CHAPTER II

ACCIDENTS : CAUSES, CONSEQUENCES & PREVENTION

2.1 INTRODUCTION :

The main objective of safety is to create among coal miners consciousness of possibility of injury to their person through accidents. In this chapter attention is focussed on the definition of accident, causes of accidents, consequences of accidents and prevention of accidents. These have been discussed in the following four sections in that order.

SECTION I

DEFINITION OF ACCIDENT

2.2 DEFINITION OF ACCIDENT :

According to regulation number (9) of Coal Mines Regulations (1957) framed under the Mines Act, (Act No. 35 of 1952), an accident is defined as "Any incident or event which occurs in or about a mine -

(i) And causes loss of life or serious bodily injury in connection with mining operations; or
(ii) An explosion or ignition; or
(iii) A spontaneous heating or out-break of fire, appearance of smoke or other indication of heating or out-break of fire; or
(iv) An influx of noxious gases; or
(v) An occurrence of inflammable gas in mine to which Regulation 44 does not apply; or
(vi) An irruption of water; or
(vii) An instantaneous failure of a pillar, part of a pillar or several pillars of coal (i.e. a "bump") in working below ground; or
(viii) A premature collapse of any part of the working; or
(ix) Any accident due to explosives; or
(x) A breakage or fracture of rope, chain, headgear, pulley or axle or bearing thereof, or other gear by which persons are lowered or raised; or
(xi) An over-winding of cages or other means of conveyance while men are being lowered or raised; or
(xii) A breakage or fracture of any essential part of winding engine, crankshaft, coupling, bearing, gearing, clutch drum, or drum shaft, or failure of emergency brake; or
(xiii) A bursting of any equipment containing steam, compressed air or other substance at high pressure; or
(xiv) A breakage, fracture or failure of any essential part of any machine or apparatus whereby the safety of persons may be endangered.

As per regulation 9, entitled "Notice of Accidents" the owner, agent or manager of a mine where such an accident occurs, is required by law to give notice thereof in Form IV-A to the District Magistrate, The Chief Inspector and the Regional Inspector of Mines, and in the case of accidents specified in subclause (i) of Regulation 9, also to the Coal Mines Labour Welfare Commissioner.
SECTION II

CAUSES OF ACCIDENTS

2.3 HAZARDS IN COAL MINING:

Unlike in a factory where the plant remains fixed where it is installed and the operative factors are known and constant (and therefore suitable for close study), in a mine fresh ground is exposed every moment, with the result that working conditions change very often and unexpectedly. The working area in a mine changes from one day to another and, in many cases even from one hour to another. Thus the working face in a mine on any day just may not have been in existence in the previous week or even on the previous day; and the newly exposed ground presents a multitude of new problems, including those of strata control, lighting, ventilation etc., further, all rocks and strata "weather" out when exposed to air. In addition, the strata in a mine are subject to natural pressures-tensions and compression which are subject to perpetual changes due to the constantly changing picture of the mine, and which - by their very nature - are not amenable to close study. Further, as mining operations consist mainly of tunneling or other mode of extraction of coal they entail the danger of collapse of roof and sides. Besides the other factors contributing to occurrence of accidents in mines are also in a state of flux. All this makes mining one of the most hazardous industries. Accident rates in coal mines "ALL OVER THE WORLD" are 3 to 8 times more than in factories.
2.4 CLASSIFICATION OF ACCIDENTS:

Accidents may be classified by place of work, by the cause of accident or by responsibility for accidents or by the agency causing accident. As a result of amendment to Rule 76 of the Mines Rules, 1955 the minor accidents are to be classified as per new classification codes (See Appendices 2-1, 2-2 and 2-3). This code of classification of accidents has been adopted by the Directorate General of Mines Safety (DGMS) since 1.1.1971, for serious and fatal accidents as well. The place of accident and cause of accident are reported in Form IV-A as items 2 and 3 respectively and the responsibility for accident is reported in Form IV-B as item 9. The agency causing the accident is to be inferred by shifting data present in Form IV.

2.5 INFLUENCE OF PLACE OF WORKING ON DEATH AND SERIOUS INJURY RATES:

The hazards of mining vary with the place of work. The hazards are lowest above ground and highest below ground. The hazards increase as one goes deeper and deeper in the mine for working. Also the hazards are less in open cast mining and more in underground mining. Consequently death and serious injury rates are highest below ground and lowest above ground. This may be seen from data presented in Table 2-1 (A) and (B).

2.6 CAUSES OF ACCIDENTS:

Causewise the accidents which are responsible for death and serious injuries are broadly categorised by D.G.M.S. (1971) as follows:
1. Ground Movement :
   (a) Fall of roof, (b) Fall of side, (c) other ground movement.

2. Transport Machinery :
   (a) Winding in shaft, (b) Rope haulage, (c) Other transportation machinery.

3. Machinery other than transportation machinery.

4. Explosives.

5. Electricity.

6. Gas, dust and other combustible material.

7. Fall other than fall of ground :
   (a) Fall of person, (b) Fall of object, (c) Other falls.

8. Other causes :
   (a) Irruption of water, (b) Flying pieces, (c) Extremity caught in between objects, (d) Miscellaneous (including unclassified).

The relative importance of these factors based on data for the period 1971-85 has been brought out through a pie diagram presented as figure 2-1.

