NOTES ON
MINE HAZARDS & ENVIRONMENT

Mine Hazarda & Environment

1.0 Mine gases & gas testing.

1.1 Define atmosphere air & mine air.

Atmosphere air : The air of the atmosphere that are breath is a mixture of several gases and its composition is practically constant over the whole surface of the earth from the sea level upto an attitude of at least 25km. It is also ideal gas or pure gas in atmospheric air.

Constituents	By weight %	BY volume %
Oxygen	23.15	20.93
Nitrogen (Including Argon and other rare inert gases)	76.81	79.04
Carbon dioxide	0.04	0.03

Argon is an inert gas, 0.94% by volume in the atmospheric air. It behaves like nitrogen and therefore its percentage is normally included in the percentage of nitrogen.

Mine Air : Mine air also mixture of several gases which contains some more impurities than ordinary atmospheric air. It contains more moisture as compared to atmospheric air.

Or

In the under ground working of a mine there is an atmosphere which is in contact with main earth, atmosphere of few place only, through shaft and other limited opening common gases found in mine air are CO_2, CO, Excess of Nitrogen very less amount of oxygen. It is also a mixture of gas's and most harmful gas.

Constituents	By weight %	BY volume %
Oxygen	23.15	20.28
Nitrogen	76.81	78.90
CO_2	0.04	0.36
CH_4	------	0.46

1.2 State different gases as found in mines, their properties & physiological effect.

Nitrogen :

Properties :

1. It is a colourless, odourless and test less gas.
2. It is lightly lighter than air.
3. It's specific gravity 0.967.
4. Practically insoluble in water.
5. It is an inert gas which neither burns nor supports combustion.
6. It is important for the growth of plants animal tissues.

Physiological effect :

1. It is not poisonous gas but silicosis due to lack of oxygen.
2. When men work at high pressure than atmosphere the blood tissue of the body begin to absorb nitrogen.
3. When high pressure reduced the nitrogen is also given up by the body quickly and this results in painful and dangerous conditions.

Carbon dioxide :

Properties :

1. It is a colourless, odourless, bitter in taste.
2. It's specific gravity is 1.52.
3. It is heavier than air.
4. It is very soluble in water.
5. It is not combustible and does not support combustion.
6. It does not sustain life.
7. Critical Temp. is 32°C.

Physiological effect :

1. Normal over contains 0.03% CO_2 in mine air breathing becomes double.
2. 6% - violent panting, headache, exhaustion.
3. 10% - Severe distress endurable for a few minutes, after half to one hour of work, suffocation and unconsciousness.
4. 15% - consciousness loss.
5. 25% - death after hours.
6. CO_2 has a mildy tonic physiological effect.
7. Its effect on the flame of a safety lamp.

Oxygen :

Properties :

1. The gas is colourless, odourless & taste less in nature.
2. It is slightly soluble in water.
3. It is lightly heavier than air.
4. Its specific gravity is 1.1.
5. Its Critical temp. 119°C.
6. Its critical pressure 50 atoms.

Physiological effect : The physiological effects of breathing in oxygen depleted air are given below.

At 17% Oxygen : faster and deeper breathing.
15% Oxygen : dizziness, buzzing in ear, rapid heart beat.
13% Oxygen : Probable loss of consciousness with prolonged exposure.
9% Oxygen : Fainting and unconsciousness.
7% Oxygen : Life endangered.
6% Oxygen : Convulsive movement, death.

Carbon monoxide :

Properties :

1. It is also known as white damp.
2. It is colourless, odourless, tasteless, and non irritating.
3. It is slightly lighter than iar.
4. It's specific gravity is 0.967.
5. It is hardly soluble in water.
6. It is combustible but does not support combustion.

7. It burns with a light blue flame in air.
8. It's Critical temp is 140°C.
9. It's critical pressure is 35 atoms.

Physiological effect :

0.01 % CO	: Tolerable for a whole shift. Slight headache may result for prolonged exposure on exertion.
0.02% CO	: Slight headache after 4 hours at rest or 2 hours at work.
0.04% CO	: Headache, nausea, possible collapse after 2 hours at rest or 45 min at work.
0.12% CO	: Palpitation and giddiness after 30 min at rest or 20 min at work.
	: Leg weariness and nausea after 2 hours at rest or 40 min at work.
	: Complete collapse after 3 hours at rest or 1 hour at work.
0.2% CO	: Unconsciousness and death after 1 hour at rest or 10 min at work.
0.5-1.0% CO	: Unconsciousness and death after 30 min at rest or 2 min at work.

Methane :

Properties :

1. It is also known as fire damp.
2. It is colourless, odourless and tasteless.
3. It is lighter than air.
4. It's specific gravity equal to 0.559.
5. It is combustible and burns with a pale blue flame but does not support combustion.
6. It is hardly soluble in water.
7. The gas is not poisonous but suffocates a person due to lack of xygen.
8. Its critical temp is 83°C.

Physiological effect :

1. When methane gas present in a large quantities of air can cause serious oxygen depletion.
2. There have been instances when men have put their heads in to cavities in the roof filled with methane and have become unconscious in no time.

Sulphur dioxide (SO_2)

Properites :

1. It is a colourless gas.
2. Its smell is sulphueous.
3. Its neither combustible nor a support a combustion.
4. It is 2.21 heavier than air.

Physiological Effect :

1. SO_2 is similar that of nitrogen oxide.
2. Owing to high solubility SO_2 produces sulphurous as well as H_2SO_4 acid on the mucous membrane.
3. The gas is very poisonous and extremely irritating to the eyes and respiratory passage.
4. Irritation of eyes, nose, throat and lungs start at a concentration of 20 ppm of SO_2.

Hydrogen sulphides or H_2S or strink damp:

Properties :

1. It is colourless & the smell of rotten eggs.
2. It is readily soluble in water.
3. It's specific gravity is 1.75
4. It is combustible but does not support combustion.
5. The gas burns in air with pale blue flame.

Physiological effect :

1. It is extremely toxic.
2. It causes irritation and inflammation of eyes and respiratory tracts at concentration of 50-100 ppm after one hour of esposure.
3. At high concentration of 200-700 ppm, it causes pains in throat and chest.

1.3 State various sources of formation of CO, firedamp, black damp & afterdamp in mines.

Sources of Formation of CO : Spontaneous combustion in coal mines.
Timber fires in metalliferrous mines.
Present in fatal quantities in afterdamp.
Diesel engine exhaust.
Blasting fumes.

Sources of Formation of Firedamp : Decomposition of timber, Gradual exudation or bleeding from the coal and adjacent strata in the roof. In the form of blower. In the form of a gas outburst. Release by roof fall or sudden fall or barometric pressure which may force the gases of the goof into the workings.

Sources of Formation of Blackdamp : Human breathing, slow oxidation of coal, Delay of mine timber, Any carboneous materials, burning of oil lamps, exhaust IC engine, blasting fume, mine fires, mine explosion.

Sources of Formation of Afterdamp : A mixture of gases left after an explosion of firedamp or coal-dust. It often contains an appreciable quantity of carbon dioxide along with some carbon monoxide, methane and unspent normal air. A typical composition of afterdamp consists of 30-50% residual air, 58-44% free nitrogen, 8-4% carbon dioxide and 4-2% carbon monoxide.

1.4 Describe flame safety lamp & its working principle.

Flame safety lamp : A flame safety lamp is used for accumulation & percentage test of fire damp. It is essential equipment for under ground mines.

Working principle : The lamp is to be lighted at the lamp carbon only, if it is not provided with relighting check the safety lamp & contraband test for visual defect.

1. The gas cap is produce when temp damp below limit of inflammability because the gas is in close proximity to which flame which receives sufficient heat to cause the gas to burn.

2. The non luminous flame produce by this burning gas in then visible as a gas-cap above the testing flame.
3. With small percentage of gas the heat given by the which flame plus the heat evolved by the burning fire damp is just sufficient to ignite the gas immediately & only a small gas cap is produced.
4. As the percentage of gas increase more heat is evolved by the burning fire damp and a bigger volume is there by ignite resulting a lower cap.
5. Finally when percentage of fire damp reaches the lower of limit of inflammability sufficient heat is generated by each succeeding layer of burning by each succeeding layer or burning fire damp.
6. Propagate flame to the next layer independently air mixture before proceeding to under ground the lamp should examine to insure. (i) That the lamp has been properly clean assembled & is securely locked. (ii) That the lamp is burning brightly with the which properly trimmed & the picker or other adjusting device are in good condition. (iii) That any defect previously represents has been offended to clear.

1.5 Explain gas testing by flame safety lamp by accumulation test & percentage test.

Accumulation Test : The purpose of this test is to ascertain if there is any accumulation of gas in places where it may be suspected or is likely to accumulate. In a mine, it the mining sirder finds accumulation of gas at any place, he has to report the mater to the overman who should take steps for determining its percentage and its removal.

