`

CERTIFICATE IN MINE ENVIRONMENTAL CONTROL

PAPER 4 - MODEL ANSWERS

RISK MANAGEMENT, FIRES & EXPLOSIONS, GASES AND STATISTICS

QUESTION 1

a) Four fundamental steps of Risk Management?

(i) Risk Identification (1)

(ii) Risk Evaluation (1)

(iii) Risk Control (1)

(iv) Risk Financing (1)

b) Four of Risk Control and explain meaning

(i) Terminate - Eliminate or Stop at source (1)

(ii) Treat - Minimize, reduce (1)

(iii) Transfer - Ensure risk by self funding or use outside insurance (1)

(iv) Tolerate - Accepted with due legal compliance for cost effectiveness (1)

c) List and describe two main groups of hazard sources - Give two examples?

(i) Energy source - Involves harm due to uncontrolled contact resulting in excessive energy transfer into or onto the body (1)

(ii) Examples are: Mechanical, electrical, gravity, momentum, noise, vibration, heat, radiation (1)

(iii) Substance - Involves harm to health due to excessive exposure because of inhalation, ingestion or skin contact (1)

(iv) Examples are: Chemicals, dusts, gases, botanical and biological (1)

d) Ways to layout or scope a Risk Assessment and its effectiveness

- Ways are:

(i) Geographical based (1)

(ii) Occupation based (1)

(iii) Hazard based (1)

- Effectiveness:

(iv) Geographical and Occupation based: - normally ensure complete and acceptable assessments (1)

(v) Hazard based: - may need expert consultation and specialist knowledge (1)

e) Five requirements to make Continuous Risk Assessment effective.

Any five of the following:

(i) Take place continually. (1)

(ii) Part of the daily management process (1)

(iii) Not be complicated or sophisticated. (1)

(iv) Ensure safety and absence of health risks at the workplace. (1)

(v) Mainly conducted by first line supervisors. (1)

(vi) Enhanced through formal training programs (1)

QUESTION 2

Calculations

a) Qty CH4 airway 2 = $11.1\ x\ \frac{0.6}{100} = 0.0666 m^3/s$

Qty CH4 airway 3 = $9.32x\ \frac{0.6}{100} = 0.1025 m^3/s$

$\therefore$ Total quantity CH4 at A = 0,1691 m^3/s

But % CH4 at C is 0,81% (Given)

Then the quantity from the blower is:

$$0.81\% = \frac{Total\ quantity\ CH4}{Total\ quantity\ mixture} x\ 100\%$$

$$0.81\% = \frac{X + 0.1691}{25.62 + X}\ x\ 100$$

$$0.81x\ (25.62 + X) = 100\ x(X + 0.1691)$$

$$20.75 + 0.81X = 100X + 16.91$$

$$20.75 - 16.91 = 100X - 0.81X$$

$$3.84 = 99.19X$$

$$\therefore X = \frac{3.84}{99.19}$$

$$= \underline{0.0387 m^3/s}$$

$$\therefore Qty\ CH4\ from\ blower = 0.04 m^3/s$$

b) Reduction in CH4 by 30%

= 0.81 x $\frac{70}{100}$

= 0.57%

Total Qty CH4 = 0.1691 + 0.04 = 0.2091m^3/s

Total Qty mixture = X + 11.1 + 9.32 + 0.04 = 20.46 + X

∴ THE air Qty required from airway 1 =

$0.57 = \frac{0.2091}{20.46+X} \times 100$

0.57 (20.46 + X) = 20.91

11.66 +0.57X = 20.91

∴ 0.57X = 20.91 – 11.66

X = 16.22m^3/s

Additional volume from airway 1 is 16.22 – 5.2 = <u>11.0m^3/s</u>

c) Procedure for testing and removing hazardous substances from a confined space.

(i) With chemicals, the Material Safety Data sheets (MSD's) can give a good indication of what can be expected in most cases of entering storage tanks, vessels or at places of spillage. These can also give information on what to sample for, precautions to be taken and how to handle the situation. (1)

(ii) The basics in all cases should involve the following for procedures and instructions:

(iii) All chemical residues should be well drained from the pit or tank prior to inspection. (1)

(iv) Where applicable, chemicals should be flushed out with sufficient water or neutralising mediums to dilute and remove excessive residues. (1)

(v) Proper earthing of enclosed vessels should be done to prevent static electricity sparking if the atmosphere is in any way suspected to be flammable during flushing or work inside. (1)

(vi) Under no circumstances should any tools or equipment capable of creating a spark or flame be used inside or within 25 m of vessels containing flammable residues or low flash point solvent, or spillage of these, unless sampling results indicate it is safe to do so. (1)

(vii) Adequate ventilation of the pit, tank or vessel must be provided at all times. (1)

(viii) Where applicable, approved PPE and breathing apparatus in case of O2 deficiency etc, must be used. (1)

(ix) The PPE mentioned above should be sufficient for at least two additional persons, if only one person to enter the vessel for work or inspection. (1)

(x) The person monitoring or sampling the atmosphere inside the vessel must be formally trained and competent in the techniques of how to do this. (1)

(xi) Heat stress / cold stress or ionising radiation hazard pre-measurements must also be done if there is even the slightest risk of this occurring at any stage. (1)

(xii) Adequate first aid equipment including a (CPR) resuscitator apparatus shall be kept on site. (1)

(xiii) Adequate fire fighting apparatus shall be kept on site. (1)

(xiv) Continuous monitoring by the competent person shall take place while work in or inspection of the vessel, pit, sump, tank or chamber is being done. (1)

d) Define a “Confined Space

Is an area that has both;

- Insufficient ventilation to remove dangerous air contaminats and or oxygen deficiency
- Restricted access or egress

e) Factors affecting the formation and stability of a flammable gas roof layer

- Rate of emission of the gas.
- Density of the gas.
- The dip of the airway.
- The air velocity.
- The degree of turbulence of the ventilating air.