From the diagram it may be seen that the most important causes are ground movement (51.12%), transportation machinery (27.09%), and falls other than fall of ground (7.91%) and together they accounted for 86.12% of all mine accidents during the period 1971-85.

2.7 RESPONSIBILITY FOR ACCIDENTS :

Responsibility for mine accidents are broadly classified by the D.G.M.S. (1971) as follows :

1. Misadventure
2. Management
3. Management and others
4. Subordinate supervisory staff
5. Deceased
6. Co-worker
7. Other multiple reasons.

The relevant data have been presented in Table 2-2 (A) and (B). The data presented in Table 2-2 (A) and 2-2 (B) show the relative share of the above seven sources for responsibility for all fatal accidents (Table 2-2 (A)) and for fall of roof accidents (Table 2-2 (B)). This type of data is extremely valuable for initiating preventive measures, and emphasizes the need for safety consciousness among management personnel and subordinate supervisory staff and the mine workers.

2.8 MATERIAL AND PERSONAL CAUSES OF ACCIDENTS:

According to Dr. H.P. Sarkar the causes of accidents may be broadly classified under the following two heads viz. (1) Material and (2) Personal.

1. Material Causes:

(i) Natural conditions: Artificial lighting, extremely limited space underground, high temperature.

(ii) Geological conditions: Accident frequency is higher when seam thickness increases from zero to sixty inches. Risks of roof fall are higher in thick seams. Inflammability of coal, gassy nature of seams also increase the risk of accident.

(iii) Machines: Manufacturing defects and bad design of machines.
(iv) Equipments: Lack of proper signaling, absence of proper means of communication, lack of protective equipments e.g. safety hat, boot, gloves, knee pads, goggles, gas mask, face shield etc.,

(v) Organization: Lack of proper organization and supervision is conducive to accidents. Bad planning creates disorder and lack of discipline results in increased accident risk.

2. Personal Causes:
They include ignorance, negligence, worry, fatigue, habits and customs. Some of the general characteristics associated with revealed accident rates are:

1. Youthful age
2. Lack of training and experience
3. Inferior personal social adjustment
4. Certain attitudes and values
5. Skill changes in elderly workers.

(a) Physical factors: Like bad health, illness, poor eyesight and defective hearing. Lack of rest and fatigue. Accident risk increases in overtime work.

(b) Intellectual factor: There is a rise in accident rate in first five years of service and later with greater experience the risk decreases. Dull persons are more prone to accidents.

(c) Psychological factors: Character, temperature and psychological reaction influences accidents. Thoughtlessness, carelessness, recklessness and bravado generally found in young men are liable to cause accidents. Financial worries, family difficulties and mal-adjustment in
married life also increase accident rate.
Cleveland's study shows that percentage distribution of personal causes of accidents are as shown in Table 2-3.
However, it would be incorrect to conclude that all accidents resulting from subjective factors originate due to the fault of workers. Experience suggests that only about 70% of all accidents are the result of carelessness on the part of the victim or his fellow workmen. This type of analysis of causes of accidents helps to stress the importance of the human factor and the need to develop safety consciousness among workmen and management personnel to bring down the rate of accidents. However, in this study the classification of D.G.M.S. (1971) as presented in Appendix-2-2 would be used to assess the effectiveness of the safety program in coal mines initiated after the nationalisation of the coal industry in 1973.

2.9 SOURCES OF DATA :
On the basis of returns received in Form IV A and B as per Regulation 9 of Coal Mines Regulations (1957) as amended from time to time, the Directorate General of Mine Safety (DGMS) complies and publishes annually statistics of accident occurring in mines i.e. coal mines, metalliferous mines and other mines. Data on accidents in coal mines are also published by CIL in its annual reports and by the Department of Coal of the Ministry of Energy (Formerly Ministry of Steel Mines and Coal) of Government of India in its annual reports.
2.10 INTERNATIONAL COMPARISONS

Data are available regarding death rates per 1000 persons employed in coal mines for important coal producing Countries. The relevant data for the pre-nationalisation period (1951-72) are presented in Table 2-4.

From the data presented in Table 2-4 it appears that the death rate per thousand persons employed in coal mines is consistently low in Holland, UK, France and India and is fluctuating in the case of Australia, Canada, USA, W. Germany etc. It may further be noted that while the death rate per 300,000 man-shifts worked is low in the case of India, the death rate per million tonnes of coal raised in India appears to be the second highest in the world next only to Japan (See Tables 2-5 and 2-6).

This is explained by the fact that labour productivity is quite low in India as compared to labour productivity in other coal producing countries of the world. This may be seen from the data on the output per man-shifts (OMS) for the period 1971-84, of eight countries viz. India, Belgium, Czechoslovakia, France, United Kingdom, USA, and West Germany plotted in Figure 2-2.

SECTION III

CONSEQUENCES OF ACCIDENTS

The Robens Committee on Safety and Health in coal mines of UK has specified in its report the following elements of cost of accidents in coal mines as enumerated by the Department of Trade and Industry in UK.
(A) Cost to the Employer:

1. Sickness or other payments made either under the employment contract or ex-gratia or both, immediately and in respect of subsequent absence wholly or partially attributable to the accident.

2. Compensation paid under legal liability or ex-gratia to the man or his dependents.

3. Expense of investigating the accident and in some cases, preparing and defending a case.

4. The cost of recruitment, training and development and of replacement for the injured man and any loss of efficiency of production resulting from the employment of a relatively unskilled or inexperienced man.