1. To test for accumulation switch off the cap lamp raise the flame safety lamp continuously with normal size of flame or a flame only slightly reduced and watch its behavior.
2. If the flame is spires or jumps the percentage of gas can be taken as nearly 3% or more.
3. No efforts should be made to raise the flame safety lamp higher than is necessary to test for accumulation because this results in keeping the flame in richer mixture of methane and air which may explode inside the lamp and extinguish the flame.
4. Even if the mixture is not explosive the gas will burn inside the lamp and it may produce CO_2 which will extinguish the flame.
5. It is unnecessary to conduct the percentage test when the flame spires up in a safety lamp as it is clear that the gas percentage is not less than 3%.

Percentage Test :

1. To conduct percentage test for methane with flame safety lamp remove all bright light in the vicinity and switch off the cap lamp.
2. Lower the flame of the safety lamp with the regulating known the there is a continues blue line across the top of the flame just above a speak of white (or yellow) light.
3. This should be done not at the place where gas percentage is to be detected, but a place nearest to it and free from gas.
4. When fire damp is present in the air at the spot of detection is below the lower limit of inflammability at burns with a non luminous flame which values in height depending in the percentage of the gas.

5. The size and height of the non-luminous flame produced by the burning of the gas depends on the size of the wick and the quality of fuel used.
6. Hence for determining the gas percentage the lamp to be used the size of wick and fuel have to be standardized.

1.6 <u>State precaution of gas testing.</u>

1. The lamp should be carried out carefully with a steady movement & with a little swing as possible.
2. The use of standard testing flame in which there is a continuous blue line across the top of the flame just above the spick of white light.
3. Avoid confusing the fuel cap with a fire damp cap.
4. Extinguish the other light in vitality & that the gas cap can clearly same.
5. If any one is examining for the presence of fire damp with safety lamp, he shall not rise the lamp higher than, it necessary to allow the presence of gas to be detected.
6. Person carry the flame safety lamp should be examine perfectly before going to U/G.

1.7 <u>Describe various parts of combustion tube flame safety lamp, special features.</u>

The name of the different parts of the lamp with their salient functions are given below :
(a) Carrying hook : For holding the lamp and carrying it at about knee-height.
(b) Vent holes : The combustion gas goes out of the lamp through these holes.
(c) Bonnet : Protects the wire gauzes and also guards the flame.
(d) Deflector ring : To divert the rising inlet air downward.
(e) Waffle ring containing inlet holes : Through this holes atmospheric air enter the lamp.
(f) Pillars : To protect the glass.
(g) Magnetic lock : To kept securely locked when in use.
(h) Outer & Inner gauze : To prevent the passage of flame from interior of lamp and the heat absorbed purpose.
(i) Combustion chimney : This assembly separates the inlet and combustion air so that the flame burns in comparatively pure air and consequently gives good light.
(j) Asbestos rings : Two asbestos rings, one each at the bottom and top of the outer glass, are put to make the joints leak prrof and prevent the explosion flame to come outside.
(k) outer glass : This should be of tough quality glass and of sufficient thickness so as to withstand the shock pressure should an explosion occurs inside the lamp.
(l) Glass retainer : A threaded annular ring which when screwed in holds the outer glass, wire gauzes and combustion chimney in position.
(m) wick retainer : It keeps the wick holder in position.
(n) Wick and wick holder : The wick passes through the wick holder.
(o) Non-spil type oil valve : For filling oil in the vessel.
(p) Wick adjuster : flame height can be regulated by this without opening the lamp.
(q) Oil vessel : Act as an oil reservoir.

1.8 <u>State limitations of flame safety lamp .</u>

An oil flame safety lamp, though a convenient, handy and inexpensive device for detection of fire damp has certain limitations :

7. It can be used only by persons trained for the purpose.

8. Even in the most experienced hands, it can detect fire damp percentage not below 2%.
9. It can be used for detection only in accessible places within the reach of the person testing for gas.

If there is shortage of oxygen, flame of the oil safety lamp will reduce in size and will be completely extinguished if the oxygen percentage is 17 or less Minimum 14% oxygen is required in air for supporting human life.

If blackdamp or CO_2 is present in air, the flame of oil flame safety lamp diminishes in size and will be extinguished if CO_2 percentage is 3 or more.

2.0 Emission of firedamp in Under Ground working :

2.1 Describe gradual exudation, blower & outburst of firedamp in under ground workings.

Gradual exudation : The gas is discharged in count less little streams is issuing from all joints and process in newly worked coal face. The quality may very in different mines and at different times, depending chiefly on the quantity of gas originally present the length of face exposed the output of cool being obtained. Where the large goofs exist, the gas accumulated in these areas is a constant source of potential danger owing to possibility of its being force out suddenly in to the mine road ways by fall of roof or sudden decreases in atmospheric press. Special precaution is necessary in gassy mines during periods of high barometric pressure as a sudden fall of pressure result in forcing gas out of the goofs in to the working place & roadways.

Blower : Where the gas is discharged continuously for a period from a definite point of issue. It is called a blower such blowers are of ten accompanied by hissing, gurgling, or noise, indicating that the gas is under considerable pressure. It sometimes may be piped direct to the face for use for lighting heating & power purpose.

Outburst : These are sudden violent discharge of gas usually accompanied by the displacement of large quantities of disintegrated coal & coal dust. When narrow roadways are formed in the coal seams the thickness of barriers between the roadways & adjacent zones becomes sufficiently to from zones of weakness in which the high pressure of gases in absorption zones is sufficient to dislodge coal at the face and side of the roadways resulting such outburst. The prime causes of an outburst due to sudden release of the strain energy from the strata. High stress in the strata may be due to geological factors, which have caused folding, faulting and intense internal thrust or it may be inclined by mining operations.

3.0 Defines fires & spontaneous heating :

Fire : To start a fire the following conditions are essential :
(i) Presence of a combustible material. (ii) Presence of a source of ignition of sufficient intensity of heat, (iii) Presence of oxygen. (iv) Contact of combustible material and source of ignition for some time.
For the fire to continue after it starts a sufficient supply of oxygen or air must be available. In the absence of oxygen the fire gradually dies down.

Spontaneous heating : Spontaneous combustion of coal or other carbonaceous matter may be defined as the process of self heating resulting eventually in its ignition without the application of external heat.

3.1 Describe causes & factor affecting spontaneous heating .

Causes of spontaneous heating :

When coal is exposed to air it absorbs oxygen at the exposed surface. Some fractions of the exposed coal substance absorb oxygen at a faster rate than others and the oxidation results in formation of gases, mainly CO, CO_2 and water vapour along with evolution of heat during the chemical reaction. The process takes place of heat during the chemical reaction. The process takes place even at normal atmospheric tempreture but it is slow and the heat evolved is not preceptible as it is carried away by the air unless the latter is stagnant. If however the rate of dissipation of heat is slow compared with the evolution of heat by oxidation, there is a gradual build-up of heat and slow rise in the temperature of coal. At the raised temperature the process of oxidation is slightly accelerated and some other fractions of coal become susceptible to oxidation. A stage is reached when the build up of heat and the rise of temperature reaches the ignition point of coal which then catches fire. Once the coal reaches its ignition point the air supply to it will only increase the combustion. The coal may be smoldering in the beginning but it may soon break up into flames if sufficient oxygen or fresh air feeds the hot coal. This process of self heating of coal resulting ultimately in its combustion is known as spontaneous combustion.

Factor affecting of spontaneous heating :

1. Chemical composition of coal : High moisture and high volatile coals are more susceptible to spontaneous heating. All bright coals with 25% or more of V.M. and 7 to 15% of moisture are prone to spontaneous heating. High rank coal with high carbon content is less liable to spontaneous heating. The proneness to spontaneous heating of coal decreases with decreasing oxygen content in the V.M. of coal.
2. Banded constituents of coal : The bright bands of coal is vitrain and clairain are more liable to spontaneous heating than the dull constituents like durain and fusain. Durain is hard and difficult to fracture and resistant to self heating. It therefore oxidizes rapidly at low temperatures but it forms only about 5-6% of the coal and is thus not so important a factor in spontaneous combustion as vetrain or clairain.
3. Friability : Coal which is easily crushed and broken into smaller size is more liable to spontaneous heating then hard coal.
4. Presence of iron pyrites : Coal containing iron pyrites in disseminated form is much liable to spontaneous heating. The broken coal presents more surface for air circulation and is also slightly warmer due to the heat of oxidation of pyrites. This results in acceleration of the process of spontaneous heating.
5. Nature of adjoining strata : Thermal conductivity of coal measure shales is only $1/3^{rd}$ that of the sandstones. If a coal heap is covered by loose shales, the heat of oxidation of coal is not dissipated as fast as in the case of coverage by sandstone and the former heap is more liable to spontaneous heating.
6. Depth of seam : The strata temperature and crushing effect of superincumbent rocks os a coal seam increase with increasing depth. Both the factors accelerate the process of spontaneous heating.

7. Thickness of seam : It is difficult to remove all the coal in a thick seam during depillaring by caving. The difficulties in extraction of coal by caving often results in nearly 50% extraction only and the remaining coal is left underground in the form of stooks, coal in the roof or coal in the parting between adjacent sections. Such coal lying in the goaf provides suitable material for spontaneous heating. Another contributory factor for spontaneous heating is thick seams is the slow velocity of air current in high galleries, due to low velocity the heat of oxidation is not removed fast enough.
8. Geological disturbances : Near a fault plane the coal and other strata are usually crushed and not hard enough. Such crushed and weak, friable coal has to be left in-situ for support near a fault zone to prevent a rock slide along the fault plane. Such coal is more liable to spontaneous heating than the comparatively harder coal at places away from the fault zone.