QUESTION 3

a) Differentiate between “Explosion resistant" and “Explosion relief (2)

- Explosion resistant: - is a design to contain the propagation of explosion energies
- Explosion relief:- is a design to "blow out” and re route explosion energies or to “vent” them harmlessly to atmosphere.

b) What is the rough “rule of thumb’ to determine an explosion relief panel size and which other two methods can be used? (3)

Rule of thumb:- allow 1 m2 of area of relief panel for every 24m3 of vessel volume.
Other methods: Vent Ratio Method or Nomogram Method

c) Describe the theory (physics) of a coal dust explosion. (9)

- Finely divided coal lifted and dispersed into he air will ignite or explode if enough oxygen is present and there is a source of ignition.
- The most common source is a flammable gas ignition. Secondary sources may be combustible material fires or hot sparks from mining machinery / electrical equipment.
- The flame produced by a small volume of flammable gas being ignited heats the surrounding atmosphere, causing a sudden rise in air pressure.
- This rapid pressure and temperature rise creates great turbulence, entraining and mixing more of the flammable gas molecules with the oxygen in the air, resulting in all of the mixture being very rapidly ignited.
- The rapid ignition of the flammable gas molecules results gas ignition / explosion.
- The gas ignition / explosion produces a flame spread of up to five times the volume of the original gas / air mixture and rapidly displaces the same volume of air.
- This fast volume displacement of air then lifts the coal dust from the roof, sides and floor of the roadway. This primary dust cloud produced is then ignited by the exploding / burning gas mixture
- The further rapid rise in the air pressure caused by the heat of the now burning coal dust and the turbulent flow of the resulting hot gases releases a pressure energy wave
- This pressure wave moves very rapidly away from the epicentre of the original ignition point and raises more dust that is then ignited by the primary flame front that moves at a slightly slower speed. (9)

d) List the main methods required to prevent a coal dust explosion (6)

- As much as possible removal of fine coal spillage.
- Reduce / control dust creating sources.
- Effective ventilation to dilute or remove flammable gas emissions.
- Sufficient and effective application of incombustible stone dust in the workings.
- Sufficient, well designed and effectively spaced flame quenching barriers.
- Prevent and / or control potential ignition and high temperature sources.

e) A fire has been extinguished by sealing. The sealed area has a volume of 80 000m3 and the gas in the area contains 50 000 ppm of CO. If the area needs to be flushed out in 7 days, calculate the quantity of fresh air required, if a constant level of 500 ppm of CO is to be maintained at the return from this area. (7)

- 50 000 ppm CO = 5% of CO
- Volume of CO in sealed area = 5% of 80 000 m3

= 4 000 m^3

- Available time to flush = 7 x 24 x 60 x 60

= 604 800 seconds

Qty CO in area 4 000/ 604 800

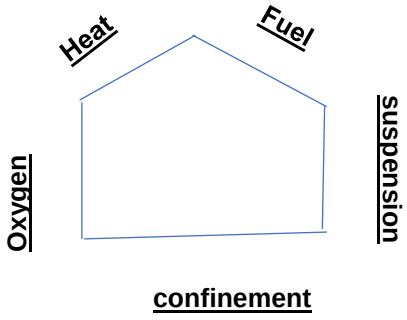
= 0,0066 m3/s (D

- CO in return not to exceed 500 ppm = 0,05% of CO
- Qty fresh air required for flushing

= 100/0.05 x 0.0066

= 13.2m^3/s

f) Sketch an Explosion Pentagon indicating the five essential elements that must simultaneously occur for an explosion to take place. (5)



g) List the four categories of explosions and give a typical example of each. (8)

- Chemical or thermal explosions - involve gases, vapours, mists and flammable dust clouds. (2)
- Mechanical explosions - bursting of any pressurised container. (2)
- Physical explosions – sudden formation of largequantities of superheated steam or vapour caused by liquid (2)
- Electrical explosions - mainly confined to high voltage equipment and related equipment that is oil filled and the explosion ignition is electric arc flash related, resulting in a chemical I mechanical explosion. (2)

(i) Mean MRR = (50 + 80 + 120 + 90 + 45 + 80 + 400 + 70 + 40 + 100)/10 (2)

= 107.5 ppm.

(ii)

Rank	Value
1	40
2	45
3	50
4	70
5	80
6	90
7	100
8	120
9	400

.-. ranking of section 6 = 8th

ranking of section 14 = 9th

(iii) Standard deviation (2)

(iv) $\sqrt{\sum \frac{(x-x)^2}{N-1}}$

50	107.5	-57.5	367.4
40	107.5	-67.5	506.3
45	107.5	-62.5	434
70	107.5	-37.5	156
80	107.5	-27.5	84
80	107.5	-27.5	84
90	107.5	-17.5	34
100	107.5	-7.5	6.3
120	107.5	12.5	17.4
400	107.5	292.5	9506.3
		Sum	11195.8
		SQRT	105.8

(v) The geometric mean

$\sqrt[n]{(a_1 \times a_2 \times ... \times a_n)}$

$\sqrt[10]{(50x40x45x70x80x80x90x100x120x400}$

= 83.86 or 84 (2)

(vi) The median and mode of the CO values (2)

(vii) From ranking 80 = median, 80 = mode

(viii) Plot a frequency distribution of the CO values (2)