5. Loss or damage to plant or investment caused by the accident.

6. Actual loss of net revenue as a result of the accident, including in some cases loss under contracts, and even of markets.

7. The extra cost of remedial measures to insure against further accidents.

8. Cost incurred or losses sustained as a result of lower morale or of friction with work-force.

(B) Cost to the State:

1. The amount of any benefit paid under the industrial injuries scheme and of any subsequent sickness benefit attributable in whole or in part to the accident.

2. The amount of any supplementary benefit payable to the man or his dependents.
3. The cost of making such payments.

4. The cost to the public services of investigating the accident, trying any legal issues and enforcing judgment.

5. The cost of hospital or other medical treatment including rehabilitation and retraining.

6. The amount of any refund of tax actually made to the victim plus the loss of future taxable capacity.

7. Loss of tax due to the reduced profitability of the employing undertaking.

(C) Cost to the Community at Large:

1. The cost of investigating the accident and of the prosecution of any claim for damages in so far as they are not borne by the State or the employer.

2. The net loss, temporary or permanent, of the goods or services provided by the injured person or by the others whose services are required to look after him.

3. Costs falling on the injured man himself, friends, dependents, insurance companies and benevolent or other funds.

Mr. A. B. Ghosh in his book "Coal Industry In India" has also discussed some of the social and economic consequences of accidents. These have been listed in Table 2-7. In this Mr. Ghosh has given due weightage to the social and economic consequences of the accident for the family of the victim of the accident whether deceased or injured either temporarily or permanently. It is necessary to dwell on this point because the Robens Committee report does not cover this aspect of the socio-economic consequences of an accident.
SECTION IV

ACCIDENT PREVENTION

NEED FOR PREVENTION OF ACCIDENTS:

So far the socio-economic consequences of accidents for the employer, the state and the society (community) have been considered. Yet it is the human consequences of accidents that in the final analysis, are most important and real and every effort should be made and no cost be spared in the task of preventing such consequences. The humanitarian aspect of accident prevention has been picturesquely described by P. B. Jhunke in the following words: "The need is that the workman shall live to enjoy the fruit of his labour; that his mother shall have the comfort of his arm in her old age; that his wife shall not be an untimely widow; that his children shall have a father and that cripples and helpless wrecks, who were once strong men, shall no longer be a bye-product of Industry". The suffering and distress of the dependents of the deceased victim and the victim himself when he becomes disabled through injury, accident or disease, are incalculable and this too needs to be prevented.

2.13 ANATOMY OF AN ACCIDENT:

The first step in the prevention of accident is to understand the anatomy of an accident and analyse the causes of accidents with a view to eliminate the occurrence of accidents. The basic theory of accident occurrence may be stated briefly as follows:

Accidents occur because of:
1). Personal factor of the injured or deceased worker;
2). Hazard or unsafe conditional factor;
3). Unsafe actional factor; and
4). Proximate casual factor or immediate causative factor such as
the sticking of a governor, failure of a break, or roof fall just
over a person in mine, which by its reaction may cause a sudden
convergence of two or more of the four factors to cause a fatal
or injury accident.

This theory of accident was advanced by Heinrich and has been
subsequently amplified by Hepburn who has recommended that
remedial measures be considered and adopted as necessary for each
of the four factors if a successful campaign against occurrence
of accidents is to be conducted. However the solutions discussed
by Hepburn under the four factors coincide with the most
practicable preventive measure suggested by Heinrich. These are
planning and organising to (a) prevent unsafe actions being
committed and (b) remove unsafe mechanical and physical
conditions.

2.14 PREVENTING COMMITMENT OF UNSAFE ACTIONS :

For the purpose of preventing commitment of unsafe actions they
may be classified under the following heads :

i) Operating without authority, failure to secure or warn;

ii) Operating or working at unsafe speed;

iii) Making safety devices in-operative;

iv) Using unsafe equipment, hands instead of equipment or
equipment unsafely;

v) Unsafe loading, placing, mixing, combining etc.;
vi) Taking unsafe position or posture;
vii) Working or moving on dangerous equipment;
viii) Distracting, teasing, abusing, startling etc., and
ix) Failure to use safety attire or personal protective devices.
For remedial measures all that is needed is issue of proper
instruction and its follow up.

