Safety in Mines

BY

DR. P. S. PAUL

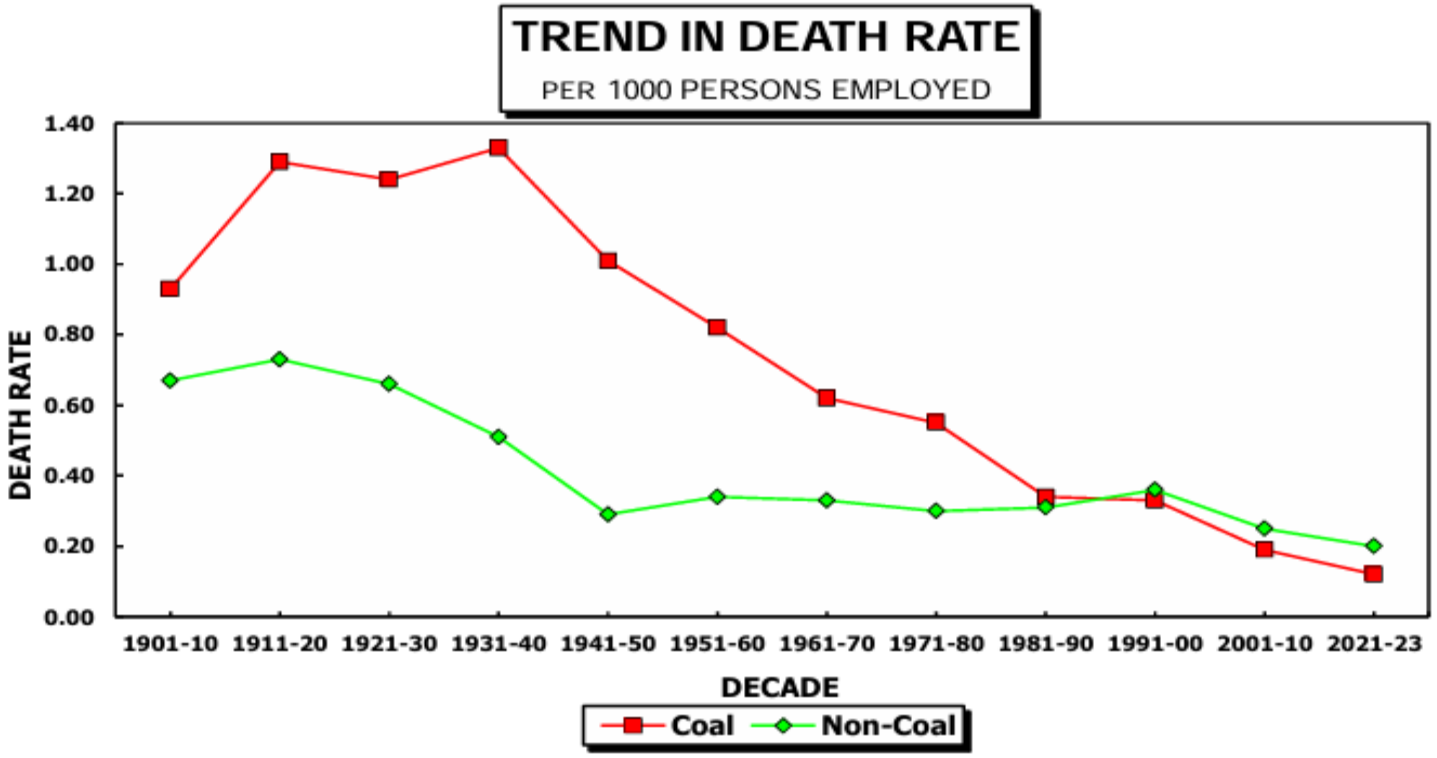
Introduction

- Mining is a hazardous profession associated with high level of accidents and injuries
- For example, in Indian coal mines the fatal and serious bodily injury rates per 1000 persons employed for the years 2021 and 2022 were 0.15, 0.08 and 0.57, 0.56 respectively
- Several causes starting from personal to sociotechnical factors are responsible for such high injury experience rates in mines

TABLE-3	Trends in fatal accidents and fatality rates per 1000 persons employed (Ten yearly average)							
	COAL MINES				NON-COAL MINES			
	Av. No. of Acc.	Acc. rate	Av. No. of Fatalities	Fatality rate	Av. No. of Acc.	Acc. rate	Av. No. of Fatalities	Fatality rate
1901-10	74	0.76	92	0.93	16	0.47	23	0.67
1911-20	139	0.94	176	1.29	29	0.57	37	0.73
1921-30	174	0.99	219	1.24	43	0.54	50	0.66
1931-40	172	0.98	228	1.33	35	0.41	43	0.51
1941-50	226	0.87	273	1.01	26	0.24	31	0.29
1951-60	223	0.61	295	0.82	64	0.27	81	0.34
1961-70	202	0.49	259	0.62	72	0.28	85	0.33
1971-80	187	0.40	264	0.55	66	0.27	74	0.30
1981-90	162	0.30	185	0.34	65	0.27	73	0.31
1991-00	140	0.27	170	0.33	65	0.31	77	0.36
2001-10	87	0.22	108	0.27	54	0.32	67	0.40
2011-20	**61**	**0.17**	**68**	**0.19**	**44**	**0.20**	**53**	**0.25**
2021-23	**35**	**0.10**	**40**	**0.12**	**32**	**0.15**	**44**	**0.20**

N.B. Data for the year 2023 is up to 31.12.2023.

Source: DGMS Standard Note, 2024



Source: DGMS Standard Note, 2024

Table - 5			Trend in death rate per thousand persons employed							
Year	Coal	Oil	Copper Ore	Gold Ore	Iron Ore	Lime Stone	Mang. Ore	Galena & Sphl.	Total Metals	All Mineral
2010	0.32	0.14	0.00	0.00	0.23	0.18	0.14	0.29	0.53	0.37
2011	0.18	0.11	0.27	0.00	0.08	0.14	0.19	1.00	0.27	0.21
2012	0.23	0.09	0.26	0.00	0.05	0.13	0.24	0.00	0.20	0.22
2013	0.23	0.19	0.00	0.29	0.09	0.09	0.11	0.67	0.37	0.27
2014	0.17	0.20	0.27	0.00	0.06	0.12	0.05	0.35	0.22	0.19
2015	0.16	0.18	0.39	0.28	0.10	0.13	0.04	0.59	0.22	0.18
2016	0.28	0.32	0.39	0.00	0.06	0.11	0.04	0.20	0.21	0.26
2017	0.18	0.04	0.00	0.00	0.08	0.16	0.18	0.98	0.33	0.23
2018	0.18	0.07	0.39	0.00	0.10	0.05	0.04	0.79	0.26	0.20
2019	0.16	0.35	1.18	0.28	0.08	0.16	0.13	0.20	0.23	0.20
2020	0.16	0.28	0.00	0.28	0.13	0.03	0.22	0.00	0.22	0.18
2021	0.15	0.11	0.00	0.00	0.12	0.05	0.04	0.59	0.24	0.18
2022	0.08	0.11	0.79	0.28	0.04	0.00	0.09	0.39	0.25	0.14
2023	0.12	0.00	0.79	0.00	0.10	0.05	0.09	0.00	0.16	0.13

N.B. Data for the year 2023 is up to 31.12.2023.