3.2 Define incubation period .

This is the term to denote the period which clapses between the time when the coal is first subjected to conditions favorable for spontaneous heating and the time of indications of heating.

In a coal mine having depillaring with caving the coal left in situ in stocks is buried under broken rocks of roof after the first major roof fall takes place. Such roof coal falls in the goaf after withdrawal of roof supports during retreating in the caving method and it gets buried after the first major roof fall. The first major roof fall therefore creates conditions under which the coal-oxidation heat cannot be dissipated fast enough with the result that the heat of oxidation builds up leading ultimately to spontaneous heating. The term incubation period has therefore special significance in a depillaring mine as all the depillaring operations should be over in a mine or a panel during the incubation period so that the depillared area can be sealed off by stopping.

3.3 State preventive measures against spontaneous heating .

Spontaneous heating in coal stock can be prevented by adopting the following measures.

1. The stocking ground should be hard and fire free from growth of any vegetation.
2. Coal should screen and stock should contain coal of one size only. Fires easily take place in coal heaps where the coal of different sizes is stocked together.
3. Shale piece in contact with coal are known to accelerate spontaneous heating. They should be picked out.
4. The coal stock should not exceed 200 tones and its height should not be more than a critical height. The critical height varies for different coal and is generally between 1.5m to 3m.
5. The coal stocks should be cleared on the basis of first come first removed, so that only fresh coal us available in the stock.
6. The coal stock should be compacted by dozer from time to time as it build up. This is the process of oxidation.
7. If possible the coal should be stocked over a network of criss cross perforated iron pipes through which water can be circulated at the slightest direction of heating.
8. In the coal stock iron pipes 50mm dia pointed and closed at the lower ends should be fixed as intervals.
9. To cut down supply of oxygen the surface of coal stock may be coated with mud.
10. Coal should not be stocked near any source of heat like boiler house, boiler ash, heap steam pipe range etc.

3.4 Explain CO/O_2 ratio & CO_2/O_2 ratio.

- When air passes along or through under ground district it becomes vitiated & during this process of vitiation oxygen is observed and CO_2 is release & in case of coal seam CO are produced.
- Production of oxides of carbon relatively to oxygen observation increases with rise of temperature.
- The CO is produced mainly by slow & incomplete oxidation of coal if diesel locomotive or other interval combustion machinery is not used under ground.
- The % of CO in a normally working mines may be about 0.005 or even lower in the return air.
- The ratio CO produced /O_2 consumed is usually between 0.11 & 0.51 in the main return of working adequate ventilation but, it may be higher even upto 1% for sample taken at the working coal faces.
- Width spontaneous heating of coal in under ground mine the ratio CO/O_2 deficiency gradually increases & in general term it may be summarized as follows:
  CO/O_2 deficiency 0.1% to 0.5% is normal to a coal seam mine.
  - (a) 1% indicates existence of spontaneous heating.
  - (b) 2% indicates heating in advanced stage approaching active fire.
  - (c) 3% or more indicates active fire.
- The CO/O_2 ratio is independent of dituation of samples by CH_4 given from the strata & coal seam.

CO_2/O_2 deficiency ratio : When a fire become active the carbon monoxide produced may be consumed by the normal process of combustion under such condition CO_2/O_2 deficiency ratio becomes a useful guide of the magnitude of the fire, but this ratio is less liable than CO/O_2 deficiency ratio in the initial stage of heating because oxidation of coal & phsites produce some CO_2.

4.0 Mine Explosion :

4.1 Describe coal dust & fire damp explosion with their causes & prevention.

Coal dust explosion : For a coal dust explosion to take place to take place the dust must be raised into are in the form of cloud & then ignited by a source of heat of sufficient intensity. Such circumstances generally exist after a fire damp explosion. The quantity amount to 30 to 40 g/m^3 of space the could may not be of a larger size but it's density is important.

For a coal dust to start an explosion the dust should be in the form of cloud in the air, so hence that are can't seam through it.

The quantity is so small that no part of a coal mine can be considered to be free from danger of coal dust explosion, when it occurs it is impossible to keep a mine free from such accumulation.

The lowest temperature at which a fine dry coal dust could be ignited & can casual the flame to travel through out the dust air mixture is 700 to 800°C.

The lower limit of inflammability of coal dust is 1 gm/sec but the higher limit is quite high & for bituminous coals it is above 200 gm/m^3 of space.

Causes of coal dust explosion : The various causes of coal dust explosion are :

1. Fire damp explosion : In mines the most likely causes of ignition of coal dust is local fire damp explosion which by conclusion races into suspension. The dust previously laying on the floor or in the sides of timber propagate on explosion through the dust air mixture.
2. Naked flame : A performed could of dust of a certain minimum density & volume may be ignited by a naked flame as the surface of heat is of considerable size & a large part of dust cloud can be heated.
3. Electrical sparks : Electrical sparks of higher voltage from short circulating & arching at electrical equipment may ignite & explosive dust air mixture.
4. Friction : Hot surface due to friction even over heated metal bearing may ignited the surrounding explosive dust cloud.
5. Shot-firing : Coal dust may also be ignited by a blown out shot although experiment have shown that it is difficult to ignite a dust cloud, in the absence of fire damp even with unstemmed as much as 750 gm permitted explosives.

Prevention of coal dust explosion :

A coal dust explosion can be prevented by :

1. Reducing the formation of coal dust at the working place haulage roads & any else holes.
2. Preventing its spread.
3. Rendering coal dust hardness by wetting it with water or mixing with inert stone dust.
4. Provision of stone dust barriers or water barriers.

Fire damp explosion : Fire damp explosion is of more frequent occurrence than coal dust explosion in mines. It may be initiating cause of the more divesting coal dust explosion in a mine are. The presence of sufficient body of fire damp mixed with the air in explosive properties. A suitable ignition agent with sufficient heat for a sufficient fire the gas air mixture to be ignited. Presence of fire damp in air between 5.4 & 14.8% forms and explosive mixture. If a suitable source of ignition is available the mixture results in a explosion. The maximum explosive violence is produce when the explosive mixture contain & about 9% of fire damp.

Fire damp in explosive percentage may be present in roof cavities roof ripping break * fissures communicating with shot hole in rise heading & also in the long wall face in the event of heavy roof fall. Door ventilating due to defective mine layout disarranged of doors or practice main cause of presence of fire damp in explosion percentage.

Causes of fire damp : The various causes of fire damp explosion in mine may be grouped under the following headings.

1. Shot-firing : Shots not properly placed causing on over charged and below out shots with detonator wrongly placed in cartridge shots fixed without examination for fire damp. Shots fixed where breaks exists in the hole or where in sufficient steaming has been used or by using defective cable or exploder.
2. Naked light : Matches or other contrabands introduced in mine illegibly.
3. Defective or damage safety lamp Defective or damage safety lamp : Glass broken part assembled or lamp tempered with exposing the flame damage lamp.
4. Electrical appliances and spark : Electrical sparks flash is or areas arresting from improperly in closed motors switch gear brushing of power cable owing to weak in

solution, returning of cables by falls of roof rubbing contacts bore signally wanes unless it is made initially safe.

5. Friction : An intensive frictional spark at a high temperature for comparatively long period is cable of causing an explosion such sparks high be produced by falling rock masses on iron physites.
6. Fires : Accidental fire or spontaneous combustion of coal may easily bring about ignition of flammable fire damp air mixture in contact with them.

Prevention of fire damp explosion : A fire damp explosion can be prevented by:
1. Avoiding dangerous accumulation at fire damp, much below the lower limit of explosibility.
2. Avoiding sources of ignition which may cause the fire damp accumulation to explode.

Proper ventilation of the mine is the correct method to prevent dangerous buil-up of firedamp. If the firedamp percentage in the return air of a ventilating district exceeds 0.8, air samples have to be taken daily in the ventilating district and steps taken to bring down the gas percentage till it falls to less than 0.8.

The second step to prevent fire damp explosions is to avoid sources of ignition of firedamp. The sources which can possibly result in ignition of gas in an underground mine have already been stated in the earlier chapter. If electricity is used the motors, switchgears and transformers should be provided with flameproof enclosures.

An intrinsically safe apparatus is one which is so constructed that during its use, the spark produced by it is not of such high temperature as to cause ignition of gas. This construction is possible with apparatus operated by voltage up to 25 volts. Signaling belts, telephones, exploders and relay are of intrinsically safe construction.