2.15 REMOVING UNSAFE PHYSICAL OR MECHANICAL CONDITIONS

The unsafe mechanical/physical conditions are classified under the following heads:
a) Inadequately guarded machinery/moving parts;
b) Unguarded machinery/moving parts;
c) Defective conditions, rough, sharp, slippery, decayed,
corroded, frayed, cracked etc.;
d) Unsafe design or construction;
e) Hazardous arrangement, process etc. (piling, storage, aisle
space, exit, lay-out, over-load, misalignment);
f) Unsafe illumination (inadequate or improperly distributed);
g) Unsafe ventilation (inadequate or improperly distributed);
h) Unsafe dress or apparel; and
i) Unsafe methods, process, planning etc.
Further, physical conditions that give rise to various hazards in mines are classified as under:
1) Presence/appearance of bad roof or sides, false bedding
condition;
2) Unsafe condition due to presence of geological disturbances in strata, bed separation, and over-riding of pillars, premature
3) Formation/appearance or accumulation of inflammable/toxic gases in mine atmosphere - Explosion hazard, gassing hazard;
4) Inadequacy of ventilation and improper distribution of air;
5) Presence of darkness in underground mines;
6) High temperature gradient met with in coal mines;
7) Presence/appearance or seepage of dangerous water accumulations either from surface or underground inundation hazard;
8) Presence or appearance of fire and/or spontaneous heating of certain coals in coal mines;
9) Danger of rock bumps, gas out-bursts, air-blasts and concentration of high strata stress during extraction of coal leading to overloading/breakage of roof supports crushing of pillars;
10) Use of explosives on a large scale in the extraction of minerals/coal;
11) Winding of men and materials through shafts/winzes;
12) Continuous shifting of work places under freshly exposed roof and dangers due to fire, gas water-logging of abandoned workings;
13) Hazards due to fouling of underground general atmosphere due to damp or fire gases after an explosion/fire;
14) Pollution of respirable air underground due to dusts, nitrus fumes of blastings etc., and
15) Hazards due to ground subsidence.
It is plain and obvious that the more a process or an environment is kept free from unsafe mechanical or physical conditions, the
lesser would be the chances for persons to run into accidents. Therefore, the part that "engineering revision" (i.e. removal of unsafe mechanical or physical conditions or amending unsafe processes or systems of work) can play in accident prevention cannot be over emphasised. Efforts to prevent accidents by methods giving emphasis on control of unsafe actions alone would not give encouraging results unless they are backed up by "engineering revision" to the extent possible.

2.16 ACCIDENT PREVENTION METHODS

The accident prevention methods discussed earlier can be summarised as under:

1) Engineering revision;
2) Personnel adjustments;
3) Instruction, persuasion and appeal;
4) Discipline.

2.17 PHILOSOPHY OF SAFETY

There is a school of thought that in view of the enormity of the human consequences of mine accidents a policy of Zero Accident Potential (ZAP) should be pursued and implemented vigorously. However, it has been urged that ZAP is an unattainable ideal - an eldorado. This is because even if safest machinery and most non-hazardous work system are employed, accidents will continue to occur either because of "misadventure" or due to human error which can be minimised but not altogether eliminated. Consequently the policy of ZAP is not feasible. Hence a new concept of MAP (Minimum Accident Potential) has been developed.
MAP concedes that accidents cannot be eliminated altogether but their incidence, severity and undesirable consequences can be minimised through the implementation of an appropriate safety program. In this study the concept of MAP is accepted and the prevention of accidents is discussed and analysed from that point of view.

2.18 NEW ANALYSIS FOR ACCIDENT PREVENTION

The classification of accidents prepared by I.L.O. (See Appendix 2-4) and the D.G.M.S. (See Appendices 2-1, 2-2 and 2-3) are primarily designed to locate the proximate cause of the accident and remove it so that accident will not recur. However to minimise the rate of accident in the long run, it is necessary to look beyond the proximate causes and ascertain the basic causative features so that they may be removed. For, one must treat the disease rather than its symptoms. It has therefore been suggested that analysis on the basis of the following criteria may be much more fruitful in prevention of accidents:

One should ask whether the accidents could have been prevented by

a) Better "System design";
b) The application of existing protective devices;
c) The application of some new protective devices;
d) Better training;
e) Better supervision;
f) Better pitmanship;
g) Additional legislation.

The answers to these questions will suggest lines of investigation and measures for prevention of accidents. In
particularly, (a) and (b) above provide a vast and rewarding field for effort and concentrating efforts on them is most likely to bring down the rate of the accidents in the immediate future. Similarly (f) better pitmanship also offers great scope for bringing down the rate of accidents. It may be noted that historically all the major accidents have been due to environmental conditions. The susceptibility to accidents of mine workers engaged in workings below ground is largely determined by the environmental conditions at the work places. In a well lighted and adequately ventilated working place free from high degree of noise and vibration, it would be reasonable to assume that the worker will be less fatigued throughout his working shift and remain vigilant to guard against any untoward accident. Thus achievement of satisfactory environmental conditions at work places in our mines assumes great importance.

If the concentration of inflammable gas in the workings below ground in coal mines is not allowed to rise above 0.75% in the general body of mine air by ensuring adequacy and continuity of ventilation, we would have taken sufficient precautions to guard against one of the principal scourges of coal mining, viz., explosion of inflammable gas which invariably takes heavy toll of human lives.

2.19 STRATEGY FOR ACCIDENT PREVENTION:

The strategy comprises of the following four elements:

1) Design;
2) Protective Devices;
3) Training
4) Exhortation.

The elements have been ranked in the order in which the pursuit of them could be expected to be effective in permanently reducing accident rates.

Exhortation is ranked the weakest because the pleading with and appeals to human being usually have but transient effect on his outlook and attitude. A revolution in social thinking and habits has to be achieved for any permanent effect to be derived from exhortation.

Training is deeper and more likely radically to alter the individual's outlook to his job; but again there is no guaranteed permanently effective and beneficial outcome.

Protective safety devices are valuable and can be of considerable effect in reducing accidents but they are rarely perfect in that they can fail or often be defeated and hence their contribution to reducing accidents permanently is substantial but limited.