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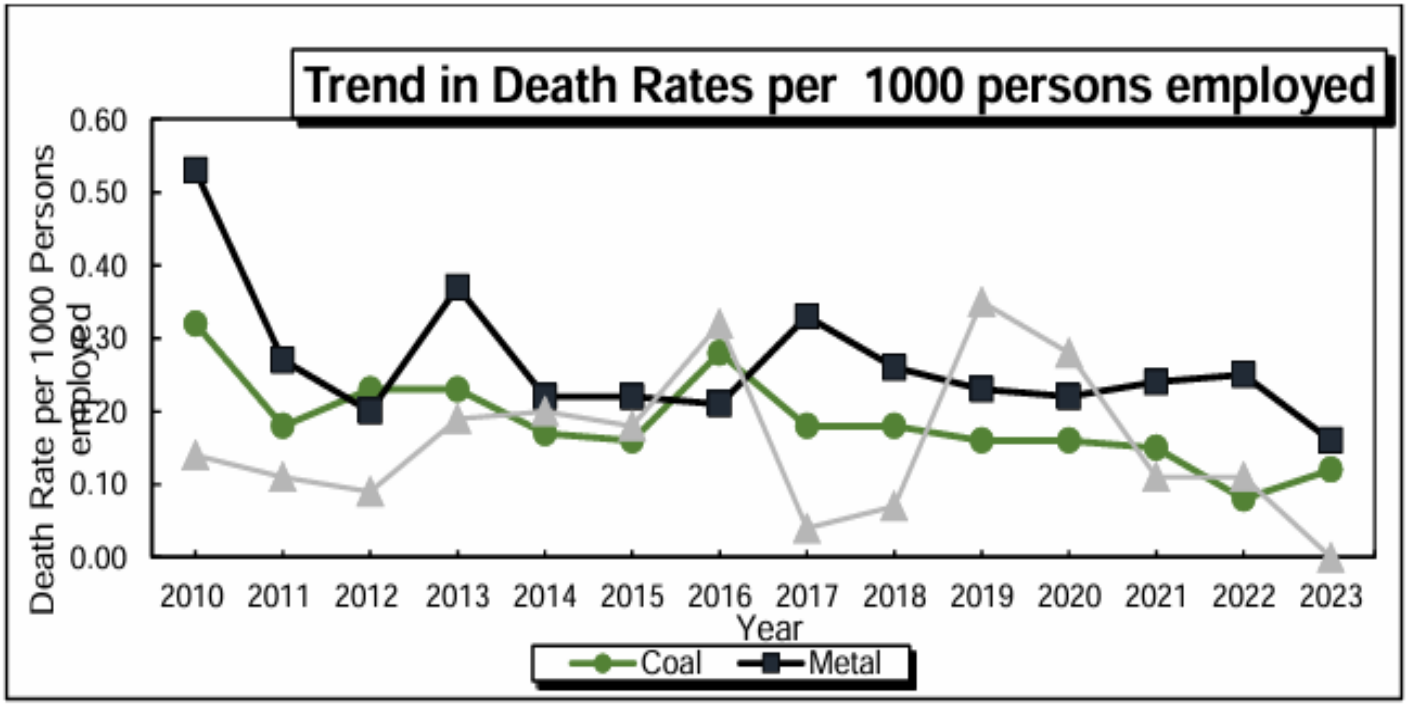
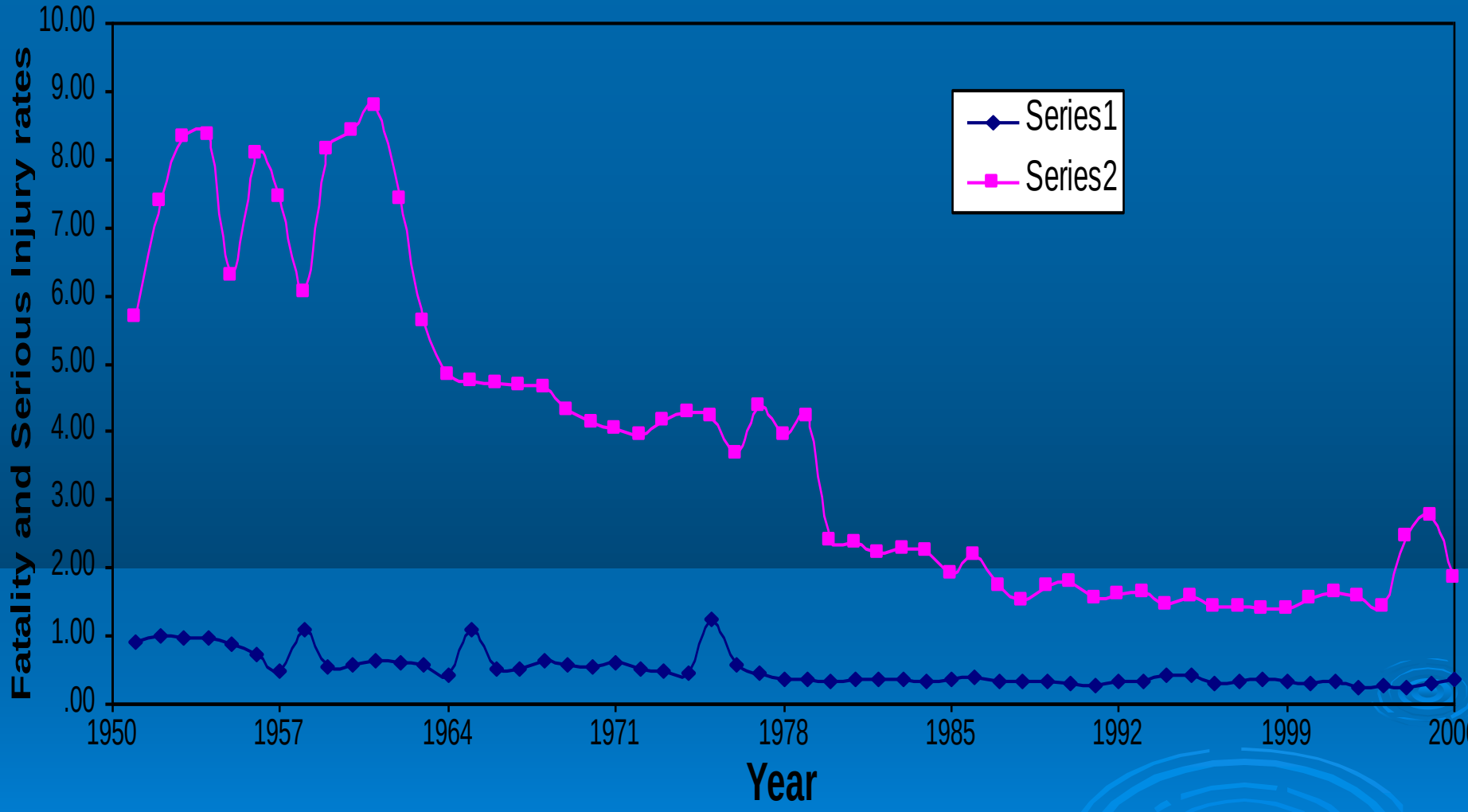


Source: DGMS Standard Note, 2024



Year-Wise Fatality and Serious Injury Rates per 1000 Persons Employed in Indian Coal Mines

Chapter – 01

Safety terms and definitions; Occupational Hazards of Mining

Safety terms and definitions

Safety

This is the conservation of human life and its effectiveness, and the prevention of damage to items as per mission requirements.

OR

Safety is the degree of freedom from risk and hazard in environment such as a mine.

Accident

This is an unplanned and undesired event in a sequence of events, that occurs through a combination of causes; it results in physical harm (injury or illness) to an individual, damage to property, a near-miss, a loss or any combination of these effects.

Q. Why do accidents take place in mines?

A: Accident causation is a complex process. But generally these are caused due to *Unsafe Acts* and *Unsafe conditions . A* combination of factors at the same moment may lead to accident causing injury or persons may escape without any injury.

Unsafe Condition

This is any condition, under the right set of condition, may create accident.

Unsafe Behavior

This is the manner in which an individual conducts himself/herself that is unsafe to himself/herself or others.

