extent of control measures" in his answer.

5.5 out of 10 marks were achieved by the candidate.

Explain what toxicology is and outline the limitations of existing methods of measuring toxicology of chemicals?

Student Response

Toxicology simply is the ability of a material to cause illness or death if a person gets exposed to it. If someone gets seriously injured or die as a result of being exposed to a small dose of a material for a short period of time, then we call this material a TOXIC material.

The limitations of methods of measuring toxicology of chemicals can be outlined as follows:

1- The methods of technology may be designed to work effectively in a specific environment and may give wrong results and be affected by :

- Hot or cold weather

- Humidity

- Presences of other chemicals rather than the one under measurement

2- The methods used nowadays are costly.

- Purchasing prices are high

- require trading that also cost money

- Most of them are designed to check one kind of toxic chemical. So if you have more toxic chemicals you need more measuring equipment (more money)

3- Some equipment used for measuring need continuous monitoring

- Regular maintenance is required.

- Regular inspection and testing.

4- Most of the methods are not foolproof. They require a great deal of knowledge and experience to use them.

- require specific hands on training

5- Some equipment used for measuring can only be calibrated and tested by vendors.

- take long time to certify them again

- Again you need to pay money for the calibration

Review by Examiner: Following issues were not discussed by the candidate:

- What about use of animals; ethical issues ?
- And what about correlating toxicology tested on animals with implementation on humans?
- What about mixed exposure of chemicals
- What about age, gender, smoking alcoholic etc.?

6.5 out of 10 marks

LTEL of H2S gas is 10 ppm/ 8 hrs and STEL is 15ppm/ 15 min. Please analyze the following exposure data for employees and comment if STEL and LTEL limits are being complied or not? Also calculate the TWA.

Morning shift 0800 to 1500 hrs

0800 to 0900 12ppm
0900 to 0915 14 ppm
0915 to 1000 10 ppm
1000 to 1100 7ppm
1100 to 1300 6ppm
1300 to 1345 14.5 ppm
1345 to 1500 12 ppm
1500 to 1600 14 ppm

Student Response

STEL was complied because the employees didn't get exposed to more the 15 ppm for more than 15 minutes.

LTEL was complied Employees didn't exposed to more than 10ppm for more than 8hrs. They got exposed to higher than 10ppm for short periods of time with gaps.

TWA :

1*12+1/4*14+3/4*10+1*7+2*5+3/4*14,5+1/4*11

= 7.66

Review by examiner: Answer is correct 10 out of 10 marks

Outline the requirements for time weightage average (TWA) calculation and compliance in a large warehouse of corrosive chemicals?

Student Response

1- Identify the corrosive chemicals in the warehouse.

- have a list of all the chemicals.

- identify the quantity of each

2- Identify the TWA for all the chemicals.

- use MSDS to identify the TWA

- use the manufacturer data.

3- Identify the situations when employees get exposed to these chemicals.

- every time?

- during maintained activities?

4- identify who may get exposed to these chemicals.

- warehouse workers only?

- all employees?

- visitors? Member of public?

- adults? Women? children?

5- identify the ways of exposure to these chemicals.

- inhalation?

- ingestion?

- absorption?

- Injection?

6- Identify the TWA for chemicals they employees may get exposed to.

- consult the manufacturer

- hire chemicals experts to help identify the combined TWA of chemicals stored.

7- After identifying the single TWA and combined TWA average for the chemicals, monitor the concentrations in the warehouse.

- use fixed monitors

- use portable monitors (gas tester)

8- collect the concentrations results for 8hrs for more than one set, for different shifts, morning, afternoon and night.

For example;

First hour the concentration of chemical A is 10 ppm

Next four hours 5 ppm

Next three hours 2 ppm

9- calculate the average concentration the employees get exposed to for average of 8 hrs.

For the above example chemical A : 1*10+4*5+3*2= 36 /8 = 4,5.

10 compare the above result to the TWA of the chemical to check compliance.

For example, chemical A TWA is 10 ppm, as per the calculation above we are complied.

Review by Examiner: The candidate answer did not include how can TWA be identified? The candidate focused on procedure for TWA calculation which was not asked by the examiner. What was required to be answered was the "arrangements and compliance for STEL and LTEL" i.e. Identifying chemicals and their STEL and LTEL? Availability of suitable detection and measuring equipment for each type of airborne chemicals. Training and competence requirement of the personnel involved in calculations.

4.5 out of 10 marks

Outline the control measures to reduce the risk of accidents to member of public from inter city transportation of flammable materials in large quantities?

Student Response

1- transportation of flammable material should be scheduled in off hours, so public are less likely to get exposed to chemicals.

- transportation during night.

- while most of public are at work or schools.

2- segregation on main roads between truck of flammable materials and vehicle.

- special lanes or routes for truck.

- use ropes or barricades to segregate.

3- have a documented procedure for transportation of flammable material.

- use benchmarking with other successful organization

- use international and national regulation of safe transportation of flammable materials

4- communicate the documented procedure with all who might be affected by this process.

- use organization website

- use TV and Radio Channels to send the message to public.

5- label the trucks with all the information about the flammable materials they carry, so if for example an accident happens police will know what is the material and how to cope with it.

- container labeling.

- the MSDS is available in the truck.

6- deliver adequate training for trucks' drivers.

- about the materials the transport

- about the hazards of the materials

- about the control measures to prevent accident or cope with accidents if happen.

7- eliminate the transportation by using trucks.

- have fixed pipe between the chemical area and the destination if possible.

8- make sure that the trucks containers are made with the right materials to protect the materials the possesses.

- can withstand fires for certain period of time.

- can withstand explosion

- can withstand corrosion to avoid pinholes

- contain grounding wire to recent the risks of static electricity

9- use special kind of lightening so drivers can easily notice the trucks.

- use flashes from all sides.

10- communicate the transportation process with the local authority like police to ease the process.

- police can advice the drivers to follow the less crowded roads.

- police may assign a police car to escort the truck.