4.2 State inflammability of coal dust and fire damp.

Inflammability of coal dust : It may be defined as its ability to cause a flame to spread away from the source of ignition. Some coal dusts are more inflammable than others. The lower limit of inflammability of coal dust is 2 gram per C. C. but the higher limit is quite high and for bituminous coals it is above 2000 g/m^2 of space. This higher limit represents a very thick cloud which is difficult to exist in a mine under normal mining conditions. The inflammability of coal dust is dependent upon the following factors :

1. The inflammability increases with the volatile matter.
2. Finer the coal dust, greater is its inflammability. The finest dust is most dangerous.
3. In a mixture of coal and rock dust in a mine the incombustible matter absorbs some of the heat of the ignition source so that the temperature and flame cannot be propagated.
4. External moisture added to coal dust reduces its inflammability and if the moisture is in sufficient quantity it binds the dust particles together thereby preventing then from rising in the air as a cloud.
5. The inflammability of coal dust increases almost directly in proportion to the percentage of firedamp present in the atmosphere.
6. Nature and intensity of ignition source factors influence the inflammability of coal dust.
7. Weathered coal dusts are more inflammable as they contain oxygen loosely combined with the coal substance.
8. The varying conditions of dust distribution and propagation of the explosion also affect the course of dust explosions.

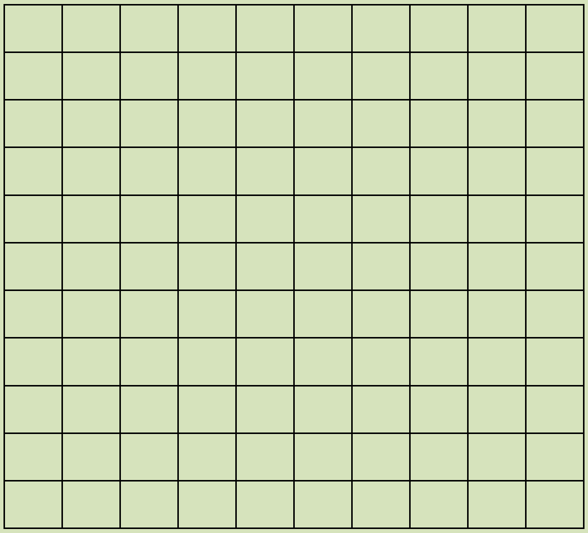
Inflammability of fire damp :The lowest percentage of methane in the air that yield on inflammable mixture is called lower limit of inflammability. The highest percentage depends on a number of factor including.

a. The direction of travel taken by the flame whether upwards, downwards or horizontally.
b. The manner in which the mixture is contained.
c. Whether the mixture is at first avoiding dangerous or moving in a stream & turbulent.
d. The initials temperature and pressure under normal conditions the mixture of fire damp & air can only be ignition within a definite range commencing with a lower limit of 11.8% methane in air.

All fire damp air mixture within the range are inflammable & capable fire damp outside these limit may be ignited but will not propagate flame.
The maximum explosive force occurs with a mixture containing about 10% of mixture. At this point there is dust about twice as which oxygen present as methane to ensure eomplete combustion in accordance with the equation. $CH_4 + 2O_2 = CO_2 + 2H_2O$

4.3 <u>Explain Cowards's diagram.</u>

Coward's diagram
If fire damp present in an area is below 5.4%, it will burn away when flame is applied to it. The gas is then combustible. If however, gas is present in air above 5.4% application of flame of source of heat of sufficient intensity will cause the mixture to explode. Below figure shows the limits of explosibility with different percentages of firedamp and oxygen. It has significance when sealing off a fire in a gassy mine and also when reopening a sealed off area. The important points to note are :



1. All mixtures lying within the triangular area XYZ, are in themselves explosive.
2. All mixtures lying to the right of PYZ contain too much methane to explode but they will form explosive mixtures when mixed with the right amount of air.
3. All mixtures lying to the left of PYX are neither explosive nor capable of forming explosive mixtures with air.

4. Lower limit of explosibility remains almost constant at about 5.4% for all percentages of oxygen down to about 12.5%.
5. The higher limit of explosibility gradually decreases from 14.8% to about 6% with decreasing percentage of oxygen.
6. No percentage of fire damp is explosive when the percentage of oxygen is 12 or less.
7. A firedamp-sir mixture may became explosive when diluted with an appropriate quantity of air which brings the new mixtures within the limits of the triangle XYZ.

4.4 State prevention, suppression & treatment of dust.

Prevention of the formation of dust : Dust is mainly produced by mining operations like drilling, coal cutting and blasting, though a small amount of dust may be produced by the crushing of mineral during free fall at chutes and transfer points. Crushing of coal pillars by rock pressure is an important source of dust production. Size reduction of mineral by crushing produced a considerable amount of dust.

Production of fine dust during drilling can be minimized by using sharp bits so that there is more of chipping than of grinding action. Sufficient thrust on the bit and suitable arrangement for the clearance of cuttings from the hole help in reducing dust production.

Dust production in rotary drilling is inversely proportional to the rate of penetration, though it varies directly with the speed of rotation. Thus high thrust at a low rotational speed produces the minimum dust. Coal cutting machines should have sharp picks and the chain should always be equipped with the complete set of picks for minimizing dust production.

Dust produced by blasting can be minimized by suitably controlling the produced of holes and the quantity and strength of the explosive used so that excessive fragmentation is avoided.

Free fall of material at the face, during transport and at transfer points should be reduced as far as practicable. The system of haulage should be reduced as far as practicable. The system of haulage should be designed, installed and used with a view to minimizing spillage. It is a good practice to keep ore bins, chutes etc. always full in order to minimize dust production by free fall of mineral.

The right method of working with adequate roof-control helps in reducing production of dust by reducing crushing of pillars.

Suppression of dust : The simplest way of reducing the concentration of dust in air to a pathologically safe limit is to dilute it by increasing the quantity of ventilation. This, however, is limited to dealing with relatively small concentration of dust, since large concentrations would require a large quantity of air which not only would increase the cost of ventilation but also create high air velocities which may raise deposited dust thus producing the opposite effect.

Suppression of air-borne dust, can be classified into two methods, (a) wet suppression and (b) dry suppression.

(a) Wet suppression of dust : This usually utilizes sprays of water for wetting fine particles suspended in the air. The wetted particles grow in size and are easily separated out by gravitational setting. Sometimes, particularly with mist spray, the spray may be directed against a surface such as a well or a curtain of brattice so that the separation of the wetted particles is enhanced owing to impingement. Fine atomized sprays or mist sprays having droplets of about 60 μm diameter have been found to be much more effective in wetting suspended dust than coarse sprays.

Water sprays have been effectively used for suppressing dust on haulage roads ans at chutes, transfer points, ore bins, skip loading stations etc. Regular spraying of shaft sets suppresses the dust collected on them thus preventing it from getting air-borne.
(b) Dry dust suppression : This usually consists of exhausting the dusty air from the point of operation and then separating the dust from the air by inertial separation, filtering, electrical precipitation etc. so that the cleaned air can be re-circulated. Means of dry dust suppression are commonly used in mines at transfer points, ore bins, crusher stations and even for cleaning the air after blasting in headings.

4.5 Describe sampling of dust in Mines.

In order to effect suitable preventive and suppressive measures for allaying dust in a mine it is essential to have a suitable device to estimate or sample air-borne dust likely to be breathed by miners. The sample pf air dust collected should be able to give knowledge of dust concretion in that area. The process of estimating by suitable device the dust concentration in the collected sample is known as sampling of dust. Sampling method can be classified as follows – (1) filtration, (2) sedimentation, (3) Inertial precipitation, (4) thermal precipitation, (5) electrical precipitation and (6) optical methods based on light scattering.
Filtration : Filtration method was primarily used to collect large samples of the order of 50mg or more for chemico-mineralogical analysis. Mass concentration could be determined by differential weighing of the filter before and after collection of the sample, but this concentration was of little value since it covered the entire particle size range, inclusive of all that particles above the respirable size range.
Sedimentation : In this method, a certain volume of air is caught in a vertical cylinder and the dust in it is allowed to settle by gravity on to a glass slide placed at the bottom of the cylinder. The slides are then examined under the microscope for determining particle concentration and size. For accurate results, it is essential to control the temperature of the cylinder in order to avoid convectional air movement inside the cylinder.
Inertial precipitation : Dust sampling instruments using inertial precipitation are base on three principles : impaction, impingement and centrifuging. Konimeter is the most widely used instrument utilizing impaction.
Thermal precipitation : This method utilizes the principle that when a body surrounded by dusty air is heated, a dust free zone is produced around the hot body, the extent of the dust-free zone depending on the temperature gradient between the hot body and the surrounding air.
Electrical precipitation : The electrical precipitation essentially consists of a charging wire maintained at a high negative potential of about 12000 volts and surrounded by an earthed concentric cylinder. Dust-laden air is drawn through the cylinder by a fan at a constant rate.
Optical method : This method utilizes the property of scattering of light by a suspension of fine particles.

4.6 Stone dust barrier .

A stone dust barrier consists of shelves placed side by side and each shelf consists of planks placed one above the other and loaded with stone dust. These are placed on supports in the main roadways of an underground mine in such a manner that the planks collapse with the shock of an explosion, thereby causing the stone dust to disperse in air form a thick stone dust cloud in the path of the oncoming explosion flame.