Only the first element, design, has a potential which if fully realised can have a permanent effect in reducing accidents. This is because it offers the possibility of actually creating systems in which identified hazards are eliminated - and if the hazard is not there the accident cannot arise - a permanent effect. The concept of design is also to be used - at many times in the sense of reducing the potential risk of a hazard. The concept of designing for safety must be considered in its widest sense. Hazards can be eliminated by design in the creation of individual machines, the planning of total system and in the establishment
of the labour centered operations in connection with the machines and systems.

2.20 BASIC ELEMENTS OF A SOUND SAFETY PROGRAM

The basic elements of a sound safety program are:

1) Management leadership
2) Assignment of responsibility
3) Maintenance of safe working conditions
4) Establishment of safety training
5) Accidents record and reporting system
6) Medical and first aid system
7) Acceptance of personal responsibility by the employees
8) Use of personal protective equipments. Reasons for not using personal protective equipments are:
   a) Ignorance
   b) Willful avoidance and
   c) Unsuitable design.
9) Rehabilitation - Job adaptation.
### STATEMENT NO. 2-1

**MANAGEMENT CONTROL SYSTEM FOR ACCIDENT PREVENTION**

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**MANAGEMENT CONTROL BY MEANS OF**

<table>
<thead>
<tr>
<th>Eliminating unsafe conditions.</th>
<th>Discovering causes.</th>
<th>Eliminating unsafe actions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Safeguarding all machines, equipment, work space etc.</td>
<td>1. Job safety analysis.</td>
<td>1. Personnel adjustment.</td>
</tr>
<tr>
<td>2. Rectifying or preventing defective condition.</td>
<td>2. Safety sampling.</td>
<td>2. Safety education and training.</td>
</tr>
<tr>
<td>3. Withdrawal of men to safety from defective work.</td>
<td>3. Investigation of accidents.</td>
<td>3. Supervision.</td>
</tr>
<tr>
<td>4. Suitable and safe design and construction.</td>
<td>4. Inspection of plant and equipment.</td>
<td>4. Discipline.</td>
</tr>
<tr>
<td>5. Safe arrangements, processes methods of work etc.</td>
<td>5. Accident statistics and its analysis</td>
<td>5. Safe campaign.</td>
</tr>
<tr>
<td>6. Adequate &amp; suitable illumination, ventilation etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Safe dress and personal protective equipment.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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28
TABLE NO. 2-1(A)

DEATH & SERIOUS INJURY RATES IN ALL MINES BY PLACE OF WORKING
DEATH RATES PER 1000 PERSON EMPLOYED

<table>
<thead>
<tr>
<th>YEAR</th>
<th>COAL</th>
<th>NON-COAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BELOW</td>
<td>OPEN CAST</td>
</tr>
<tr>
<td></td>
<td>GROUND</td>
<td>GROUND</td>
</tr>
<tr>
<td>1961</td>
<td>0.91</td>
<td>0.43</td>
</tr>
<tr>
<td>1966</td>
<td>0.76</td>
<td>0.17</td>
</tr>
<tr>
<td>1971</td>
<td>0.89</td>
<td>0.30</td>
</tr>
<tr>
<td>1972</td>
<td>0.79</td>
<td>0.14</td>
</tr>
<tr>
<td>1973</td>
<td>0.79</td>
<td>0.24</td>
</tr>
<tr>
<td>1974</td>
<td>0.74</td>
<td>0.15</td>
</tr>
<tr>
<td>1975</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1976</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

@ Excluding Chasnala Disaster.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>COAL</th>
<th>NON-COAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BELOW</td>
<td>OPEN CAST</td>
</tr>
<tr>
<td>1961</td>
<td>12.65</td>
<td>1.59</td>
</tr>
<tr>
<td>1966</td>
<td>6.43</td>
<td>1.60</td>
</tr>
<tr>
<td>1971</td>
<td>5.63</td>
<td>1.12</td>
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<tr>
<td>1972</td>
<td>5.49</td>
<td>1.36</td>
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<tr>
<td>1973</td>
<td>6.16</td>
<td>1.12</td>
</tr>
<tr>
<td>1974</td>
<td>6.52</td>
<td>1.12</td>
</tr>
<tr>
<td>1975</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
# TABLE 2-2(A)