Review by examiner:

Sr#2. How will you do it?

Sr#3 very bookish and generic

Sr4 bookish

Adeem: Sr9 Hazard marking signs is better word

Overall practical approach missing

No mention of emergency preparedness and response

No Container segregations to avoid centripetal force of material

No Engg controls including speed limits

No online tracking of vehicles for their speed and other issues

No Spill control procedures

4 out of 10 marks

Explain the epidemiology and outline its uses for OH&S provisions at the workplaces?

Student Response

Epidemiology is simply the study of spread of an illness or a disease in a special group of people or in a special area. In fact, how one unhealthy condition can spread and stay active for long time in one area affecting wide population.

It's uses for OHS provisions at workplaces can be outlined as follows :

1- can be used to determine what kinds of health hazard the employees are exposed to, by using gadgets and equipment to identify the hazards. Or using the ill health accidents to determine what kind of health hazards are available in the workplace.

2- can be used to determine the required control measures needed to ensure health and safety of workers. For example, if there is Influenza A viruses is noticed in one workplace (poultry sector), then separating people from affected animals my help controlling this condition.

3- it's also used to evaluate the common health condition in the workplace, to identify the reasons and the controls.

4- to determine the required kind of training employees need, specially working in an effected area. So, the knowledge help the employees avert the health issues.

5- to determine what kind of fascinations employees need to overcome the presence of any epidemic disease. For example, giving employees shots again influenza A.

6- to determine the right selection of PPEs for the employees who happen to be in a place of an epidemic disease. For example, providing the right kind of gloves and filters for those who work wit birds having influenza A.

7- determine the kind and frequency of inspecting affected or previously affected areas. To make sure that the condition is under control.

8- to determine the kind of medicines the organization need to provide in case of a spread of a disease. For example, in remote areas if a disease spread it good to have in hand the medicines needed to control it until victims are sent to hospitals.

Review by Examiner: Answer is Good and covered almost all aspects as asked in question by examiner

9 out of 10 marks

Outline the requirements for labeling and traceability of chemical substances at the workplaces?

Student Response

1- labeling and traceability must be done by competent employees.

- who know the chemicals in the workplace. And been trained of how to work with chemicals.

- who know the international and national regulations of labeling. Example, OSHA standards.

2- provision of labeling materials. For example, signs, letter in different color, MSDSs etc...

The labeling materials also should be compatible with the kind of chemical. For example, provide a signs with a toxic pictograms to label toxic chemicals.

3- have a bulletin board to be used to post information about the chemicals and the MSDSs of chemicals in the storage area for example.

4- provision of adequate lightening in the area of chemicals so labels can be easily identified and read.

5- have a list of all chemicals in the workplace with the location and the quantity. So, the inventory of chemicals can be easily identified.

6- have a documented procedure for receiving and sending chemicals. For example, storage supervisor signs a log book mentioning what kind of chemicals he received, quantities etc... and if he need to send the chemical somewhere in the organization he should sign a log book mentioning the type, quantity of chemicals and where to be sent.

7- frequent inspections to make sure that chemical are labels and traced as required. For example, every three months.

8- identify the national rules of chemicals labeling.

- to be identified by qualified person who knows the national rules or advised by national authorities about the required regulations

- to be implemented as required to avert fines, and the implementation must be confirmed through frequent inspections.

9- benchmarking. Identify how other successful organization label and trace their chemicals, by visiting them and by exchange of information. So this saves time and ensure effective implementation.

10- have a good way of reporting mislabeling of chemicals, so employees can report that some chemicals are not labeled properly or not labeled at all.

Review by examiner:

Examiner did not ask how to apply?

Pt 7. Is again compliance which has not been asked in this context?

Pt 8 should be in the start i.e. to identify and establish the criteria for inspection

Pt 9 is out of context

Overall, chronological order and a systematic approach is missing.

4 out of 10 marks

05/03/2018, 12:15 - Adeem: Outline the possible future improvements in PPE's designs which could eliminate their limitations?

05/03/2018, 12:35 - Mansoor IDSE KSA: Nanomaterial will be used to make PPEs more comfortable and effective :

1- safety helmets will be more tougher to withstand impacts to give more protection against impacts.

2- it will be possible to integrate other devises with safety helmets. For example, gas alarms to alert workers about hazardous condition.

3- safety helmets will be more light-weighted without affecting its toughness to make workers more comfortable using them.

4- eye protection (glasses) will be scratch resistant so it can be used for longer time without affecting the transparency .

5- eye protection will be tougher to protect people from flying objects

6- spectacles will respond automatically to the environment so it gives the protection as needed. For example, becomes dark durning sunshine.

7- communication devises will be embedded to the eye protection, so workers can communicate comfortably.

8- more robust footwear will be developed, to protect workers from foot injuries.

9- gloves will be able to heal themselves from contamination, so this safe time and money if no need to change the gloves once contaminated

10- gloves will have built in first aid in case of emergency to provide effective and fast response to injuries.

Review by Examiner:

There is no answer on any improvement in elimination to supervise the compliance to wear PPE's?

8 out of 10 marks

Outline the implications of clean energy replacing the existing fossil fuel based sources from occupational health and safety perspective?

Student Response

1- clean energy may present new set of hazards for workers. For example, working at hight with wind power installations that generate electricity.

2- clean energy may get workers exposed to new set of hazards that they don't know how to cope with. For example exposure to radiation.

3- workers may get exposed to toxic or contaminated materials. For example, working in recycling.

4- workers may get exposed to hazardous chemicals. For example, working with wast materials.

5- clean energy may help reducing global warming. For example, using electricity rather than coal will reduce carbon emission, then reduce heat.

6- clean energy will improve public health by reducing emissions of coal and natural gases.

Note: It has bad and good implications.

Review by Examiner:

More detailed answer was needed.

Pt 3 and 4 are not clear

Candidate needs to explain more about the points you mentioned. Emphasize on elimination of engines and engine driven equipment because with the clean energy, electrical motors will prevail

5 Marks

Outline various mechanical properties of materials and explain how each property influences the failure of mechanical structures?