In this type of barrier the stone dust rests on planks which run longitudinally in the road way and whose length equals the width of the shelves. These planks rest on a rigid frame, the two main members of which are at least 150 mm in depth and rest on their edges on two fixed rigid brackets. Neither the frame, nor the planks are fastened either to each other or to the fixed brackets.

According to the loading of the shelves and the total quantity of stone dust on the shelves, the barriers may either be as :

(1) Light, also called primary or first barrier, or

(2) Heavy, also called secondary or second barrier.

Light type of barriers are intended for use nearest to a possible point of ignition. They consist of light loaded shelves not more than 35 cms in width. Heavy types of barriers are intended for use further from the possible site of explosion. They, therefore, contain more dust because the greater distances will give the explosion the opportunity to develop greater violence which will then be difficult to stop.

To ensure its successful operation a barrier must be provided with shelves which collapse in the event of an explosion.

5.0 Mine inundation :

Abandoned mines and quarries get filled with water and pose a problem for the working of mines below and near such water logged areas.

Most of the accidents resulting in inundation have arisen due to –

1. The inaccuracy of old plans.
2. The lack of old plans.
3. Errors of judgment of neglect of precautions.
4. unsuspected presence of old shafts, boreholes or drifts connecting old galleries full of water.
5. Sudden collapse of water bearing strata.
6. Sudden bursting of a dam to hold water.

State sources of water in mines & its danger .

Sources of surface water : Sources of water on the surface are river, water tanks, low lying areas which can accumulate water, rain catchments areas water logged quarries dams on the up stream side, from the records of flooding associate will loss of life or damages to work are :

- Over flow of monsoon water through pits or incline.
- Erosion causing area of highest flood level to increase.
- Borehole kept unprotected in the vicinity of river bed.
- Wrong sitting and inadequate heights of mine interval.
- Blockage of culvert, bridge or higher water level in the main river on the down stream side causing rise of water level on the up stream side.

Preventive measure :

1. Mine entrance should not be site nears the river bed.
2. A brick wall should be made around the inclined mouth.
3. A drainage should be made along the subsided areas.
4. Cracks appearing at surface should be filled by cement sponging.

5. There must be sufficient over the roof of under ground working.
6. In rainy season when depillaring with caving is adopted the water rushing through cracks. To deal with such situation adequate pumping capacity is essential.
7. do not make any workings vertically below and within 15m of either bank of a river, canal, or lake.
8. Observe the precaution laid down in the mining regulation when approaching water logged working.

Sources of underground water : The dangerous of in rising under ground water may be due to one of the following :

1. Normal water absorbed or presence of rock masses.
2. Water absorbed on porous rock masses.
3. Water accumulation in old working or in goaves.
4. Change of water connection strata.

Preventive measures :

- Making proper provision to ground against the danger of irruption of water ot other liquid mater.
- All survey work should be carried out accurately and plans made by competent surveyor.
- All geological disturbances should be shown on mine plans.
- While copying old plan, magnetic variation and shrinkage of man must be taken into account.
- Water dams should be provided whenever necessary.
- Driving drainage & tunnels to dewater properly.

5.2 State precaution against inundation .

Steps against inundation of mine workings :

1. Maintain a surface plan of the mine with contours and showing particularly low-lying areas, lakes, water courses, boreholes, wells, dams, quarried outcrop zone.
2. Cut suitable drains round the periphery of the quarry to prevent inflow of rain water or surface water into the quarry.
3. Ensure that there is sufficient cover over the roof of underground workings.
4. If the mine is worked near the outcrop by quarrying or by inclines and the workings have been abandoned resulting in their water logging, leave a sufficient thickness of solid mineral.
5. If the strata above the mineral bed are permeable and outcropping in a river or lake, caving method of depillaring should be avoided unless the mine has adequate pumping capacity.
6. Leave sufficient barrier of solid mineral against adjoining mine on the rise side of the mine.
7. Where dams have to be built underground to hold water, they should be of adequate dimensions and well anchored in the floor and roof stone and in the sides, to prevent leakage.

8. Do not make any workings vertically below and within 15m of either bank of a river, canal, or boundary of a lake or tank without permission of the appropriate authorities.
9. Observe the precautions laid down in the mining regulations when approaching waterlogged workings.

5.3 Describe burnsides safety boring apparatus.

An underground drilling machine which has replaced the once-familiar Burnside drilling equipment used when approaching water-logged underground workings is VOLSAFE-500 manufactured and marketed by VOLTAS LTD. It can drill holes of 500 mm or 75 mm in dia. upto a depth of 150 m at any angle upto 360°. It is powered by an electrical flameproof motor of 15 H.P. A separate pump unit of 7.5 H.P. is used for water circulation but a pump to develop hydraulic pressure for hydraulic controls is integral part of the drilling machine and it has a capacity of 73 rpm at 25 kg/cm^2. The drilling pipes are only 1.5 m long due to underground limitations on lengths. The safety boring attachment of the machine can shut off water at a pressure upto 45 kg/ cm^2 and avoids possibility of danger from water inundation.

A pair of anchoring buckles has been provided as a safety measure to ensure that the attachment does not come out of the borehole under pressure encountered due to water logging on the other side. AW drill rods can be inserted through the packing's of the stuffing box – this being water light during the time of boring. After the water is tapped, the full length of rods and drill bit can be withdrawn to outside the full way taper cock, the cock can be shut and the stuffing box unscrewed, then the drill bit can be withdrawn – this operation being perfectly safe.

5.4 State precaution while approaching water logged area .

Precaution while approaching logged area is as follows: ---

1. Examine old plans or records to determine the position of working information on the extent of the old workings and their condition can be had from old experienced supervisory staff.
2. Instead of working a district, drive only one or two exploratory headings nearly at right angles to the general outline of old workings.
3. In a thick seam it is necessary to bore holes in upward and downward direction also.
4. Provide proper lighting at the working place and escape-route.
5. Drill the holes with a suitable machine like the Volsafe 500 boring apparatus which enables water, if tapped, to be shut off immediately by a valve.
6. Build emergency shut off door at about 15m away from the site of boring machine for closing it immediately in an emergency.
7. Fill up the depressions on the escape route so that it is not filled with water, when tapped and does not obstruct the workers when retreating in a hurry.
8. Provide a drain or pipe line f suitable size and gradient to deal with any possible flow of water when the make of water at the face increases or when the bore holes tap the old workings.
9. Appoint only experienced workers and supervisory staff at the face.
10. Increase the pumping capacity of the mine beforehand to deal with water when it is tapped.
11. Watch for any unusual seepage in the flow of water at the face or in the bore holes. It should however be noted that in some of the accidents due to inundation there was rarely any indication of increase flow of water at the working places.

5.5 Describe water dams- its construction & design.

Design of Water Dams : A rain forced concrete dam can be properly designed to withstand a known pressure for a road of given dimension.

- In most cases, wide tolerance would have to be allowed, particularly where a dam has to be erected in weak ground or in roads on coal.
- A most important factor is that of securing adhesive to the roof, floor & sides, so as to eliminate the possibility of the dam being displaced as a whole.

5.6 Explain water danger plan.

Water danger plan : The water danger plan should show the following features to serve the purpose of grounding against danger of surface and underground inundation.

- The position of the working below ground and wory bore hole and shaft with depth including opening cross measures drift, good, pumping station.
- The general direction and rate of dip of the strata.
- Such section of the seam may be necessary to shoe any substantial variation in the thickness or character there of and showing the working section.
- The position of every duke, fault and other geological disturbances with the amount and direction of flow.
- The position and RL of permanent beach mark.
- Surface drainage system of mine.
- Working times to draw usual attention to danger of inundation arising out of.
  (a) surface water.
  (b) Un-consolidated strata.
  (c) Under bearing.

6.0 Mine lighting & Illumination :

6.1 State effect on safety level of illumination at different working places at mines with reference to D.G.M.S. circulars.

Intensity of light : It is the relative amount of luminous energy given by any source and is measured is candles or candle power or in candelas.

A light source generally gives different intensities in different directions. Hence candle power or candela does not convey the correct picture unless direction is specified.

Mean horizontal candle power (M.H.C.P.) : It is the average candle power of a lamp in all directions in a horizontal plane passing through the centre of the source and is usually obtained by rotating the lamp about a vertical axis.

Mean spherical candle power (M.S.C.P.) : It is the average candle power of a lamp in all directions, or the candle power of a uniform source giving the same total flux of light. It is directly proportional to the total light given by the lamp and s measured by taking intensity reading in all directions.

Illumination : The illumination at a surface is measured on foot candles r in meter candle. One meter candle is the intensity of illumination on a surface 1 distant from a source of one candela. Illumination at a surface is inversely proportional to the square of the distance of the surface from the source of light, and directly proportional to cosθ where θ is the angle between the normal to the surface and the direction of the light rays.

Lumen (lm): This is the unit of light (luminous flux) emitted by a light source.

Lux : It is the unit of illumination is S.I. units. A lux is an illumination of 1 lumen/m3.

Luminous efficiency : it is expressed in lumens per watt consumed and is from 10 to 20 in modern incandescent lamps, the higher values being for the larger lamps.