## CLASSIFICATION OF FATAL ACCIDENTS BY RESPONSIBILITY

### IN INDIAN COAL MINES

#### ALL FATAL ACCIDENTS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MIS</th>
<th>MANAGEMENT</th>
<th>MANAGEMENT &amp; SUP.</th>
<th>SUB DECEASED</th>
<th>CO-WORKER</th>
<th>OTHERS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ADVENTURE</td>
<td>OTHERS</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1969</td>
<td>55</td>
<td>42</td>
<td>30</td>
<td>39</td>
<td>24</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>(%)</td>
<td>(26.1)</td>
<td>(18.9)</td>
<td>(14.2)</td>
<td>(19.5)</td>
<td>(11.4)</td>
<td>(4.7)</td>
<td>(5.2)</td>
</tr>
<tr>
<td>1970</td>
<td>55</td>
<td>38</td>
<td>33</td>
<td>27</td>
<td>22</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>(%)</td>
<td>(28.3)</td>
<td>(19.6)</td>
<td>(17.0)</td>
<td>(13.9)</td>
<td>(11.3)</td>
<td>(7.2)</td>
<td>(2.6)</td>
</tr>
<tr>
<td>1971</td>
<td>57</td>
<td>43</td>
<td>26</td>
<td>32</td>
<td>18</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>(%)</td>
<td>(28.6)</td>
<td>(21.6)</td>
<td>(13.1)</td>
<td>(16.1)</td>
<td>(9.1)</td>
<td>(6.5)</td>
<td>(5.0)</td>
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<td>1972</td>
<td>47</td>
<td>30</td>
<td>32</td>
<td>47</td>
<td>21</td>
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<td>13</td>
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<tr>
<td>(%)</td>
<td>(23.5)</td>
<td>(15.0)</td>
<td>(16.0)</td>
<td>(23.5)</td>
<td>(10.5)</td>
<td>(6.6)</td>
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<tr>
<td>1973</td>
<td>44</td>
<td>34</td>
<td>32</td>
<td>35</td>
<td>15</td>
<td>4</td>
<td>8</td>
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<tr>
<td>(%)</td>
<td>(25.6)</td>
<td>(19.8)</td>
<td>(18.6)</td>
<td>(20.3)</td>
<td>(8.7)</td>
<td>(2.3)</td>
<td>(4.7)</td>
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<tr>
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<td>62</td>
<td>28</td>
<td>29</td>
<td>40</td>
<td>22</td>
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<tr>
<td>(%)</td>
<td>(31.0)</td>
<td>(14.0)</td>
<td>(14.5)</td>
<td>(20.0)</td>
<td>(11.0)</td>
<td>(4.5)</td>
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@ Provisional.
### TABLE 2-2(B)

**CLASSIFICATION OF FATAL ACCIDENTS BY RESPONSIBILITY**

**IN INDIAN COAL MINES**

**FALL OF ROOF ACCIDENTS**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MISADVENTURE</th>
<th>MANAGEMENT</th>
<th>MANAGEMENT &amp; SUB</th>
<th>DECEASED</th>
<th>WITHIN MULTI-</th>
<th>OTHER</th>
<th>TOTAL</th>
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<tr>
<td>1970</td>
<td>26</td>
<td>12</td>
<td>16</td>
<td>13</td>
<td>5</td>
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<td>1</td>
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<tr>
<td>1971</td>
<td>39</td>
<td>15</td>
<td>9</td>
<td>19</td>
<td>4</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>1972</td>
<td>24</td>
<td>8</td>
<td>17</td>
<td>26</td>
<td>8</td>
<td>1</td>
<td>4</td>
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<tr>
<td>1973</td>
<td>22</td>
<td>10</td>
<td>11</td>
<td>25</td>
<td>1</td>
<td>-</td>
<td>3</td>
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<tr>
<td>1974</td>
<td>31</td>
<td>9</td>
<td>14</td>
<td>30</td>
<td>10</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>1975</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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**TABLE 2-3**

PERCENTAGE DISTRIBUTION OF PERSONAL CAUSES OF ACCIDENTS

<table>
<thead>
<tr>
<th>CAUSE OF ACCIDENT</th>
<th>PERCENTAGE</th>
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<tbody>
<tr>
<td>1. FAULTY ATTITUDE</td>
<td>14</td>
</tr>
<tr>
<td>2. FAILURE TO RECOGNISE POTENTIAL HAZARDS</td>
<td>12</td>
</tr>
<tr>
<td>3. FAULTY ADJUSTMENT OF SPEED AND DISTANCE</td>
<td>12</td>
</tr>
<tr>
<td>4. IMPULSIVENESS</td>
<td>10</td>
</tr>
<tr>
<td>5. IRRESPONSIBILITY</td>
<td>8</td>
</tr>
<tr>
<td>6. FAILURE TO KEEP ATTENTION CONSTANT</td>
<td>8</td>
</tr>
<tr>
<td>7. NERVOUSNESS AND FEAR</td>
<td>6</td>
</tr>
<tr>
<td>8. DEFECTIVE VISION</td>
<td>4</td>
</tr>
<tr>
<td>9. SLOW REACTION</td>
<td>4</td>
</tr>
<tr>
<td>10. ORGANIC DISEASE</td>
<td>4</td>
</tr>
<tr>
<td>11. BLOOD PRESSURE</td>
<td>2</td>
</tr>
<tr>
<td>12. DEPRESSION</td>
<td>2</td>
</tr>
<tr>
<td>13. INEXPERIENCE</td>
<td>2</td>
</tr>
<tr>
<td>14. FATIGUE DUE TO WEAK HEALTH</td>
<td>2</td>
</tr>
<tr>
<td>15. IMPROPER DISTRIBUTION OF ATTENTION</td>
<td>2</td>
</tr>
<tr>
<td>16. SENILITY</td>
<td>2</td>
</tr>
<tr>
<td>17. MISCELLANEOUS</td>
<td>6</td>
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100%
<table>
<thead>
<tr>
<th>YEAR</th>
<th>BELGIUM</th>
<th>CANADA</th>
<th>FRANCE</th>
<th>HOLLAND</th>
<th>INDIA</th>
<th>JAPAN</th>
<th>POLAND</th>
<th>U.K.</th>
<th>U.S.A.</th>
<th>WEST GERMANY</th>
</tr>
</thead>
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<tr>
<td>1956</td>
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<td>0.00</td>
<td>0.45</td>
<td>1.72</td>
<td>0.87</td>
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<td>0.00</td>
<td>0.77</td>
<td>0.20</td>
<td>0.49</td>
<td>1.86</td>
<td>0.97</td>
<td>0.54</td>
<td>1.88</td>
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<tr>
<td>1958</td>
<td>0.83</td>
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<td>0.79</td>
<td>0.50</td>
<td>1.10</td>
<td>1.77</td>
<td>1.16</td>
<td>0.45</td>
<td>1.59</td>
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<tr>
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<td>0.73</td>
<td>0.39</td>
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<td>1.70</td>
<td>0.88</td>
<td>0.51</td>
<td>1.44</td>
<td>0.88</td>
</tr>
<tr>
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<td>0.54</td>
<td>0.20</td>
<td>0.59</td>
<td>1.99</td>
<td>0.70</td>
<td>0.51</td>
<td>1.71</td>
<td>0.79</td>
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<td>0.45</td>
<td>1.79</td>
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<tr>
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<td>0.23</td>
<td>0.59</td>
<td>1.38</td>
<td>0.69</td>
<td>0.47</td>
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<td>0.30</td>
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<td>1.97</td>
<td>0.60</td>
<td>0.38</td>
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<td>2.20</td>
<td>0.43</td>
<td>0.36</td>
<td>1.60</td>
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</tr>
<tr>
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<td>0.39</td>
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<td>1.59</td>
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<td>0.31</td>
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* Provisional.
### TABLE 2-5