Hazards

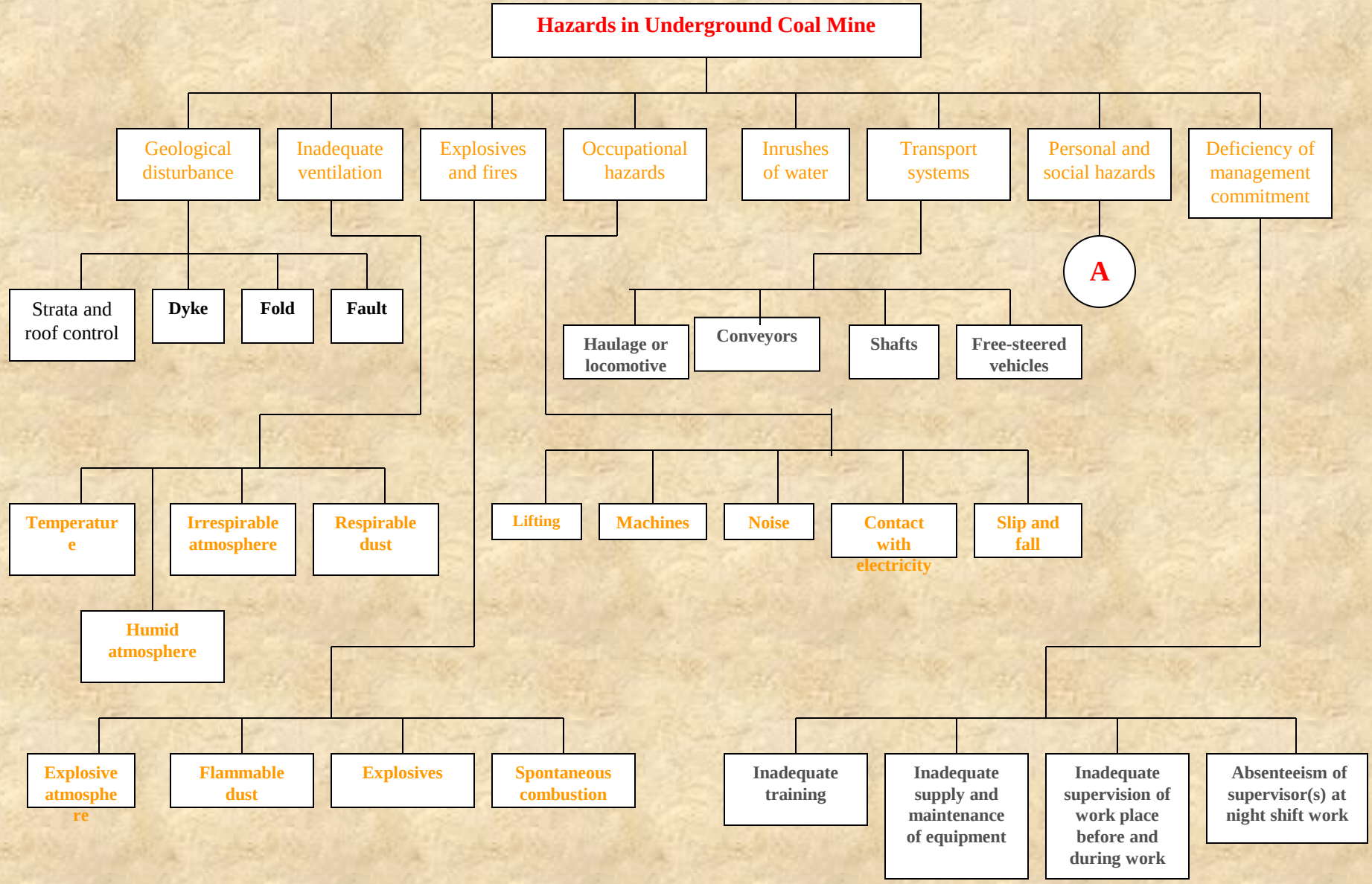
This is the source of energy and physiological and behavioral factors which, when uncontrolled effectively, results in harmful occurrences.

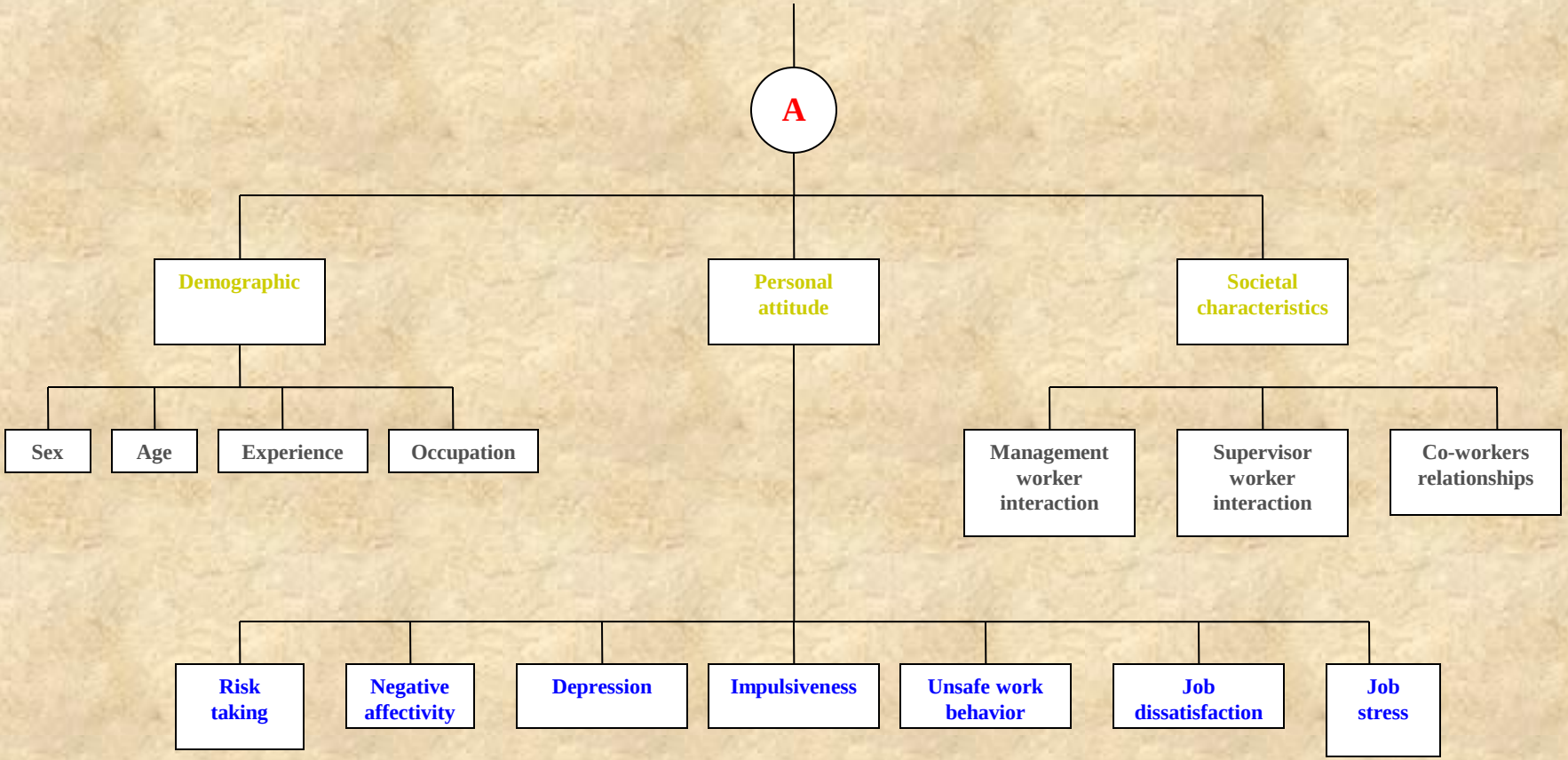
Safe

This is protected against any possible hazards.

Hazards in Mines

This is the source of energy and the physiological and behavioral factors which, when uncontrolled effectively, results in harmful occurrences


Hazards in Underground Coal Mine
Geological disturbance
Inadequate ventilation
Explosives and fires
Occupational hazards
Inrushes of water
Transport systems
Personal and social hazards
Deficiency of management commitment
A
Strata and roof control
Dyke
Fold
Fault
Haulage or locomotive
Conveyors
Shafts
Free-steered vehicles
Temperature
Irrespirable atmosphere
Respirable dust
Humid atmosphere
Lifting
Machines
Noise
Contact with electricity
Slip and fall
Explosive atmosphere
Flammable dust
Explosives
Spontaneous combustion
Inadequate training
Inadequate supply and maintenance of equipment
Inadequate supervision of work place before and during work
Absenteeism of supervisor(s) at night shift work


A
Demographic
Personal attitude
Societal characteristics
Sex
Age
Experience
Occupation
Management worker interaction
Supervisor worker interaction
Co-workers relationships
Risk taking
Negative affectivity
Depression
Impulsiveness
Unsafe work behavior
Job dissatisfaction
Job stress

Chapter - 2

Accidents and their classification;

and

Statistics of Fatal and Serious accidents in Indian Coal as well as Metalliferous Mines (Upto 2006)

What accidents come under the purview of the Mines Act?

What accidents are not included in the statistics published by the CIM?