Student Response

1- Tensile strength, the maximum pulling strength a material can with stand before failure. This is a positive prosperity since a sign of failure can be noticed before the failure happens, so structure materials can be checked to make sure that they can withstand the extended pulling strength, so structure doesn't fail.

2-compression strength, the maximum load (force) that causes that material to break. Materials should be designed to with stand the extended load. For example, if a scaffold platform is designed to withstand 3 tons, so if it is loaded with 10 tons it will collapse due to overloading.

3- Hardness, the ability of a material to withstand penetration, which is a good trait. Mechanical structure should be made and tested to withstand any penetration force by strengthening its surfaces to prevent collapse.

4- Brittleness, material breaks into part without previous signs. This is a negative trait of materials. So in mechanical structure failure due to brittleness can happen without any notice. Again test of structure materials must be done to make sure that they cannot brittle without notice under the intended load.

5- Ductility, the material deforms before failure. This is a good trait since failure can be anticipated. If the mechanical structure is made of ductile materials, then failures can be prevented by inspection that could identify ductility in the structure.

6- Toughness, the ability of a material to resist failure of fracture. This will help in increasing the life of mechanical structures.

7- Elasticity, the ability of a material to return to its shape. This trait will help the structure to withstand different condition that might affect the integrity of the material and eventually the structure.

8- Plasticity, the ability of a material to take a new shape under forces. For example, some sheet of the airplane wings is able to change the shape under some conditions to prevent collapse.

9- Malleability, the ability of a material to change shapes without fracture under a compression strength.

Review by Examiner:

The answer is good and satisfies the points asked by examiner in the question

9 marks

Sole boards are used under the scaffold standards to avoid sinking in the ground. Explain this phenomenon using scientific formula and calculations?

Student Response

Here we speak about the importance of PRESSURE and how it is important for safety.

If we install and fix the standard of a scaffold directly to the ground, this means that pressure (the force by unit area) is exerted onto a small area which is directly under the standard. But if we install a sole board under the standard, above the ground surface, this will distribute the pressure of the standard onto the board area. So, without the board the force will be exerted onto a small area causing more pressure which could lead to sinking and scaffold collapse, but with the board the force will be exerted to a big area causing less pressure which can be tolerated by the board. This can be illustrated using the below equation:

Pressure = force / area

If for example

the force is 400 pound.

The area of the standard end is 10 square-inch

The area of the board is 216 square inch

Without the plank :

Pressure = 400 /10 = 40psi

With the plank:

Pressure = 400/216 = 1.85

It is noticed that the pressure with the board has significantly reduced.

Review by Examiner:

The answer is good and satisfies the points asked by examiner in the question

9 marks

Outline the factors to consider before you select the monitoring and measuring equipments for airborne chemical substances?

Student Response

1- The concentration of the airborne chemical. For example, chemicals present in very low concentration (which may be harmful) required special kind of monitoring equipment that can this hazardous low concentration.

2- The types of monitors we need e.g. fixed or portable. For example, for operators working in oil plant it's important to give the H2S portable devise since H2S may release accidentally anywhere in the plant.

3- The OEL of the airborne chemicals. So monitoring and detection devises can be designed to alarm if a dangerous limit is reached.

4- The environment conditions at the workplace like, temperature, humidity, etc... All these should be considered since it can affect the integrity of the equipment. For example some detection devises don't give accurate results in low oxygen area.

5- The competency and the skills of the employees who are going to use the equipment. For example, if the employees are just labors who have less level of competence and training providing foolproof equipment is necessary, but if the employees have high skill new cutting edge equipment an be utilized.

6- The ability to integrate the equipment with other system. For example, it's preferable to select an equipment that can send alarms to control rooms or emergency responders if a hazardous condition arises.

7- how many airborne chemical agents we have? So monitoring equipment must be provided to identify the presence and the concentrations of all hazardous chemicals, bearing in mind that detectors most of the time are designed to detect one kind of chemicals.

8- durability of the equipment must be considered. If one detector selected needs frequent maintenance with the vendor this may cause us to work without them sometimes, so it's important to select the equipment the required less maintenance.

9- the cost of the equipment. For example, the capital cost and the running cost for the equipment must be considered to make sure we have the budget needed to maintain the equipment. It is unbecoming to select an equipment that requires a lot of money for recalibration while we don't have the required budgeting.

10 national requirements of detectors needed to be provided in such a workplace. This can be done by consulting the local authority about what types and numbers of monitoring equipment need to be provided.

Review by Examiner:

Calibration requirements was not covered

Pt 10 has been phrased incorrectly. Regulatory body does not provide with the number of detectors required or type of detectors to be used. It should be written as “the legal requirements for measuring and monitoring airborne chemical substances to ensure the equipments are suitable and sufficient"

8 marks

Outline the criteria for selection of Suitable PPE’s for the organization?

Student Response

1- The environment condition in the workplace. For example, employees who work in too cold area may need to be provided with suitable PPEs against cold condition.

2- The hazardous substances in the workplace. For example, areas were H2S may release require the provision of SCBA.

3- How employees may get exposed to the hazards, inhalation, ingestion, absorption, injection. So PPEs are provided based on the rout on entry of the hazardous substances.

4- The physical condition of the employees. For example some employees can use SCBA inside confined space but other may be able to carry the cylinder so they tend to used SABA instead.

5- Employees feedback about the existing PPEs and their suggestion about the required PPEs. Eventually they are the ones who use PPEs so they will help identify the right PPEs.

6- Previous experience with the existing PPEs and accidents happened although they were used. This will help identify the gap in the existing PPEs and replacing them with better ones.

7- Foolproof or complex? It’s important to consider if the PPEs are easy to be used or not. Foolproof PPEs are recommended since we can’t make sure the competency of all who might need to use the like visitors, and contractors.

8- Competency and level of training of employees. For example, using SCBA requires adequate training. So once we provide it the employees must be trained.