Reflection : When light falls upon a surface, part of it is reflected and part absorbed. In the case of a transparent body majority of the light passes through. Only that part of light which is reflected is useful for illumination. A white surface is a good reflector of light and in underground mines, to improve the lighting effect, the following places have to be white-washed.

Lighting in Mines :

(a) On the surface :Where the natural lighting on in sufficient in every engine house, in the vicinity of every working shaft, at every opencast working, at every shunting on Marshalling yard and at every place where work person have to work.

(b) Bellow ground :

1. At every shaft inset and shaft bottom or siding which is in regular use.
2. In every traveling roadway where 50 or more person work during the shaft and in working stope in metal furious mines.
3. At the top and bottom of every self-acting incline in regular use.
4. At every place on haulage roadway at which tubs are regularly coupled or uncoupled, attached or to detached from a haulage rope.
5. At every place at which tubs are regularly filled mechanically.
6. At every room and place containing any engine, motor or other apparatus.
7. At every place where any pillar in underex traction.
8. At every first aid station below ground.

Every lighting fitting in underground coal mines has to be of flame proof design.

7.0 Mine dust :

Physical properties of dust, composition, size, concentration & time of esposure.

Physical properties of dust :

1. Composition : The properties of dust affecting the development and severity of lung diseases are chiefly composition, size and concentration though particle shape is also an influencing factor. Chemical and mineralogical compositions of the dust particles determine the degree of virulence. While minerals like silica and asbestos are degree of virulence. While minerals like hematite have been reported to have a prophylactic effect on toxic dusts. Free crystalline silica in any dust has been almost universally accepted as the most important hazard component of any dust. It can, by association, make any

type of pneumoconiosis disabling. Thus it becomes necessary to ascertain the free silica content of any dust in order to assess its physiological importance.

2. Size of particle : This is the most important of dust that governs its physiological effect. The maximum tissue damage is caused by dusts of about one micrometer size and it decreases with particles of both higher and lower sizes. The maximum retention occurs for 1μm particles whereas 0.25μm particles lend themselves lest to retention. The percentage of retention again increases with ultra fine particles, whose deposition is governed more by Brownian motion than gravitational settling, but tissue damage caused by very fine particles is neglible, probably because of the face that very particles are too quickly dissolved to reduce any toxic effect. In particle, all dust below 5μm size is usually considered to be dangerous.
3. Concentration: Concentration of dust can be expressed as (a) mass of dust per unit volume of air, (b) number of particles per unit volume and (c) surface area of particles per unit volume. Mass concentration was the earliest-adopted indicator of dust hazard when sugar tube method of dust sampling was prevalent in South Africa. But the total mass of a dust cloud could give a very wrong estimate of its harmfulness since only a few large particles can completely out-weigh the effect of a large number of particles of respirable size. Today therefore mass concentration, of course, in the respirable size range, has been reestablished as a danger criterion mainly based on its correlation with the incidence of pneumoconiosis established from recent studies in several European countries.
4. Time of Exposure : Experiments on animals show that larger lung dosages of dust produce faster development of silicosis and the same holds true for men also. While with exposure to large dust concentrations, it takes only a year or few years for the development of nodular fibrosis, the period of exposure required for the development of silicosis progressively increases with decreasing concentration. It is thus obvious that the time of exposure to a certain dust concentration is an important factor in the development of pneumoconiosis and it is logical to correlate the incidence of pneumoconiosis with the cumulative dust exposure, which can be easily calculated from the length of employment of the worker if the average shift concentration of dust to which the worker is subjected is known.

Describe sampling of dust by gravimeter dust sampler & other methods.

Gravimetric dust samplers : These are of two main types. Those using a gravitational settling type of elutriator and those using cyclones for elutriation. The MRE dust sampler and the SFI dragger sampler belong to the former type while the SIMPEDS (safety in mines personal dust sampler) and SIMQUADS (safety in mines quarry dust sampler) in U.K, BAT-I in Germany and the American gravimetric dust samplers, belong to the latter type. While the former are relatively bulky and serve as good long duration fixed point dust samplers, the latter are usually light and can be mounted on a miner's safety helmet or clipped to his coat lapel so as to be near his breathing point. That is why they are generally chosen for personal dust samplers.

The British gravimetric dust samplers with both gravitational settling and cyclone type of elutriators are claimed to give a dust separation curve closely matching the one recommended by the Johannesburg Conference. The SFI dragger sampler gives a curve which differs only slightly from the above. But the BAT-I sampler as also the American samplers give a difference separation curve as indicated by curve. However this curve is closer to the alveolar dust retention curve.

Other method of sampling can be classified as follows – (1) filtration, (2) sedimentation, (3) Inertial precipitation, (4) thermal precipitation, (5) electrical precipitation and (6) optical methods based on light scattering.
Filtration : Filtration method was primarily used to collect large samples of the order of 50mg or more for chemico-mineralogical analysis. Mass concentration could be determined by differential weighing of the filter before and after collection of the sample, but this concentration was of little value since it covered the entire particle size range, inclusive of all that particles above the respirable size range.
Sedimentation : In this method, a certain volume of air is caught in a vertical cylinder and the dust in it is allowed to settle by gravity on to a glass slide placed at the bottom of the cylinder. The slides are then examined under the microscope for determining particle concentration and size. For accurate results, it is essential to control the temperature of the cylinder in order to avoid convectional air movement inside the cylinder.
Inertial precipitation : Dust sampling instruments using inertial precipitation are base on three principles : impaction, impingement and centrifuging. Konimeter is the most widely used instrument utilizing impaction.
Thermal precipitation : This method utilizes the principle that when a body surrounded by dusty air is heated, a dust free zone is produced around the hot body, the extent of the dust-free zone depending on the temperature gradient between the hot body and the surrounding air.
Electrical precipitation : The electrical precipitation essentially consists of a charging wire maintained at a high negative potential of about 12000 volts and surrounded by an earthed concentric cylinder. Dust-laden air is drawn through the cylinder by a fan at a constant rate.
Optical method : This method utilizes the property of scattering of light by a suspension of fine particles.

Pneumoconiosis : Dust in mines and other dusty places of work in factories causes diseases of the lungs which are grouped under the general term pneumoconiosis. The term is applied to all conditions in the lungs resulting from the inhalation of dust over long periods, but in recent years, distinct terms are being used to denote the diseases caused by specified dusts, silicosis, siderosis, berylliosis, asbestosis, etc. dusts from lime stone, shale and some metallic ores are not harmful. Although it is generally agreed that anthracite and bituminous dusts do not produced lung disease, they do cause asthmatic conditions when breathed over a long period.
Causes : From a pathological point of view, pneumoconiosis can be divided into two groups : (a) collagenous and (b) noncollagenous. Noncollagenous pneumoconiosis is caused by nonfibrogenic dusts and is characterized by (i) alveolar architecture remaining in tact, (ii) minimal stromal reaction consisting mainly of reticulin fibres and (iii) reversibility of dust reaction. Collagenous pneumokonisis is characterized by (i) permanent alteration or destruction of alveolar architecture, (ii0 collagenous stromal reaction of moderate to maximal degree and (iii) permanent searing of lungs. It may be caused by fibrogenic dusts or altered tissue response to non-fibrogenic dusts.

Silicosis : This is the most disabling and worst of all the dust diseases. It results in fibrous tissues of the lungs and may ultimately lead to tuberculosis. Workers engaged on stone drifting, tunneling, rock drilling, and stone crushing are more prone to silicosis
Causes : Silicosis is caused by fibrogenic dusts massive fibrosis is an altered tissue response to a relatively nonfibrogenic dust.
Prevention : Experiments have been carried out in Germany for preventing dangerous silica dust from reaching the alveoli of the lung by artificially increasing their size. This is done by releasing a large quantity of fine aerosol of sodium chloride into the dusty air.

Asbestosis : Asbestosis is a kind of pneumoconisis which results from the inhalation of hydrated magnesium silicate. An important feature of this disease is the presence of abesots bodies in the lung and aputum. Fibrosis of the lungs develops faster in asbestosis than in silicosis and in extreme cases a person may die of asbestosis within five years of the onset of symptoms.
Causes : Asbestosis is caused by fibrogenic dusts massive fibrosis is an altered tissue response to a relatively nonfibrogenic dust.

Nystagmus : This is peculiarly an underground miner's disease. The term nystagmus is applied to a disease in which the muscles and nerves of the eyes are affected and there is an abnormal movement or oscillation of the eyeballs. This disease is caused by working over a number of years in places of insufficient light. Where naked lights are used, as in metal mines, the incidence of nystagmus among miners is low. Electric cap lamps have also broughtr down the incidence of nystagmus in coal and metal mines. Before the introduction of electric cap lamps in coal and metal mines. Before the introduction of electric cap lamps in coal mines, the older type of flame safety lamp with less than 0.6 candle power had resulted in nystagmus among a large number of coal mines. It is stated that a miner suffering from nystagmus cannot see the gas cap in a flame safety lamp. The supervisory staff in coal mines are therefore required to undergo periodical eye testing once in 5 years.