Classification of Mine Accidents/Injuries

Fatal: Which results in death of one or more person

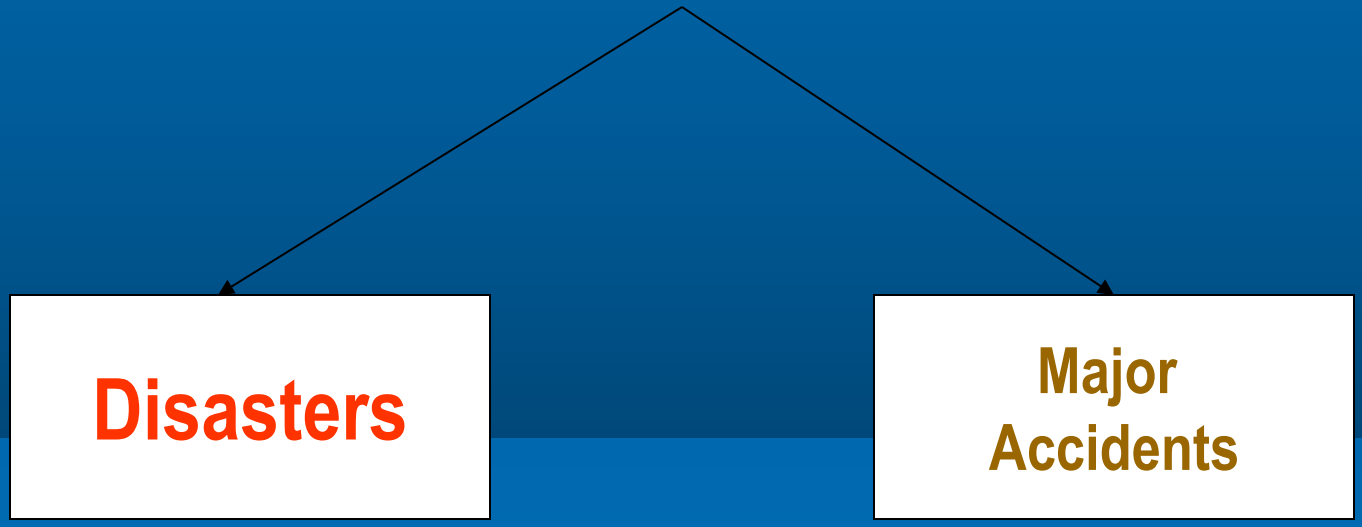
Serious: Which results in serious bodily injury to one or more person. Serious bodily injury is defined as an injury which involve the permanent loss of any part of the body or permanent loss of or injury to the sight or hearing or any permanent in capacity or fractures of any bone or joints.

Reportable: Which results in reportable injury to one or more person. Reportable injury is defined as any injury other than a serious bodily injury which involves the enforced absence of the injured person from work for a period of 72 hours or more.

Classification of Mine Accidents/Injuries (Contd.)

Minor: Which results in minor injury to one or more person. Minor injury is defined as any injury other than a serious bodily injury which involves the enforced absence of the injured person from work for a period exceeding 24 hours but, less than 72 hours.

Accidents



Conclusion

Average death rates due to the coal mine accidents are 114 per year.

Whereas, in Delhi alone over 2000 deaths are reported annually in traffic accidents

But, we can not conclude from the above figure that walking or driving on the streets of Delhi is more risky than working in coal mines.

In order to evaluate the chances of a person being killed or injured at work in a mine or a factory, on the road, in the air, in the water, it is necessary to evaluate to evolve a common yardstick by which the standards of safety in different industries or elsewhere can be measured.

Major Accidents in the Indian Coal Mines (Post Independence period)

Sl. No	Dates of Accident	Name of Mines	Fatalities	Cause
1	12/07/1952	Dhemomain	12	Roof fall
2	05/08/1953	Majri	11	Inundation
3	14/03/1954	Damra	10	Explosion of fire damp.
4	10/12/1954	Newton Chikli	63	Inundation
5	05/02/1955	Amlabad	52	Explosion of fire damp.
6	26/09/1956	Burra Dhemo	28	Inundation
7	**19/02/1958**	Chinakuri	175	**Explosion of fire damp.**
8	20/02/1958	Central Bhowra	23	Inundation
9	05/01/1960	Damua	16	Inundation
10	**28/05/1965**	**Dhori**	**268**	**Coal dust explosion**
11	11/04/1968	West Chirmiri	14	Premature collapse of workings
12	18/03/1973	Jitpur	48	Explosion of fire damp.
13	08/08/1975	Kessurgarh	11	Roof fall
14	18/11/1975	Silewara	10	Inundation
15	**27/12/1975**	**Chasnala**	**375**	**Inundation**

Major Accidents in the Indian Coal Mines (Post Independence period)

16	16/09/1976	Central Saunda	10	Inundation
17	04/10/1976	Sudamdih	43	Explosion of fire damp.
18	22/01/1979	Baragolai	16	Ignition of fire damp
19	24/08/1981	Jagannath	10	Water gas explosion
20	**16/07/1982**	**Topa**	**16**	**Roof fall**
21	14/09/1983	Hurriladih	19	Inundation
22	13/11/1989	Mahabir	6	Inundation
23	25/01/1994	New Kenda	55	Fire/suffocation by gases
24	26/09/1995	Gaslitand	64	Inundation
25	06/07/1999	Prascole	6	Fall of roof/collapse of workings
26	24/06/2000	Kawadi	10	Failure of OC bench
27	02/02/2001	Bagdigi	29	Inundation
28	05/03/2001	Durgapur Rayatwari	6	Collapse of partings/workings
29	16/06/2003	Godavari Khani-7LEP	17	Inundation
30	16/10/2003	GDK-8A	10	Roof fall
31	15/6/2005	Central Saunda	14	Inundation

Trends of Fatal and Serious Accidents in Coal Mines in India

Year	Fatal accidents		Serious accidents	
	Accidents	Fatalities	Accidents	Injuries
1995	137	219	757	813
1996	131	146	677	723
1997	143	165	677	725
1998	128	146	523	560
1999	127	138	595	650
2000	117	144	661	707
2001	106	141	667	720
2002	81	97	629	650
2003	83	113	563	578
2004	90	99	599	608
Average per year	114	141	635	673

Note: (i) Lignite is included in coal.