9- Cost of the PPEs must be considered. We cannot suggest PPEs the organization cannot afford. But we can think of other options that are within our budget.

10- The legal requirements. To provide the required PPEs as needed for employees safety and to avoid fines.

9 marks

A Steel bridge was designed to serve for 40 years. However, the bridge collapsed only after 1 year of its construction. Outline possible reasons which may have led to the collapse of the bridge?

Student Response

1- the bridge was badly designed as follows :

- designed by unqualified engineers who don't have experience and knowledge about constructing such a bridge.

- not considering the external forces that may affect the integrity of the bridge, weather condition.

2- the bridge may have been subjected to more than the intended load. For example, if the bridge was designed to bear 20 tons but 40tons load were transported regularly through the bridge, this could have caused the collapse.

3- poor construction materials, bricks, steel, etc

- couldn't withstand the intended load.

- have low compression and tensile strength.

4- unauthorized modification on the bridge could have caused the collapse. For example, adding a new lane on a bridge without calculating and studying the effect on the bridge could have caused the collapse.

5- uncontrollable acts, like earthquakes may have affected the integrity of the bridge. Especially if this was not considered during the design.

6- the bridge may have been constructed by unqualified contractors. Even if the design was perfect, unqualified contractors could have interpreted some standards incorrectly, or bypassed some othe requirement inadvertently, leading to a weak bridge. Unqualified contractors may have been chosen just to save money, means the contractor who offered less price was earned the project comprising h&s.

7- frequent maintenance for example activities such as utilities maintenance activities for electrical, IT, water lines, because excavations and other activities happened with them and all these things could have affected the integrity of the bridge if not well planned.

8- unprotected foundations of the bridge. Foundations should be protected against accidental collisions with vehicles. Car accidents could have happened and affected the foundation of the bridge leading to the collapse. This can be prevented by constructing rigid barriers around the foundations.

Review by Examiner:

All 5 points covered i.e. Design, Construction, Environmental and other factors, maintenance requirements, usage beyond the capacity. Candidate must however add design software limitations, human errors in design, factor of safety and other assumptions. Design by incompetent engineer does not sound professional answer

8 marks

UNIT 2: Principles and Applications of Science and Technology in Safety

Total Time: 5:00 hours
Total Questions: 15

Total Marks: 150
Passing Marks: 75

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- Use bullet points for questions asking to **Outline** and make sure each bullet point has unique and valuable content.

Part A
(Each Question carries 10 Marks)

1- You have been tasked by the Managing Director to identify the requirements of suitable PPEs for the whole organizational need. **Outline** the criteria you will establish to ensure you identify suitable PPEs for all employees?

2- A courier company delivery staff has complained about the ill-health issues due to manual handling. They often have to deliver heavy parcels (upto 15 Kg Each) to 3rd and 4th Floors where lifts are not installed. **Outline** the control measures to eliminate the risk of ill health due to manual handling in the specific context mentioned above?

3- You have been tasked as investigating officer subsequent to a sudden collapse of scaffold which resulted into fatal injuries at the workplace. The scope of investigation is "To find out the root cause of the collapse of scaffold". **Outline** your action plan?

4- You are working as a safety officer in a 30 storey hotel building with more than 500 rooms. you have been tasked to get fire emergency escape system designed from a reputable engineering firm. **Outline** the features you wish to be included in the design keeping in view the prevailing technological advancements available?

5- You are working as safety officer in a company offering 3rd party inspection services. One of your clients in Government sector has requested you to carry out the inspection using X-Ray method of the metallic bridge. **Outline** the control measures you will take to reduce the risk of exposure to the workers and member of public at this site?

Part B
(Each Question carries 10 Marks)

6- **Outline** the control measures to reduce the risk of accidents to member of public from inter-city transportation of flammable materials?

7- **Explain** toxicology and outline the limitations of prevailing methods of measuring toxicology of chemicals?

8- **Outline** various workplace examples where Potential Energy can be a hazard from Occupational Health and safety perspective?

9- **Outline** the instances where destructive testing methods can be effectively used?

10- A suitably designed product failed at worksite. **Outline** the factors which may have influenced the performance of the equipment?

11- **Outline** the control measures to eliminate the risk of contact with overhead power lines?

12- **Outline** the characteristics of effective escape routes within an organization?

13- **Explain** in detail the Stochastic Health Effects and Non- stochastic Health Effects?

14- **Outline** the control measures which should be put in place if it is not technically possible to prevent exposure to biological agents?

15- **Outline** the factors which may influence the effectiveness of engineering controls?

(End of Question Paper)

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Part A
(Each Question carries 10 Marks)

1- You are working in a company which is involved in manufacturing and installation of telecom towers. Working at height has been assessed as the key process and you as safety engineer has been tasked by the management to devise engineering controls for the safety of people working at height.
Suggest 3 different engineering controls for work at height safety and also explain if they will reduce/eliminate likelihood or severity or both?

2- You are working in a surface treatment plant where number of chemical processes are carried out. Due to the presence of chemicals, there are airborne chemicals at the workplace which have lately caused ill health issues to the workforce. The management wishes to take measures to eliminate/ reduce ill health effects due to airborne chemicals.
Outline in a step by step process how will you carry out the control measures?

3- Your company houses 2 boilers (Old/ repaired and modified) which are used to produce steam. During your visit as safety manager to the boilers site, you notice that boiler operations are manual. There is a pressure gauge installed on each boiler and once a threshold pressure is reached, an alarm rings and the operator adjusts the setting to bring down into the safe range. The situation is a matter of concern as it is dependent on the vigilance of the operator and may cause boiler explosion. You discussed the issue with the top managemen who tasked you to devise an engineering control through a sub-contractor.
Explain the features of proposed engineering control you wish to suggest which will reduce/eliminate the likelihood of the hazard.

4- LTEL of H2S gas is 10 ppm/ 8 hrs and STEL is 15ppm/ 15 min. Please analyse the following exposure data for employees and comment if **STEL** and **LTEL** limits are being complied or not? Also calculate the **TWA**.