Ankylostomiasis : Ankylostomiasis or miner's anaemia is practically the same disease as hookworm disease and is caused by a thread like blood sucking worm which enters the body through the skin. Miners working in unsanitary condition and cutting coal, standing in dirty water with bare feet over long hours, may be affected by this disease. The symptoms are pain in stomach, loss of apetite, constipation, followed by diarrhea and dysentery. A person seriously affected looks anaemic, positive knowledge is obtained by examining the stools for hookworm eggs.

8.0 Noise & Vibration .
8.1 Describe sources of noise & vibration effects & its control.

Sources of noise : The major sources of noise at mines can be classified a mechanical, electrical and fluidic installation, mechanical noise is created by vibrations, friction or impact. Electrical noise is created by the alternating frequency of the power supply. Fluidic noise is corrected by the turbulent eddies in a fluid stream.

Such noise may be greatly magnified by vibration of attached structure.

Vibration effect :

1. The low frequency vibrations are produced in industrial vehicle like trucks, tractor, dumper coal cutting machine etc. It has not too much harmful effect.
2. The high frequency vibration produces harmful effects, both local & general. The local effects are produced at frequency below 40 Hz and with amplitude of several magnitude as in operating heavy pneumatic drift.

Control :

1. Control of noise at sources : The design of components should be considered with respect to noise.
2. Selection of machine : Noise should be considered at design state and prepare on such manner that it produces less noise.
3. Separation of noise & receivers : Noise level deccey with increasing distance.
4. Insulation : Noise sources may be insulated by barriers between increasing distance.
5. Absorption : Noise absorption can be achieved by the use of light material of plans.
6. Isolation : Noise sources may be isolated from their mainting such as rubber and spring. To minimize the impact of noise from heavy moving machinery

(a) The exhaust of all earth moving plant should be fitted with silence suitable for use in residential areas.
(b) Acoustic panels should fitted mean the dump trucks when ever possible.
(c) Muff lens should be fitted the drill wings before they put in operation.

Heavy duty while plant by ventue of their high horse power are capable is generating high noise level.

10.0 Mine environment (Introduction only)

10.1 Afforestation : Biological reclamation follows technical reclamation pits of 20-30cm. depth are excavated and filled with moisture of soil and fertilizer. Sampling are then planned preferably at the common cement of monsoon.

The Indian Experiences shows that the top soil if stored beyond one year, losses its nutrients it could be profitably mixed with rocks and platinum could then the raised on this mixed soil.

On the spoil slopes gases or quick growing herbaceous species should be shown. This would help rapid binding and consolidation of soil on slopes. This will also provide protection against erosion by reducing rain off and rain drop slash.

10.3 Top soil Management : Every holder of a PL/ML shall where ever top soil exist and is to be excavated, for prospecting / mining operations, stop it in a separate plane. The top soil so stored shall be utilized subsequently for the restoration or re-habitation of the land which is no longer required for prospecting mining operation.

10.4 Air and water Management : Sources of process waters and potable water should be ascertained. The problem of efficient and sewage disposed should be careful studied, special with regard to the re-cycling of the process water.

Water from mines which might large quantities of salts should not be allowed to enter the local water courses from where water might be taken for irrigation and for live stock.

10.6 Reclamation & Re-habitation : Every holder of a PL/ML shall under take to phased restoration, reclamation and re-habitation and shall complete this work before the conclusion of such operation and the abandonment of the prospect mine.

PL – prospecting license.
ML – Mining lease.

10.7 Water Dam Management : Considering for the site of selection are :

- Site under lain by maximum available thickness of unsaturated material should be selected.
- A site under lain with lowest permeability should be chosen and it should not be under lain by shallow unconfined a quifens.
- Sites adjacent to streams, where the contaminate seepage or lea chute and ground water may discharge into them must not be selected.
- If such locations are not available the design should provide for minimum seepage.

Tailing dam for land water disposal should be constructed to their final height before milling commences and all down stream slopes of the dams should be vegetated as quickly as possible.

11.0 Rescue Apparatus :

Proto-IV : The apparatus is designed for a 2 hours use. Breathing is through the mouth and the nasal passages are closed by a special nose clip. After donning the apparatus the wearer has to take a few breaths of pure oxygen and flash out the nitrogen from his respiratory system. In actual use the exhaled air passes over the protosorb which removes the CO_2. on inhalation the regenerated air passes round the special cooling chamber, inhalation valve and inhalation tube to the lungs. On exhalation the air passes through the exhalation tube and exhalation valve to the breathing bag for further regeneration.

The apparatus is so designed that when worn, the oxygen cylinder remains on the back and the breathing bag and cooling unit on the front of the wearer. Weight of the apparatus when fully charged is 15.6 kg.

Wearer of Proto apparatus Mark IV cannot speak and the communication among brigade members is by pre-decided audible signals of horns.

It consists of the following :

(a) A light alloy cylinder of 2 liter (empty) capacity, containing 300 liter of oxygen compressed to 150kg/cm^2. It is fitted with main valve, a pressure gauge valve, a by-pass valve, a reducing valve. The main valve is the cylinder closing/opening valve which is kept open by a locking device when the apparatus is in use. The reducing valve reduces the pressure of oxygen supplied to the wearer and ensures 2 liter of oxygen per minute. The by-pass valve is manually operated by the wearer if the reducing valve fails or when the wearer needs more oxygen than that supplied by the reducing valve. The pressure gauge valve admits high pressure oxygen to the pressure gauge.

(b) Breathing bag made of vulcanized rubber and divided into two compartments by a partition except at the bottom end. The bag contains 2 kg of CO_2 absorbent known as protosorb. It is a mixture of calcium hydroxide and caustic soda and it keeps the percentage of CO_2 in the breathing circuit below 2%. The wearer breaths from and into the bag which serves as an air reservoir.

(c) A cooling chamber of copper containing sodium phosphate which is in crystal form at ordinary temperature but liquefies at 35° C absorbing much heat in the process.

(d) Inhalation valve, exhalation valve and relief valve. The relief valve allows the escape of any oxygen in excess of the wearer's requirement.
(e) Nose clip, mouthpiece, inhalation and exhalation tubes. Weight of sodium phosphate is 170 g.

Proto-V : This apparatus is an improvement over Mark IV. It is available as a 1 hour or 2 hours apparatus. In 1 hour apparatus the coolant is $CaCl_2$ but in 2 hours apparatus it is soda phosphate as in Mark IV. Weight of 1 hour apparatus is 14.5 kg and that of 2 hours apparatus is 17.2 kg. Oxygen flow rate in 2 hours apparatus is 2.0 leter/min. and in 1 hour apparatus 2.5 liter/min.

2 hours Mark V apparatus is fitted with a warning signal to indicate approaching cylinder exhaustion, and it can be supplied with a wide vision face piece and a speaking diaphragm. The by-pass valve is of push button type instead of the hand-wheel type of Mark IV. Excepting the differences stated above between the Mark IV and Mark V apparatus the specifications of Mark V are the same as those of Mark IV. Latest apparatus in the market is Mark IV model 80 which is practically like Mark IV, the spare parts of both being interchangeable.

Drager BG-174 : Like the Proto apparatus the Drager apparatus is also compressed oxygen type, with closed circuit for the inhaled and exhaled air, rendering the wearer self dependent in an atmosphere of toxic and poisonous gases, whatever their percentages.

This apparatus completely automatic and the breathing air is controlled by the respiratory valves.

The exhaled air is regenerated by absorption of CO_2 as it passes over an air cooled regenerating alkali cartridge.

The main specifications of Drager Model BG-174 are :

Safe working period	4 hours hard work.
Cylinder capacity, empty	two liter.
Cylinder capacity with O_2 at 200 kg/cm^2	400 liters.
Breathing big capacity, approx.	6 liters.
Weight of apparatus, fully charged	12.8 kg.
Oxygen flow rate	1.5 liter/ min.
Oxygen feed by lung governed valve	as required by wearer.

<u>The special features of the Drager BG-174 are :</u>

1. When the cylinder valve is opened the breathing bag is automatically flushed with an inrush of 7 liter of oxygen. Thus it is not necessary to evacuate any nitrogen from the apparatus by breathing from it.
2. A warning whistle is fitted in the inhalation passage below the inhalation valve. It is controlled by the pressure in the oxygen line which leads from the pressure reducer to the lung demand valve. It gives a warning if the apparatus is used with the cylinder valve closed or if the cylinder is empty.

3. In addition to the lung demand valve which operates automatically in case of higher oxygen demand. There is a manually operated by-pass valve for by-passing the pressure reducer and admit more oxygen to the circuit.
4. A rechargeable soda-lime cartridge can be used for training purposes.
5. The pressure reducer reduces the oxygen pressure to a tolerable working pressure 4 kg/cm^2.
6. The breathing bag is protected on all sides.
7. A face mask for wide vision can be used instead of the gas mask tight protective goggles with triplex safety glasses.
8. Any excess pressure arising in the circuit in case f low oxygen consumption is eliminated through the automatic relief valve.