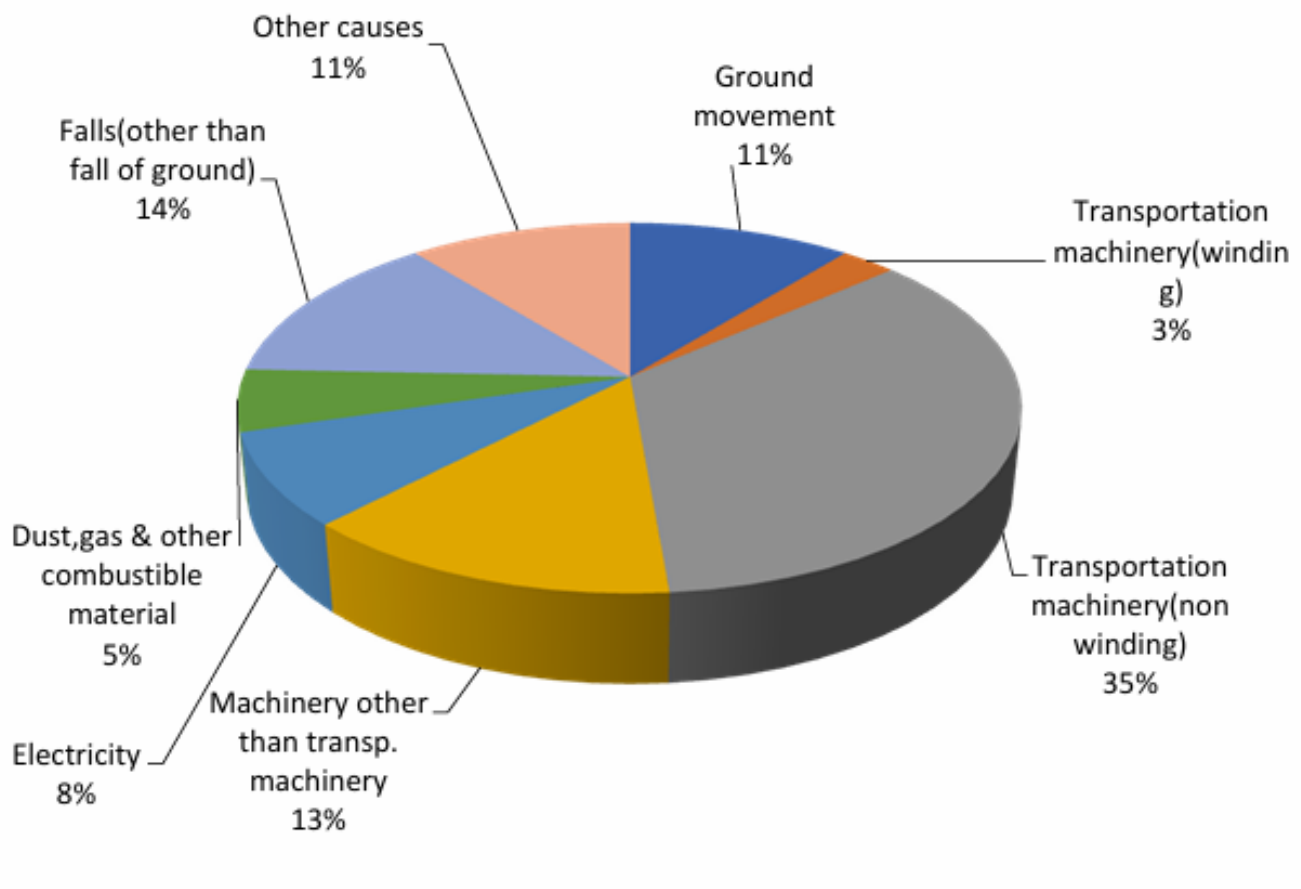


Fig.1 Cause-wise distribution of fatal accidents in coal mines during 2023

Source: DGMS Standard Note, 2024

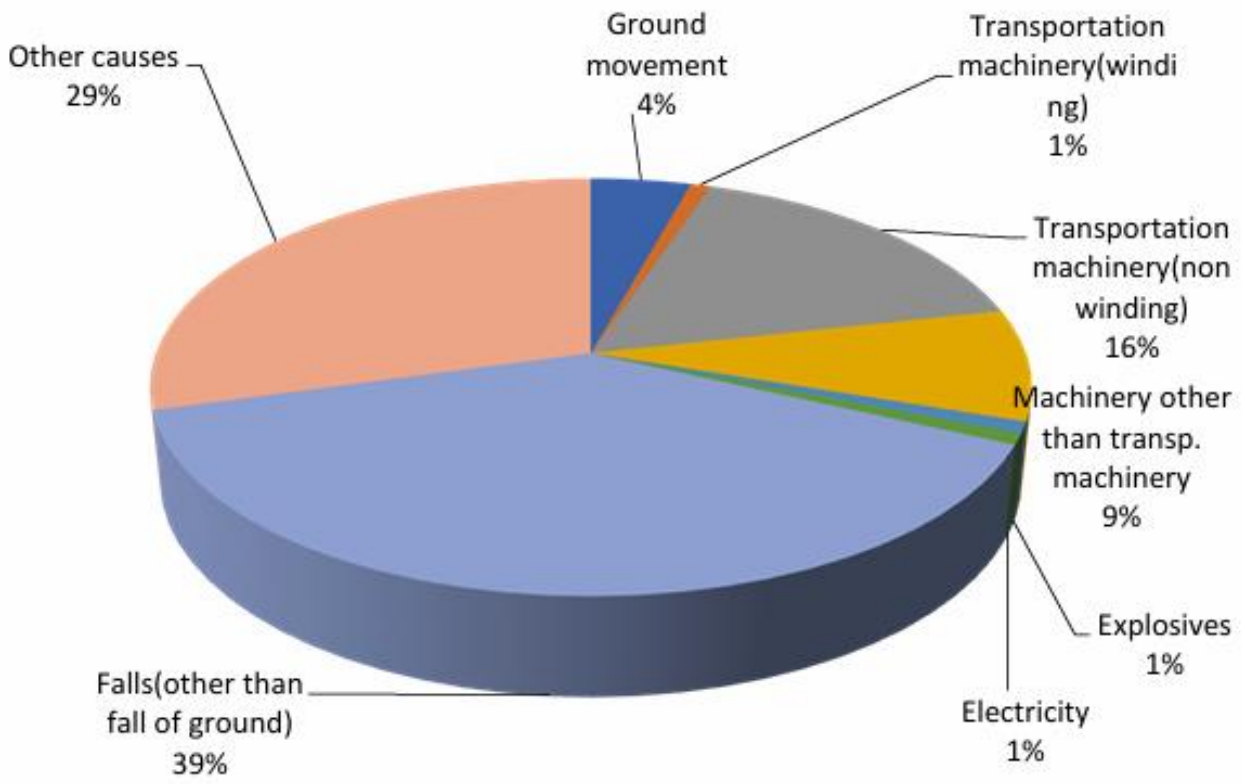


Fig.2 Cause-wise distribution of serious accidents in coal mines during 2023

Source: DGMS Standard Note, 2024

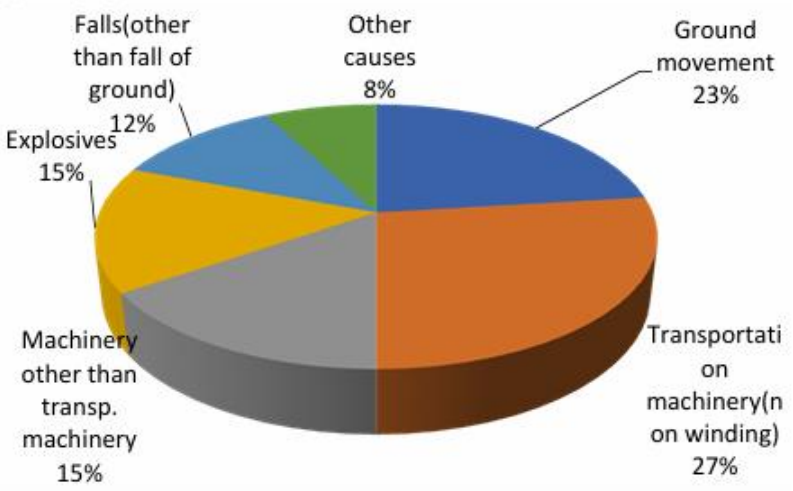


Fig. 3 Cause-wise distribution of fatal accidents in metalliferous mines during 2023

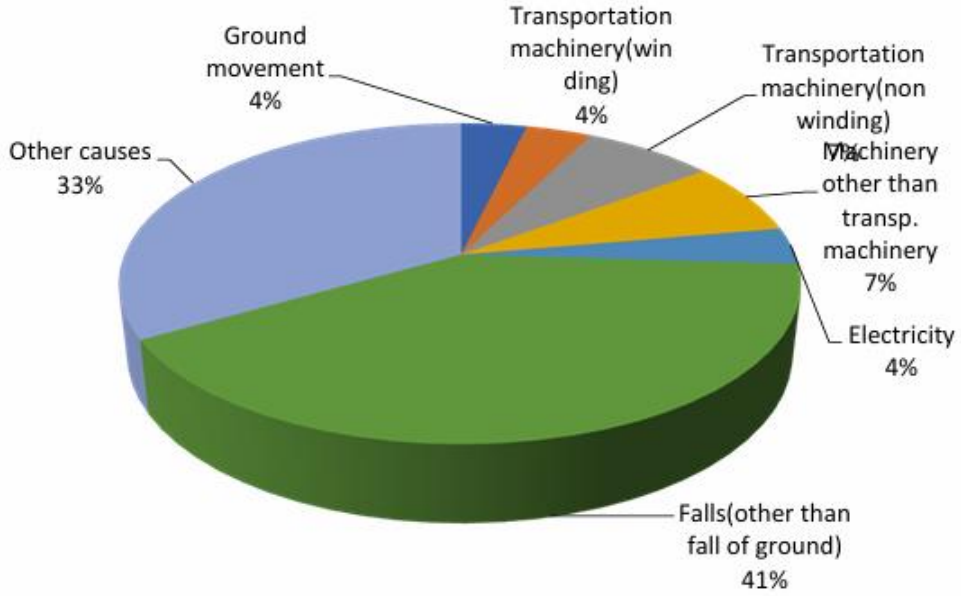


Fig.4 Cause-wise distribution of serious accidents in metalliferous mines during 2023