Morning shift 0800 to 1600 hrs (8am to 4pm)

Time	8 to 9	9 to 9:40	9:40 to 10:15	10:15 to 11	11 to 1:00	1:00 to 1:45	1:45 to 4
Exposure	12 PPM	18 PPM	11 PPM	9 PPM	14 PPM	14.5 PPM	14 PPM

5- You have been tasked as investigation officer by the regulatory body subsequent to a boiler explosion at a factory. **Develop a checklist** of atleast 10 suitable questions you wish to ask the user agency to identify the root cause of collapse. Your checklist must be in the following format;

Sr#	**What to Ask (Look Into)**	**Why to Ask?(Look For)**

Part B
(Each Question carries 10 Marks)

6- **Outline** the selection consideration for monitoring and measuring devices for a workplace having airborne chemical?

7- **Explain** various mechanical properties of materials and identify which properties are desired in the materials and which properties are not desired?

8- **Explain** why studying various forms of energy is important from occupational safety and health perspective. Give suitable examples?

9- **Explain** the working principle of a screw jack and how it can be used to lift heavy loads by a single person?

10- **Outline** the reasons and contributory factors for material failures?

11- **Outline** the control measures for working on **live** electrical equipment?

12- **Outline** the product designers' limitations to eliminate OHS hazards from the tools & equipments?

13- **Explain** how "Earthing" can be effective against the risk of electrocution?

14- **Outline** the **"Factors"** you will consider in a Fire Risk Assessment?

15- **Explain** how car seat belt works during the collision and saves you?

(End of Question Paper)

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Part A
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Exposure	12 PPM	18 PPM	11 PPM	9 PPM	14 PPM	14.5 PPM	14 PPM

2- You are working as safety engineer in a large warehouse of Aviation parts. There have been many vehicle accidents of serious nature at the site. The Top Management wishes to increase awareness about the hazards associated with moving vehicles and how to take control measures. You have been tasked to chalk out a plan about the awareness week campaign.

Outline different methods through which you will be creating awareness for the workforce of almost 3000 employees and managers. Your financial limitation for this campaign is 5000$?

3- The top management of a construction company wishes to improve the safety performance of the organization and they intend to apply engineering controls to various activities. They have allocated a budget of 1 Million Dollars to be utilized over a period of next 1 year. You have been made the project team leader as a Safety advisor. However, you believe that not all activities can be accommodated with engineering controls in given financial resources.

Outline the criteria for priortizing the activities which will be provided with engineering controls?

4- **Explain** with suitable mathematical calculation that why Sole boards are recommended to be used for working on fragile roofs. You must assume the weight of a normal person to be around 80 Kg.

5- You have been tasked as investigation officer by the regulatory body subsequent to sudden collapse of a recently fabricated roller coaster. **Develop a checklist** of atleast 10 suitable questions you wish to ask the manufacturer/ user agency to identify the root cause of collapse. Your checklist must be in the following format

Sr#	**What to Ask (Look Into)**	**How will you use this information to establish the facts (Look For)**

Part B
(Each Question carries 10 Marks)

6- **Explain** the principle of hydraulic equipments and discuss in detail how it can be used to lift heavy loads in various hydraulic equipments?

7- **Outline** the limitations of design testing softwares?

8- **Outline** the characteristics of effective escape routes within an organization?

9- **Explain** the principle of fire and how could it be used to eliminate the risk of fire propagation?

10- **Outline** the control measures for working on live electrical equipment?

11- **Outline** the control measures to reduce/eliminate the risk of occupational health hazards to a medical lab worker?

12- **Explain** various uses of information technology for Occupational Safety and Health provisions at the workplaces around the world?

13- **Outline** the factors which may influence the effectiveness of engineering controls?

14- **Outline** various OHS hazards (NOT THE RISKS) to the workers of an atomic power plant?

15- Explain the purpose of Non Destructive Testing (NDT) and identify prevailing methods of NDT?

(End of Question Paper)

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Part A
(Each Question carries 10 Marks)

1- You are working in a construction company which has extensive site operations. There have been accidents due to the vehicles movement at the sites. 90% of the accidents were related to reversing of vehicles. There have been many adminsitrative controls deployed earlier but they all were ineffective. Management now wishes to implement suitable engineering controls.

Suggest 1 best Engineering Control including its salient features to eliminate/ reduce the risk of accidents with reversing vehicles?

2- A hydraulic boom crane having maximum capacity of 100 Ton was being used to lift a load of 90 Tons in a constrained space and got toppled. During the investigation, it was observed that automatic sensor installed on the crane was removed so that load may be lifted at desired boom angle and length so the operator tried to lift the load at 30 degree angle while extending the boom to full length.

Explain with mathematical calculations and a sketch that how the load increased beyond the lifting capacity of the crane?

3- You have been tasked as investigation officer by the regulatory body subsequent to sudden collapse of a recently fabricated steel bridge. **Develop a checklist** of atleast 10 suitable questions that prompt your mind and can be conclusive in identifying the root cause

Sr#	What to Ask (Look Into)	How will you use this information to establish the facts in order to identify root cause/s (Look For)

4- A reputable Pizza Delivery Chain is experiencing the violence with its delivery persons in certain areas of the city. This results into cash and mobile phones snatching alongwith injuries to the delivery personnels. The management is really concerned over this issue and has been taking many administrative controls but they were ineffective. You work in a Safety Consulting firm and has been tasked to provide the solution.

   a- **Outline** the control measures to eliminate/ reduce the risk of violence with delivery personnels
   b- **Explain** the features of emergency response procedure in case of injury to delivery personnel

5- You are working as safety engineer in an organization whose workers are likely to be exposed with airborne chemical substances. The organization has all the data available about the chemical substances for example; LTEL and STEL etc which is sufficient to take control measures. The organization frequently measures the PPM values of airborne chemicals as well. Yet there are ill health issues due to exposure with Chemical substances.

   Outline what could possibly be the reasons for the ill-health cases in context with the scenario mentioned above?