Self Rescuer : A self rescuer is essentially a gas mask in a simplified form without the corrugated hose tubing and the mouthpiece is attached directly to the canister. Its weight is low, nearly 1 kg. the chemicals are the same as those used in the gas mask and the wearer is protected against CO if it does not exceed 2% by volume in the air to be inhaled, if the oxygen is sufficient to support life and if the air does not contain other toxic gases and vapour. The self rescuer does not supply oxygen but functions to convert carbon monoxide, a highly toxic gas, into carbon dioxide, a non toxic gas. The main purpose of self rescuer is to enable the wearer to escape through an atmosphere resulting after a fire of after an explosion in a mine.

A self rescuer should be used immediately at the first sign of fire or explosion, even if no smoke is visible. Waiting until smoke is visible may prove fatal because the area could be filled with a poisonous concentration of odorless, colorless CO in advance of the smoke. The miner should therefore don the self rescuer immediately on seeing any one of the following signs : clouds of smoke, smell of combustion gases, headache and giddiness, unexpected dust eddies, sudden pressure surge. Any of these signs may be indicative of fire or an explosion.

Smoke helmet : This apparatus require the wearer to depend upon other man for supply of fresh air when the wearer himself is working in an irrespirable atmosphere. The smoke helmet is a helmet made of tough polathene having mica eye pieces fitted in aluminum frame. It is provided with canvas strapping to cover the shoulder. The helmet totally covers the face and head of the wearer and is provided with a flexible hose pipe of 25 mm bore, 30 m long. The wearer receives supply of fresh air through the hose pipe from a hand-driven bellow in fresh air operated by a second person. The bellow is operated sufficiently fast to supply requirement of air of the wearer. The exhaled air passes from the helmet via the loose joints of canvas strapping's around the shoulders of the wearer.

Gas mask : In gas masks, self rescuers and some other rescue apparatus the chemical hopcalite consisting of a mixture of manganese dioxide and copper oxide, is used as a catalyst which changes CO to CO_2. The conversion is an exothermic action by generation or heat.

This is an apparatus used by the wearer to protect him from poisonous atmosphere containing mainly CO and also other toxic gases in small percentages. It is essential that the atmosphere should contain sufficient oxygen to support life and should not contain more than 2% of CO. If an atmosphere contains more than this percentage of CO, it is likely that it will not contain sufficient oxygen to support life or combustion of a flame safety lamp. It should also be remembered that when the CO percentage is nearly approaching 2, it is an indication that the fire is in an advanced stage, making the place unbearably hot for workers to enter or work. A person wearing gas mask is not dependent on others for respiration or air supply.

A gas mask consists of :

A metal canister containing layers of the following filters and granular absorbents.

(i) Anhydrous calcium chloride as a drier to remove water vapour. This is usually the top-most layer.

(ii) Hopcalite- it acts as a catalyst which changes CO to CO_2. It also absorbs organic vapours.

(iii) Cotton wool to remove dust and smoke.

(iv) Silica gel to remove ammonia and water vapour.

(v) Causite to remove sulphuretted hydrogen.

(vi) Impregnated activated charcoal to remove organic vapours and the acidic gases. This is the bottom most layer.

A face piece fitted with eyepieces and an exhalation valve and connected to the canister by a corrugated hose pipe. Wide vision face mask is also available in place of the face piece with twin eyepieces.

Firedamp : A mixture of methane and air. It may be explosive depending on the composition (5.4-14.8% methane in air). Though methane is not toxic, its presence reduces the oxygen percentage of air. Normal human being can survive in 15% oxygen, in an atmosphere containing 28% methane. Any further increase in methane content will mean danger to life.

Blackdamp : A mixture of extinctive gases, namely excessive nitrogen and carbon dioxide. Chokedamp is another name for blackdamp. Like firedamp, the ill effect on health by blackdamp is mainly caused due to lack of oxygen.

Afterdamp : A mixture of gases left after an explosion of firedamp or coal-dust. Carbon monoxide is the most toxic element in afterdamp and the death toll occurs mainly due to the presence of carbon monoxide in the event of mine explosion.

Whitedamp : Amixture of carbon monoxide and air where the source of carbon monoxide os other than explosion such as strata emission, diesel engine exhaust etc.

Stinkdamp : A mixture of air and hydrogen sulphide which is more poisonous than even carbon monoxide.

Maintenance of safety lamp : Routine maintenance work for safety lamp consists of :

1. Cleaning of the various components.
2. Proper assembling of lamp.
3. Checking air-tightness of the lamp glass fitting. The flame should not flicker while blowing air directly by mouth or by a tube on the outer glass packing.
4. Checking of the gauze. If it is found damaged, i.e. broken or burnt away, it should be destroyed so that it cannot be reused.
5. cleaning the gauze off black soot. It is of primary importance because if there is soot deposition on the gauze, its heat dissipation capacity reduces. Thus there is a chance of the gauze getting red-hot and impairing the safety of the lamp.
6. Checking the wick adjuster. It should work freely.

Velox GL-50 Flame Safety Lamp :

1. Lower Section : This comprises a fuel vessel fitted with a burner, a round wire wick passing through the burner, side oil filling arrangement and a screw spindle flame adjustment device. The oil vessel has ratchet at the top and provision for magnetic locking.
2. Middle Section : This consist of a composite lower flange, which is screwed on the fuel vessel and a composite middle ring assembled with five steel rods to the provide bonet and chimney at top. The steel rods connecting the lower flange and the middle ring also protect the glass. Separate air inlet and outlet ports are provided to avoid mixing of fresh inlet air with gases of combustion. This improves air circulation and results in sharp reactions of methane gas with the flame. There is only one cylindrical thick toughened glass which forms part of the middle section. During assembly the glass which forms part of the middle section. During assembly the glass to provided with asbestos gaskets at the lower end, and also at the upper end below the outer wire gauze. The asbestos gaskets make the glass assembly air tight at the top and at the bottom and should never be omitted during assembly.
3. The Upper Section : This consists of a bonnet and chimney with hood provision of top feed device, ie. For enabling mine air near roof to enter the lamp from the top. It also has two wire gauzes, each of 20 mesh. The bonnet protects the wire gauzes and is provided with a handle for holding the lamp. The hot gases of the flame rise by convection to the top of the gauzes and through them and the outlet holes of the bonnet, to the atmosphere.

While washing in coal mines : The roof and sides of the following places below ground in a coal mine shall be kept affective white washed.

(a) Every shaft inset and shaft bottom or siding and every by pass which is in regular use.
(b) The top & bottom of every haulage plane, every regular stopping place, siding, loading by pass and junction except with in 100 mt of theface.
(c) Every traveling roadway.
(d) Every room and place containing only engine, motor or other apparatus.
(e) Every first aid station below ground.

Standard of lighting according to DGMS circular .

1964 circular DGMS	cm / sq ft.
Pit bottom	1.5-3.0
Main junction	1.25
Roadway	0.4
Haulage engine and control gear room	1.5
Depillaring Zone (deg-1)	1.5 at floor level.

CO / O_2 ratio :

1. When air passes through in underground district it becomes ventilated oxygen is absorbed a carbon monoxide is released and in coal seam, carbon monoxide are produced.
2. The production of oxides of carbon relatively to oxygen absorbation is increases with the rise of temperature.

3. Thus regular and systematic analysis of return airways shows indication of spontaneous heating or fire in the district. This is called CO / O_2 deficiency ratio.

CO_2 / O_2 ratio :

1. When a fire becomes active, the CO produced may be consumed by the normal process of combustion under such condition CO_2 / O_2 deficiency ratio become useful guides of the magnitude of the fire.
2. But ratio is less liable than CO / O_2 deficiency rate in the initial stage of heating because oxidation of coal and pyrites produced some CO_2.

Occupational diseases :

A worker working in mines may have to face some occupational health hazards mainly due to environmental and working conditions. The main diseases are :

1. Nystagmus.
2. Ankylostomiasis.
3. Pneumoconiosis.
4. Silicosis.
5. Asbestosis.
6. Siderosis.

Difference between GL-50 and GL-60 safety lamp.

GL-50 Safety Lamp	GL-60 Safety Lamp
1. Petrol is used as fuel. 2. GL-50 is used on only Deg-I and Deg-II gassy mine. 3. Weight of GL-50 safety lamp is 1.6 kg with fuel. 4. It has one bottom feed device. 5. It has re-lighted manually. 6. It is used for accumulation test of methane gas. 7. Time is more. 8. Automatic flame extinguisher is not arranging on GL-50.	1. Colorless K oil is used as fuel. 2. It is used in all degrees of gassiness in coal mine. 3. Weight of GL-60 lamp is 1.7 kg with fuel. 4. It has an additional bottom feed device. 5. It has self re-lighted mechanism. 6. It is used for percentage test of methane gas. 7. Time consume as less. 8. Automatic flame extinguisher is to be providing which check the problem due to the failure magnetic locking.

Why carbon monoxide (CO) gas is poisonous gas in mines.

The CO enters in to the body, the body in fully the bloods pigments are carry of hemoglobin. The commixed to the hemoglobin carboxy hemoglobin formed. The blood colour change in red to pink. Also oxygen reduced effect of brain tissue are quickly damaged or person at dead. Thus the reason of above CO gas is the poisonous gas – Oxy-hemoglobin (HbO_2).