Source: DGMS Standard Note, 2024

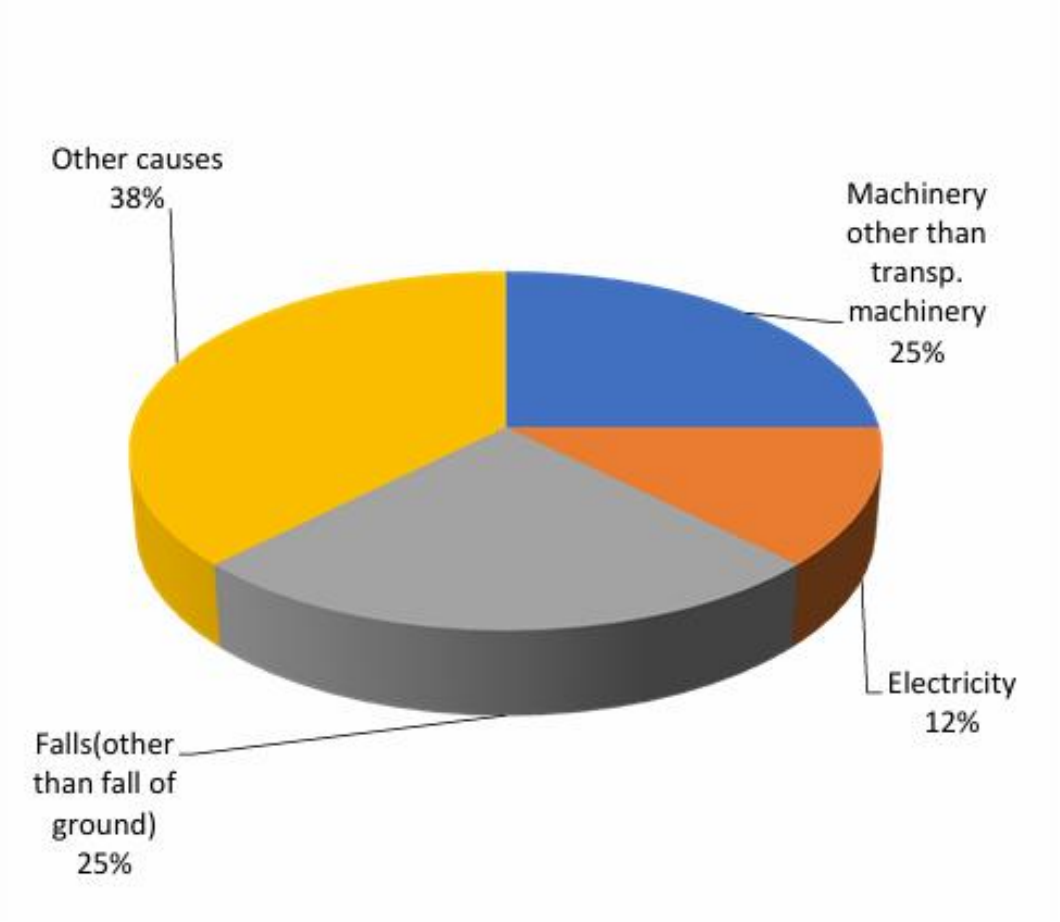


Fig. 5 Cause-wise distribution of serious accidents in oil & gas mines during 2023

Source: DGMS Standard Note, 2024

Chapter - 3

Frequency Rates and Severity of Accidents (With Case Study)

The usual practice is to calculate the death
rates and injury rates on the basis of:

i. 1000 persons employed
ii. 3-lakh manshift worked
iii. Million ton of coal produced

To calculate the frequency rates per 1000 persons employed, it is necessary to know the actual figures of average daily employment in mines.

Frequency rate (FR) for fatal, serious and reportable injuries can be calculated as follows:

$$\text{FR/Fatal} = \frac{\text{No of fatal injuries}}{\text{Average daily employment}} \times 1000$$

$$\text{FR/Serious} = \frac{\text{No of serious injuries}}{\text{Average daily employment}} \times 1000$$

$$\text{FR/Reportable} = \frac{\text{No of Reortable injuries}}{\text{Average daily employment}} \times 1000$$

Frequency Rate (FR) per 3 lakh manshift worked can be calculated as below:

$$\text{FR/ 3 lakh Manshift worked} = \frac{\text{No of injuries}}{\text{Total Manshift worked}} \times 3{,}00{,}000$$

$$\text{FR/ Million ton per of coal produced} = \frac{\text{No of injuries}}{\text{Total coal produced}} \times 10^6$$

One basis of measurement of safety performance is the frequency of accidents, another is their severity. Severity rate can be calculated as follows:

$$\text{Severity} = \frac{\text{Mandays lost} \times 1000}{\text{Average daily employment}}$$

$$\text{Or} = \frac{\text{Mandays lost} \times 300000}{\text{Total Manshift worked}}$$

$$\text{Or} = \frac{\text{Mandays lost} \times 10^6}{\text{Million ton of coal produced}}$$

Severity Index:-----

Severity Index (SI) can be calculated based on following formula:

$$SI = \frac{(300F + 10S + R) \times 100{,}000}{\text{Man-shift worked}}$$

F = Number of deaths

S = Number of serious injuries

R = Number of Reportable injuries

The weightage of 300:10:1 for fatal, serious, and reportable injuries was perhaps arrived at by estimating relative manshift lost by each type of accidents. A modified approach has been established by the DGMS and is as follows:

$$SI = \frac{(50F + S) \times 10^5}{\text{Man-shift worked}}$$

Accident Proneness:-----

Though FR and SI values can be taken to identify accident proneness of mines; however, it is preferable to compute Arithmetic mean (AM) and Geometric mean (GM) of SI usually for five years periods to identify accident prone mines. The DGMS uses the arithmetic mean for identifying the accident proneness. Accident proneness indices are defined as follows:

$$AM = \sum_{i=1}^{n} SI/n$$

$$AM = \left(\prod_{i=1}^{n} SI \right)^{1/n}$$

Both frequency rate and severity rate indices are useful measures of safety performances of mines.

These indices generally are used to identify the accident proneness of mines and based on these indices accident proneness of the same mine may vary.

To incorporate both frequency and severity rate, a combined index (CI) has been proposed, where CI is defined as:

$$CI = \frac{FR \times SI}{1000}$$

where, CI = Combined Index

FR = Frequency Rate Index

SI = Severity Index

Case study (from 1995-2004)

Average Yearly Fatal/Serious Injuries in Indian Mines

Place of employment	Average daily employment	Average number persons killed per year	Average number persons seriously injured per year
Below ground	2,58,000	110	493
Opencast workings	75,000	18	71
Above ground	1,35,000	13	109
Total	4,68,000	141	673

Calculate the Frequency Rates, Severity Rate, Severity Index as per DGMS, and Combine index of Coal Mine Accidents in India.

Chapter - 4

Basic Causes of Accident Occurrence;

and

Cause wise Accident Analysis (from 1995-2004)