**TREND IN DEATH RATE PER MILLION TONNES OF COAL RAISED**

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<td>0.72</td>
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<td>0.00</td>
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<td>3.05</td>
<td>2.75</td>
<td>2.92</td>
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<td>0.41</td>
<td>0.64</td>
<td>NA</td>
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<tr>
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<td>0.50</td>
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<td>0.51</td>
</tr>
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<td>1.54</td>
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<td>0.47</td>
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<td>NA</td>
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### TABLE 2-7

**SOME SOCIAL AND ECONOMIC CONSEQUENCES OF ACCIDENTS**

<table>
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<th>SOCIAL</th>
<th>ECONOMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Grief over the loss of loved ones</td>
<td>1. Wage losses</td>
</tr>
<tr>
<td>2. Denial of education</td>
<td>2. Medical and hospital fees</td>
</tr>
<tr>
<td>3. Lack of guidance for children</td>
<td>3. Property damage</td>
</tr>
<tr>
<td>4. Psychological effects of a change in standard of living</td>
<td>4. Production loss for employer</td>
</tr>
<tr>
<td>5. Physical handicaps causing readjustment, retraining and job replacement</td>
<td>5. Loss of earning capability</td>
</tr>
<tr>
<td>7. Psychic damages affecting behavior</td>
<td>7. Loss of profit on idle machinery damaged or awaiting repairs</td>
</tr>
<tr>
<td>8. Embarrassment and lost pride</td>
<td>8. Work stoppage for assisting the injured curiosity, clearing up, etc., which results in non-productive wage paid to non-injured</td>
</tr>
<tr>
<td>10. Interpersonal relation affected adversely from anger, resentment etc.</td>
<td>10. Loss of talent</td>
</tr>
</tbody>
</table>

**Source:** Safety - principles, instruction and readings by Alton L. Thygerson, Prentice Hall, Inc. 1992 p. 25.
APPENDIX 2-1
CLASSIFICATION OF ACCIDENTS BY PLACE OF WORK

1. Below Ground

1.1 Development area
1.2 Other than development area
1.3 Long well face
1.4 Other de-pillaring / stopping area
1.5 Tramming roadway

1.6 Other rope haulage road-way
1.7 Shafts and sinking shafts (including inclined shafts)
1.8 Inclines and winzes
1.9 Others (Specify)

2. Opencast Working

2.1 Bottom Bench
2.2 Top of the quarry
2.3 Other benches

2.4 Rope haulage road-way
2.5 Other transportation roadways
2.6 Others (Specify)

3. Above Ground (Excluding Opencast Workings)

3.1 Aerial ropeway site
3.2 Rope haulage roadway
3.3 Other transportation roadways
3.4 Railway line belonging to the mine
3.5 Site of ore handling plants (including screening plants, dressing plants, crushing plants, etc.)
3.6 Workshop, power house, and other engine rooms
3.7 Depot
3.8 Other (Specify)
APPENDIX 2-2

DGMS CLASSIFICATION OF ACCIDENTS BY CAUSE

1. Ground Movement
   1.1 Fall of roof
   1.2 Fall of sides (other than overhangs)
   1.3 Fall of overhangs
   1.4 Rock burst or bump
   1.5 Air blast

2. Transportation Machinery
   2.1 Winding in shafts

3. Transportation Machinery (other than winding in shafts)
   3.1 Aerial ropeway
   3.2 Rope haulage
   3.3 Other rail transportation
   3.4 Mechanical conveyors

4. Machinery other than Transportation Machinery
   4.1 Drills
   4.2 Coal cutting machines
   4.3 Coal loading machines
   4.4 Haulage engine
   4.5 Winding engine
   4.6 Shovels, draglines, excavators etc.
5. Explosives

5.1 Solid blasting
5.2 Deep hole blasting
5.3 Air blasting etc.
5.4 Other explosive accidents

6. Electricity

6.1 Overhead lines
6.2 Other power cables
6.3 Switch gear, gate end boxes, pommel etc.
6.4 Energised machines
6.5 Other electrical accidents

7. Dust, Gas and other Combustible Material

7.1 Occurrences of Gas
7.2 Influx of Gas
7.3 Suffocation by gas
7.4 Explosion or ignition of gas, dust etc.
7.5 Out-break of fire or spontaneous heating
7.6 Other accidents due to dust, gas and combustible material.