Part B
(Each Question carries 10 Marks)

6- **Outline** the purpose of monitoring and measuring of hazardous substances at the workplaces?

7- **Can** you lift 20 tons load manually with a screw jack?Explain how?

8- **Outline** common end user requirements for tools that must be incorporated in their design from health and safety perspective?

9- **Explain** the purpose of Non Destructive Testing (NDT) and outline its limitations?

10- **Outline** the control measures for working on **live** electrical equipment?

11- **Outline** the circumstances when a fire risk assessment must be reviewed?

12- **Explain** the process of Noise Risk Assessment at the workplace?

13- **Explain** how "Earthing" can be effective against the risk of electrocution?

14- **Outline** the factors which may influence the effectiveness of engineering controls?

15- **Explain** 5 uses of Information Technology for Health and Safety provisions at the workplaces?

(End of Question Paper)

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- Support your answers with **logical arguments** and **examples**. Generic and Bookish answers will not be accepted by the examiners.
- All Questions are compulsory and must be answered to gain maximum marks
- Use bullet points for questions asking to **Outline** and make sure each bullet point has unique and valuable content.

Part A
(Each Question carries 10 Marks)

1- You have been tasked by the Managing Director to identify the requirements of suitable PPEs for the whole organizational need. **Outline** the criteria you will establish to ensure you identify suitable PPEs for all employees?

2- A courier company delivery staff has complained about the ill-health issues due to manual handling. They often have to deliver heavy parcels (upto 15 Kg Each) to 3rd and 4th Floors where lifts are not installed. **Outline** the control measures to eliminate the risk of ill health due to manual handling in the specific context mentioned above?

3- You have been tasked as investigating officer subsequent to a sudden collapse of scaffold which resulted into fatal injuries at the workplace. The scope of investigation is "To find out the root cause of the collapse of scaffold". **Outline** your action plan?

4- You are working as a safety officer in a 30 storey hotel building with more than 500 rooms. You have been tasked to get fire **emergency escape system** designed from a reputable engineering firm. **Outline** the features you wish to be included in the design keeping in view the prevailing technological advancements available?

5- You are working as safety officer in a company offering 3rd party inspection services. One of your clients in Government sector has requested you to carry out the inspection using X-Ray method of the metallic bridge. **Outline** the control measures you will take to reduce the risk of exposure to the workers and member of public at this site?

Part B
(Each Question carries 10 Marks)

6- **Outline** the control measures to reduce the risk of accidents to member of public from inter-city transportation of flammable materials?

7- **Explain** toxicology and outline the limitations of prevailing methods of measuring toxicology of chemicals?

8- **Outline** various workplace examples where Potential Energy can be a hazard from Occupational Health and safety perspective?

9- **Outline** the instances where destructive testing methods can be effectively used?

10- A suitably designed product failed at worksite. **Outline** the factors which may have influenced the performance of the equipment?

11- **Outline** the control measures to eliminate the risk of contact with overhead power lines?

12- **Outline** the characteristics of effective escape routes within an organization?

13- **Explain** in detail the Stochastic Health Effects and Non- stochastic Health Effects?

14- **Outline** the control measures which should be put in place if it is not technically possible to prevent exposure to biological agents?

15- **Outline** the factors which may influence the effectiveness of engineering controls?

(End of Question Paper)

International Diploma in Safety Engineering (IDSE)
NCFE Certified Qualification

UNIT 2: Principles and Applications of Science and Technology in Safety

Total Time: 5:00 hours
Total Questions: 15

Total Marks: 150
Passing Marks: 75

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Part A
(Each Question carries 10 Marks)

1- Inertia is the property of matter by which it continues in existing state of rest or uniform motion unless the state is changed by external force. This is the reason; the vehicles take quite some distance after the brakes are applied. **Outline 5** different Health and safety hazards at the workplaces due to the inertia and suggest the suitable control measures against each??

2- Bolts are used in the construction of Steel Lattice telecom towers. **Outline** which type of forces act simultaneously on the bolts and what factor can lead to the failure of the bolts resulting collapse of the structure?

3- Your organization houses a range of electrical equipments which are being used at various sites. The management wishes to establish the inspection frequencies of all electrical equipments. **Outline** the factors which will dictate the frequency and type of inspections for each type of electrical equipment?

4- A company which provides taxi services through mobile phone applications has recently recorded a number of violence issues with the drivers where the robbers who hired taxi services and looted the drivers or snatched the cars taking advantage of deserted places? The management is concerned with the increasing number of violence issues. You as a safety advisor have been tasked to develop a strategy to eliminate the violence issues. **Explain** a **single** effective solution with cost and other implications. Please note that the provided solution must be feasible both financially and technically.

5- A Steel bridge was designed to serve for 40 years. However, the bridge collapsed only after 1 year of its construction. **Outline** possible reasons which may have led to the collapse of the bridge

Part B
(Each Question carries 10 Marks)

6- **Outline** the OH&S hazards with the labeling of chemical substances at a large chemical warehouse of a factory?

7- **Outline** the possible causes of exothermic runaways in process industries and suggest suitable controls to avoid each of them?

8- **Outline** the limitations of visual testing/inspection methods which could lead to occupational safety and health implications?

9- **Outline** the circumstances where the organization must opt for customized designed products instead of purchasing off the shelf products?

10- **Outline** the uses of microscopic lab analysis and the information it may reveal about the material failures?

11- **Outline** various hazardous environments which may affect the physical condition of electrical equipments and suggest suitable control measures to protect the electrical appliances against each environment?

12- **Outline** the circumstances when a fire risk assessment must be reviewed?

13- **Outline** the transmission chain resulting biological infections to workers and what control measures could be in place to break the link at each point?

14- **Explain** how use of information technology has simplified the incident investigations? Please give suitable examples to support your arguments?

15- **Outline** the factors which may influence the effectiveness of engineering controls?

(End of Question Paper)

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UNIT 2: Principles and Applications of Science and Technology in Safety

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- Use bullet points for questions asking to **Outline** and make sure each bullet point has unique and valuable content. You must give examples for each bullet point to clarify your answer.