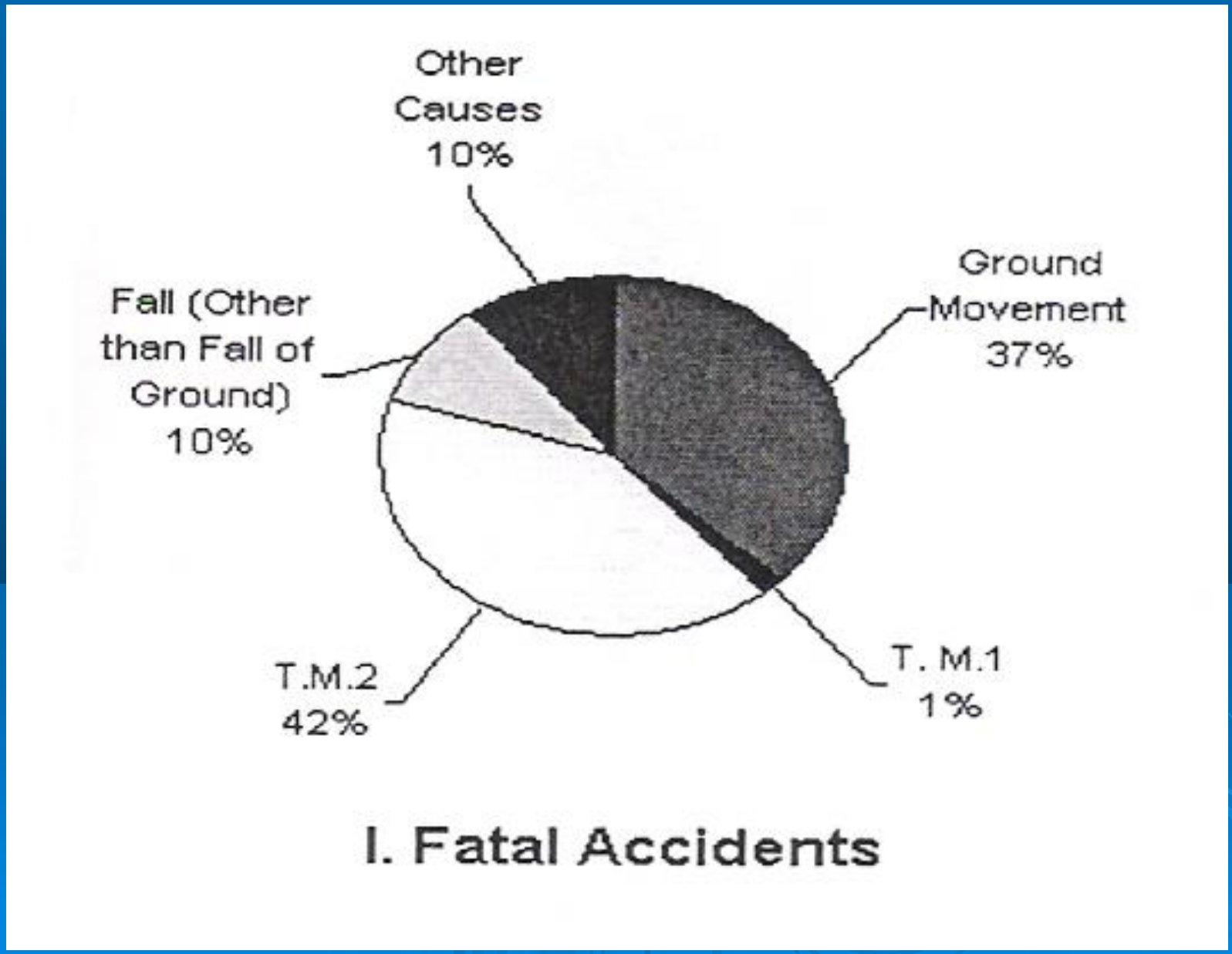
Basis Causes of Accident Occurrence

In order to identify the root causes of accidents, it is a common practice to safety professional to find out the factors associated with accidents.

The DGMS classification of accident causes is as follows:

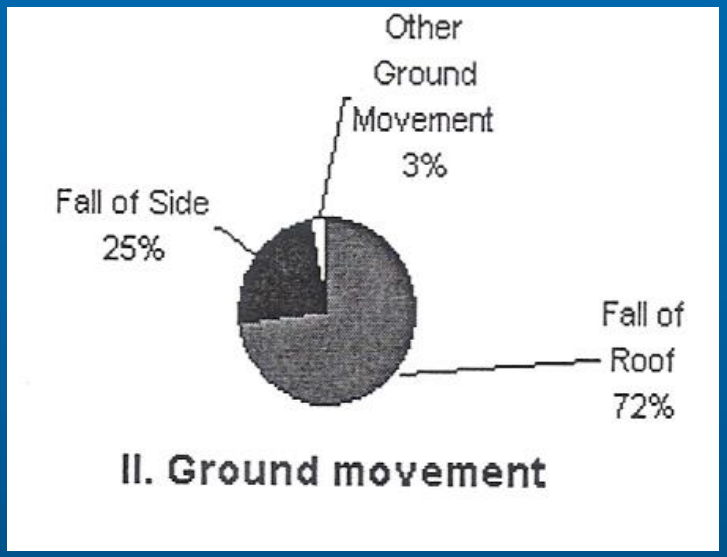
1. Ground movement
2. Transportation Machinery (winding in shaft)
3. Transportation Machinery (Other than winding in shaft)
4. Machinery other than Transportation Machinery
5. Explosives
6. Electricity
7. Dust, gas and other Combustible Materials
8. Fall (other than fall of ground)
9. Other causes

Fatal Accidents in Indian Coal Mines (Last 10 Years)

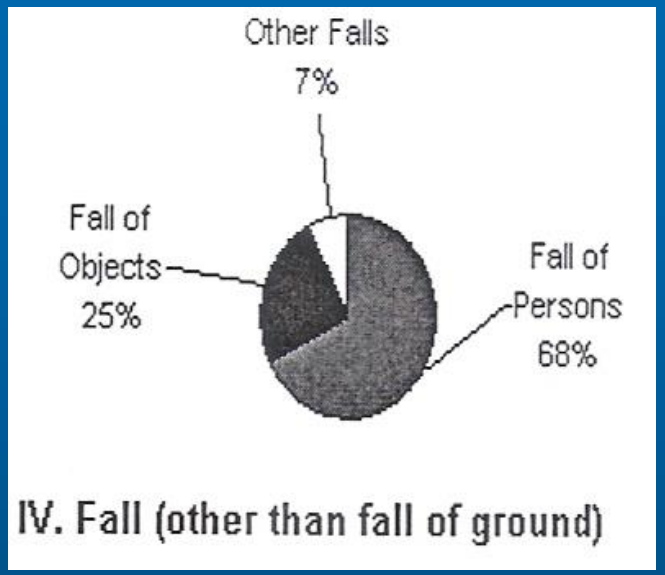


I. Fatal Accidents

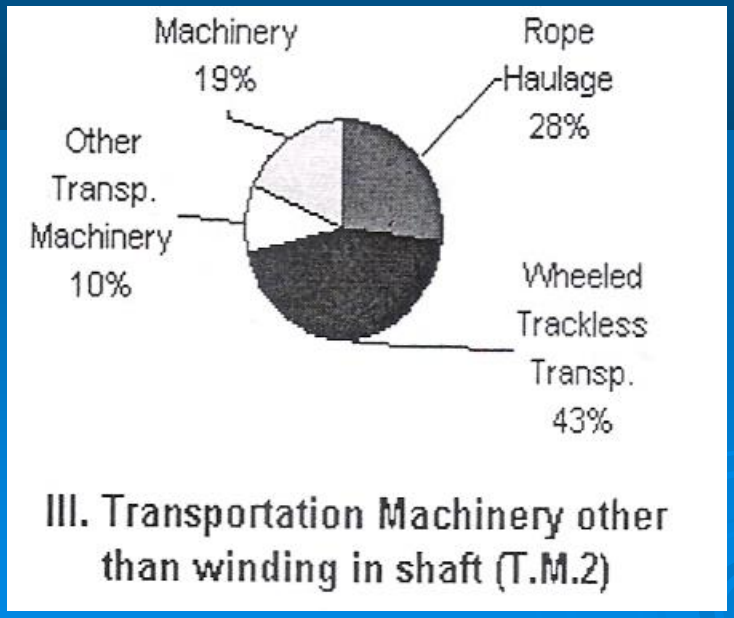
Fatal Accidents in Indian Coal Mines (Last 10 Years)