8. Falls (other than falls of ground)

8.1 Falls of persons from height or into depths
8.2 Falls of persons on the same level
8.3 Falls of objects other than falls of ground including rolling objects
8.4 Other falls (Specify)

9. Other Causes

9.1 Irruption of water
9.2 Flying pieces
9.3 Extremity caught inbetween objects
9.4 Unclassified (Specify)
APPENDIX 2-3

DGMS CODE FOR SUB-CLASSIFICATION OF ACCIDENTS
DUE TO ROPE HAULAGE (CODE 3.2)

1. By Run-away Tubs
   1.1 Due to breakage of rope
   1.2 Failure of attachment to rope
   1.3 Failure of coupling
   1.4 Due to defective coupling
   1.5 Failure of draw-bar
   1.6 Inadequate provision or non-provision of sprags.
   1.7 Failure of stock-block/buffer
   1.8 Failure of engine brake/sprags
   1.9 Other causes of runaway (Specify)

2. By Tubs Under Movement
   2.1 By rope
   2.2 By gravity
   2.3 By hand tramming in close proximity
   2.4 By other hand tramming
   2.5 By guiding
   2.6 By uncontrolled movement
   2.7 By other moving tubs

3. By Other Tubs
   3.1 By derailing or derailed tubs
   3.2 By tubs being re-railed

4. In the Process of Coupling and Uncoupling
   (including attachment of clips) etc.
   4.1 Of tubs
   4.2 Of tubs/set of tubs with rope

5. By Sprags
   5.1 Being inserted
   5.2 Being with-drawn

6. By Set Riding
   6.1 Authorised
   6.2 Un-authorised
7. By my moving Rope

7.1 Direct
7.2 Main and Tail
7.3 Endless under-rope

8. By Moving Parts

8.1 Pulleys
8.2 Tube wheels

9. By Other Unspecified Causes of Haulages
THE I.L.O. CLASSIFICATION OF INDUSTRIAL ACCIDENT

The tenth conference of Labour statisticians convened by I.L.O. in 1962 recommended that, for the study of circumstances surrounding industrial accidents, these accidents should be classified as follows:

A Classification of Industrial Accidents according to the type of Accidents:
1. Falls of persons.
2. Struck by falling objects.
3. Stepping on, striking against or struck by objects excluding falling object.
4. Caught in or between objects.
5. Overexertion or strenuous movements.
6. Exposure to or contact with harmful substances or radiation.
7. Exposure to or contact with electric current.
8. Exposure to or contact with extreme temperatures.
9. Other types of accidents, not elsewhere classified, including accidents not classified due to lack of sufficient data.

B. Classification of Industrial Accidents according to Agency:
1. Machines.
1.1 Prime movers, except electrical motors.
1.2 Transmission machinery.
1.3 Metal working machines.
1.4 Wood and assimilated machines.
1.5 Agricultural machines.
1.6 Mining machinery.
1.7 Other machines not elsewhere classified.

2. Means of Transport and Lifting equipment
   2.1 Lifting machines and appliances.
   2.2 Means of rail transport.
   2.3 Other wheeled means of transport, excluding rail transport.
   2.4 Means of air transport.
   2.5 Means of water transport.
   2.6 Other means of transport.

3. Other Equipment
   3.1 Pressure Vessels.
   3.2 Furnaces, ovens, kilns.
   3.3 Refrigerating plants.
   3.4 Electrical installations, including electric motors, but excluding electric hand tools.
   3.5 Electrical hand tools.
   3.6 Tools, implements and appliances, except electric hand tools.
   3.7 Ladders, mobile ramps.
   3.8 Scaffolding.
   3.9 Other equipment not elsewhere classified.

4. Materials, substances and radiations
   4.1 Explosives.
   4.2 Dust, gases, liquids and chemicals, excluding explosives.
   4.3 Flying fragments.
   4.4 Radiations.
   4.5 Other materials and substances not elsewhere classified.
5. Working environment:

5.1 Outdoor.

5.2 Indoor.

5.3 Underground.

6. Other agencies not elsewhere classified:

6.1 Animals.

6.2 Other agencies not elsewhere classified.

7. Agencies not classified for lack of sufficient data.

C. Classification of Industrial Accidents according to the nature of the injury:

1.0 Fractures.

2.0 Dislocations.

3.0 Concussions and other internal injuries.

4.0 Amputations and enucleations.

4.1 Other wounds.

5.0 Superficial injuries.

5.5 Contusions and crushings.

6.0 Burns.

7.0 Acute poisonings.

8.0 Effects of weather, exposure and related conditions.

8.1 Asphyxia.

8.2 Effects of electric currents.

8.3 Effects of radiations.

9.0 Multiple injuries of different nature.

9.9 Other and unspecified injuries.
D. Classification of Industrial Accidents according to the Bodily location of the injury:

1. Head.
2. Neck.
3. Trunk.
4. Upper limb.
5. Lower limb.
6. Multiple locations.
7. General injuries.
8. Unspecified location of injury.