Part A
(Each Question carries 10 Marks)

1- LTEL of H2S gas is 10 ppm/ 8 hrs and STEL is 15ppm/ 15 min. Please analyse the following exposure data for employees and comment if STEL and LTEL limits are being complied or not? Also calculate the TWA.

Morning shift 0800 to 1500 hrs

Time	8 to 9	9 to 9:30	9:30 to 10:15	10:15 to 11	11 to 1:00	1:00 to 1:45	1:45 to 4
Exposure	12 PPM	14 PPM	10 PPM	7 PPM	6 PPM	14.5 PPM	13 PPM

2- You are working as safety engineer in an organization whose workers are likely to expose with airborne chemical substances. The organization has all the data available about the chemical substances for example; LTEL and STEL etc which is sufficient to take control measures. The organization frequently measures the PPM values of airborne chemicals as well. Yet there are ill health issues due to exposure with Chemical substances. **Outline** what could possibly be the reasons for the ill-health cases?

3- Your organization houses a range of electrical equipments which are being used at various sites. The management wishes to establish the inspection frequencies of all electrical equipments. **Outline** the factors which will dictate the frequency and type of inspections for each type of electrical equipment?

4- You are working as a Safety Advisor to one of the biggest shopping mall in the area. In a recent fire emergency, there have been cases where visitors could not be safely evacuated. The

management now wishes to have some operational controls (Either Engineering or Administrative) to ensure they have data available that no one is inside the building. **Explain** what type of operational control will you suggest to the management. Also explain in detail about the features of proposed operational control. You must include Financial implications of the proposed measures.

5- A Steel bridge was designed to serve for 40 years. However, the bridge collapsed only after 1 year of its construction. **Outline** possible reasons which may have led to the collapse of the bridge

Part B
(Each Question carries 10 Marks)

6- **Explain** how physical nature of chemical subtances at the workplace can affect the type and extent of required control measures?

7- **Outline** the requirements for identification and traceability of chemical substances at the workplaces?

8- PPEs are considered as last resort in hierarchy of control measures. **Outline** the limitations of PPEs and **suggest** what possible PPEs design modifications can be incorporated to minimze these limitations?

9- **Outline** the limitations of destructive testing methods?

10- **Outline** the risk factors which may influence the severity of electric shock to workers being exposed to electronic equipments?

11- **Explain** the principle of fire and how could it be used to eliminate the risk of fire initiation and fire propagation?

12- **Explain** the health and safety implications with the atomic power plants?

13- **Outline** various detection methods for biological agents at the workplaces and provide the limitations of each method?

14- **Outline** what could be the possible reasons for a boiler explosion and what engineering controls can be deployed to prevent boiler explosion?

15- **Outline** the factors which may influence the effectiveness of engineering controls?

(End of Question Paper)

International Diploma in Safety Engineering (IDSE)
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UNIT 1: Achieving Continual Improvement in OH&S Management System

Total Time: 5:00 hours
Total Questions: 15

Total Marks: 150
Passing Marks: 75

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- Use bullet points for questions asking to **Outline** and make sure each bullet point has unique and valuable content. You must give examples for each bullet point to clarify your answer.

Part A
(Each Question carries 10 Marks)

1- Accident investigation findings revealed that the cause of accident was “Poor communication” of messages within the organization where the operators were required to stop the work before the sunset but they continued their job. This resulted into vehicle collisions and fatal injuries. The management has shown concern over communication procedure ineffectiveness and they intend to improve it. You as a safety officer have been tasked to present a report with opportunities for improvement in subject procedure for its effectiveness. **Outline** your action plan in chronological order.

2- You are working in an organization involved in Oil and Gas drilling operations. The company wishes to establish, implement and maintain an OH&S management system based on ISO 45001:2018. You as a safety engineer have been tasked by the management to identify the key processes which can have negative influence on OH&S performance of the organization. **Outline** the criteria for identifying the key processes specific to your organization.

3- You are working in a large construction company as safety officer. During the annual management review meeting, it was presented that 90% departments failed to achieve their OH&S objectives. **Outline** possible reasons, with examples, why OH&S objectives could not be achieved.

4- A multinational courier company puts huge resources for the training of its employees related to Occupational Safety and Health. During quarterly safety meeting at head office, the management was interested to see if the effectiveness of the training is commensurate with the resources input. You as a safety officer need to present the outcomes of training in **quantifiable** manner so that management may compare the resource input versus results achieved. **Outline** what will you present in next quarterly meeting?

5- During an actual fire emergency, the organization failed to evacuate some visitors and employees from the workplace in timely manner. This resulted into minor injuries to many visitors as well as the employees. You checked the records of fire emergency rehearsal and found everything to be perfect in documents. **Outline** what had gone wrong in your opinion and what further evidence will you seek to identify the root cause/s of failure.

Part B
(Each Question carries 10 Marks)

6- **Identify** various methods through which the organizations can get the applicable legal requirements?

7- **Outline** the contents of an effective OH&S policy document?

8- **Outline** the purpose of "Documented" OH&S management system and elaborate the term extent of documented information?

9- **Outline** the reasons due to which the safety culture of an organization may become negative?

10- **Explain** how leadership at various functions can contribute towards occupational health and safety performance of the organization?

11- **Outline** the external issues which may influence the OH&S performance of the organization for a courier company?

12- **Outline** the characteristics of an effective Permit to Work document?

13- **Explain** in detail how a 3rd party independent audit for OH&S management system can help organizations in continual improvement?

14- A non conformity identified during audit is a window of opportunity for the organization. **Explain** Why and give 3 suitable examples from workplaces?

15- **Outline** various risks associated with 100% IT based OH&S management systems. Please give suitable examples for each bullet point?

(End of Question Paper)

International Diploma in Safety Engineering (IDSE)
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UNIT 2: Principles and Applications of Science and Technology in Safety

Total Time: 5:00 hours
Total Questions: 15

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Passing Marks: 75

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Part A
(Each Question carries 10 Marks)

1- You are working in a company which is involved in manufacturing and installation of telecom towers. Working at height has been assessed as the key process and you as safety engineer has been tasked by the management to devise engineering controls for the safety of people working at height.
Suggest 3 different engineering controls for work at height safety and also explain if they will reduce/eliminate likelihood or severity or both?

2- You are working in a surface treatment plant where number of chemical processes are carried out. Due to the presence of chemicals, there are airborne chemicals at the workplace which have lately caused ill health issues to the workforce. The management wishes to take measures to eliminate/ reduce ill health effects due to airborne chemicals.
Outline in a step by step process how will you carry out the control measures?

3- Your company houses 2 boilers (Old/ repaired and modified) which are used to produce steam. During your visit as safety manager to the boilers site, you notice that boiler operations are manual. There is a pressure gauge installed on each boiler and once a threshold pressure is reached, an alarm rings and the operator adjusts the setting to bring down into the safe range. The situation is a matter of concern as it is dependent on the vigilance of the operator and may cause boiler explosion. You discussed the issue with the top managemen who tasked you to devise an engineering control through a sub-contractor.
Explain the features of proposed engineering control you wish to suggest which will reduce/eliminate the likelihood of the hazard.

4- LTEL of H2S gas is 10 ppm/ 8 hrs and STEL is 15ppm/ 15 min. Please analyse the following exposure data for employees and comment if **STEL** and **LTEL** limits are being complied or not? Also calculate the **TWA**.

Morning shift 0800 to 1600 hrs (8am to 4pm)

Time	8 to 9	9 to 9:40	9:40 to 10:15	10:15 to 11	11 to 1:00	1:00 to 1:45	1:45 to 4
Exposure	12 PPM	18 PPM	11 PPM	9 PPM	14 PPM	14.5 PPM	14 PPM

5- You have been tasked as investigation officer by the regulatory body subsequent to a boiler explosion at a factory. **Develop a checklist** of atleast 10 suitable questions you wish to ask the user agency to identify the root cause of collapse. Your checklist must be in the following format;

Sr#	**What to Ask (Look Into)**	**Why to Ask?(Look For)**

Part B
(Each Question carries 10 Marks)

6- **Outline** the selection consideration for monitoring and measuring devices for a workplace having airborne chemical?

7- **Explain** various mechanical properties of materials and identify which properties are desired in the materials and which properties are not desired?

8- **Explain** why studying various forms of energy is important from occupational safety and health perspective. Give suitable examples?

9- **Explain** the working principle of a screw jack and how it can be used to lift heavy loads by a single person?

10- **Outline** the reasons and contributory factors for material failures?

11- **Outline** the control measures for working on **live** electrical equipment?

12- **Outline** the product designers' limitations to eliminate OHS hazards from the tools & equipments?

13- **Explain** how "Earthing" can be effective against the risk of electrocution?

14- **Outline** the **"Factors"** you will consider in a Fire Risk Assessment?

15- **Explain** how car seat belt works during the collision and saves you?

(End of Question Paper)

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Part A
(Each Question carries 10 Marks)

1- You are working in a construction company which has extensive site operations. There have been accidents due to the vehicles movement at the sites. 90% of the accidents were related to reversing of vehicles. There have been many adminsitrative controls deployed earlier but they all were ineffective. Management now wishes to implement suitable engineering controls.

Suggest 1 best Engineering Control including its salient features to eliminate/ reduce the risk of accidents with reversing vehicles?

2- A hydraulic boom crane having maximum capacity of 100 Ton was being used to lift a load of 90 Tons in a constrained space and got toppled. During the investigation, it was observed that automatic sensor installed on the crane was removed so that load may be lifted at desired boom angle and length so the operator tried to lift the load at 30 degree angle while extending the boom to full length.

Explain with mathematical calculations and a sketch that how the load increased beyond the lifting capacity of the crane?

3- You have been tasked as investigation officer by the regulatory body subsequent to sudden collapse of a recently fabricated steel bridge. **Develop a checklist** of atleast 10 suitable questions that prompt your mind and can be conclusive in identifying the root cause

Sr#	What to Ask (Look Into)	How will you use this information to establish the facts in order to identify root cause/s (Look For)

4- A reputable Pizza Delivery Chain is experiencing the violence with its delivery persons in certain areas of the city. This results into cash and mobile phones snatching alongwith injuries to the delivery personnels. The management is really concerned over this issue and has been taking many administrative controls but they were ineffective. You work in a Safety Consulting firm and has been tasked to provide the solution.

   a- **Outline** the control measures to eliminate/ reduce the risk of violence with delivery personnels
   b- **Explain** the features of emergency response procedure in case of injury to delivery personnel

5- You are working as safety engineer in an organization whose workers are likely to be exposed with airborne chemical substances. The organization has all the data available about the chemical substances for example; LTEL and STEL etc which is sufficient to take control measures. The organization frequently measures the PPM values of airborne chemicals as well. Yet there are ill health issues due to exposure with Chemical substances.

   Outline what could possibly be the reasons for the ill-health cases in context with the scenario mentioned above?

Part B
(Each Question carries 10 Marks)

6- **Outline** the purpose of monitoring and measuring of hazardous substances at the workplaces?

7- **Can** you lift 20 tons load manually with a screw jack?Explain how?

8- **Outline** common end user requirements for tools that must be incorporated in their design from health and safety perspective?

9- **Explain** the purpose of Non Destructive Testing (NDT) and outline its limitations?

10- **Outline** the control measures for working on **live** electrical equipment?

11- **Outline** the circumstances when a fire risk assessment must be reviewed?

12- **Explain** the process of Noise Risk Assessment at the workplace?

13- **Explain** how "Earthing" can be effective against the risk of electrocution?

14- **Outline** the factors which may influence the effectiveness of engineering controls?

15- **Explain** 5 uses of Information Technology for Health and Safety provisions at the workplaces?

(End of Question Paper)