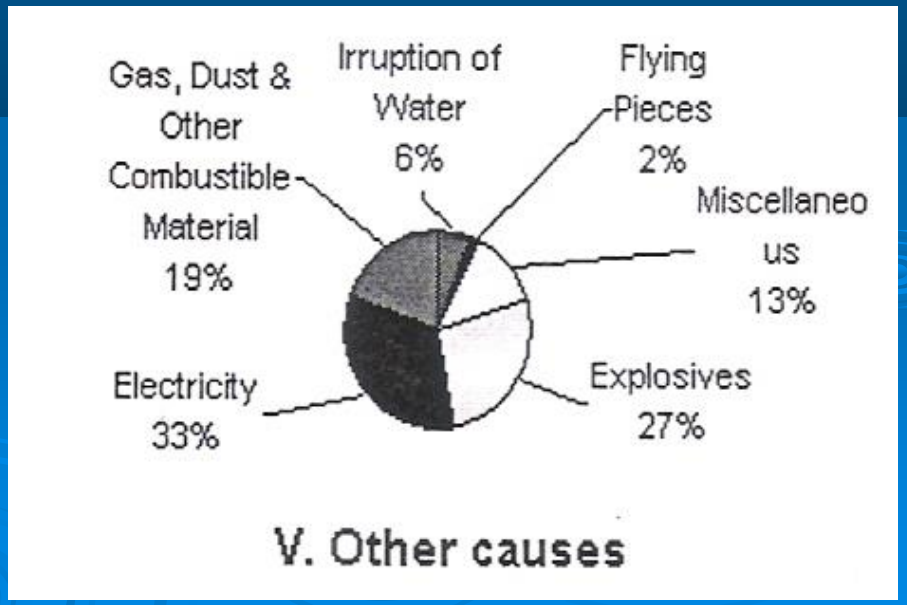
II. Ground movement



IV. Fall (other than fall of ground)

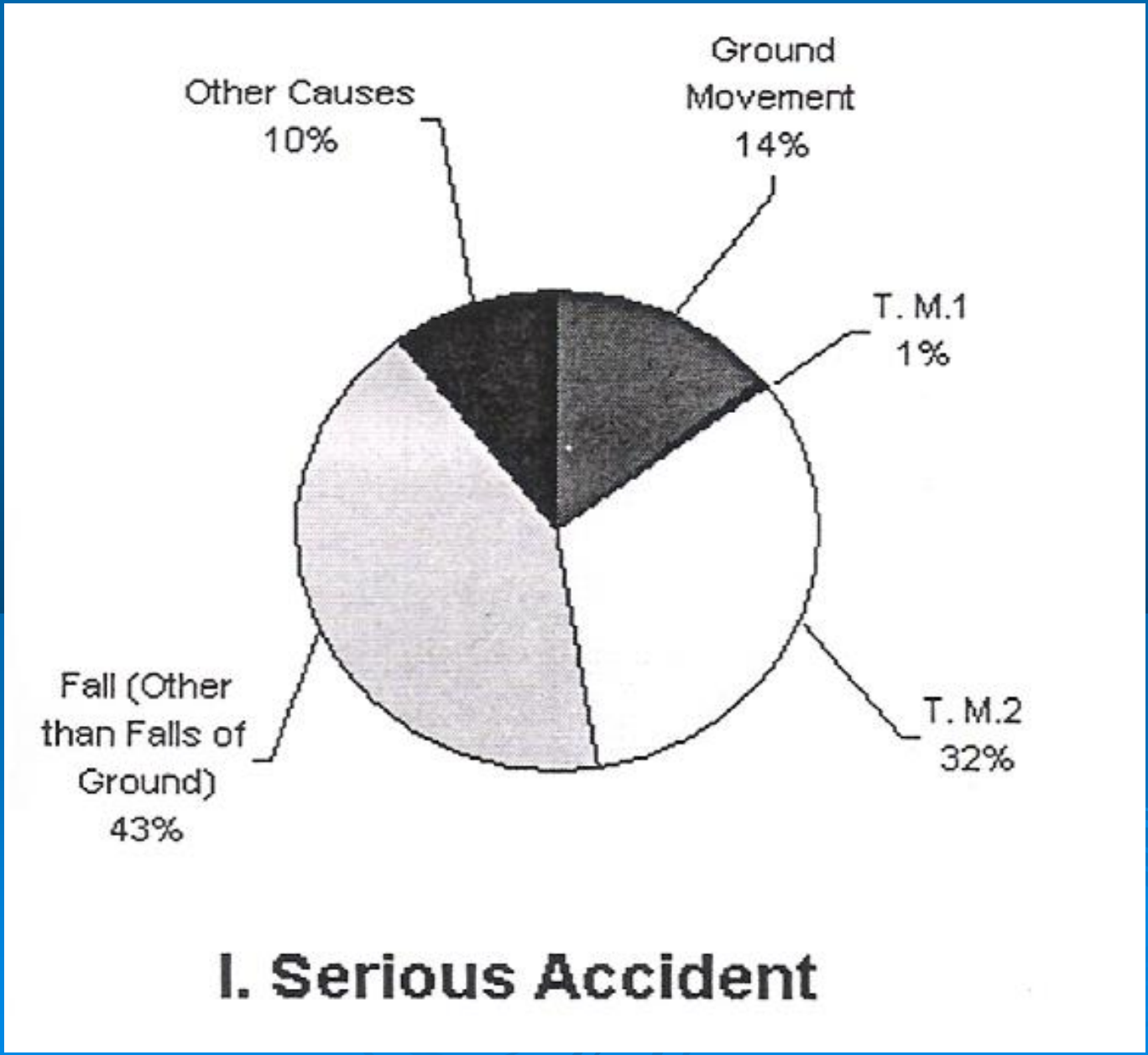


III. Transportation Machinery other than winding in shaft (T.M.2)

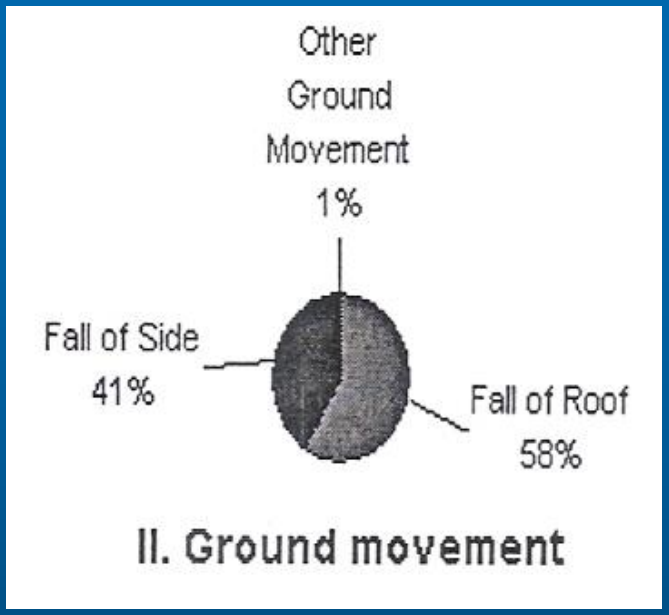


V. Other causes

Fatal Accidents in Indian Coal Mines (Last 10 Years)



Fatal Accidents in Indian Coal Mines (Last 10 Years)



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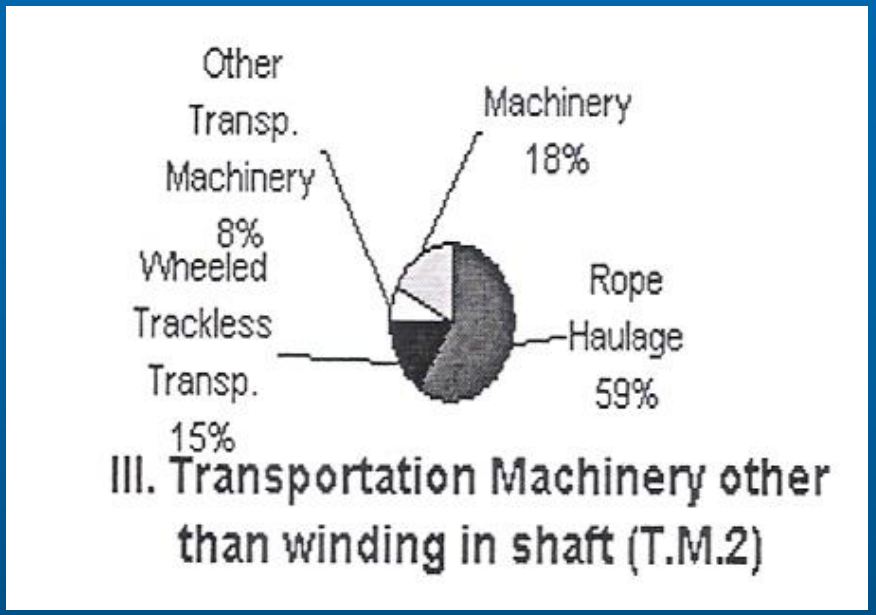

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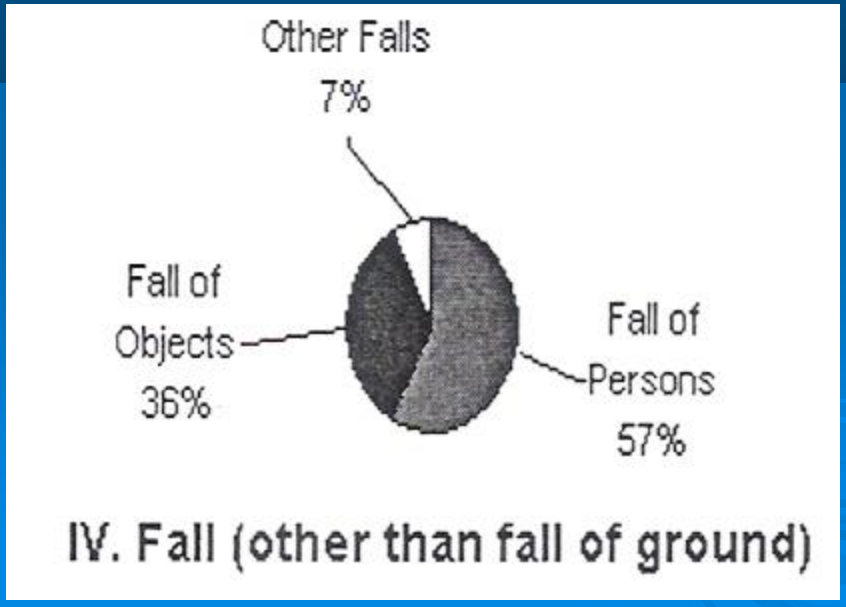

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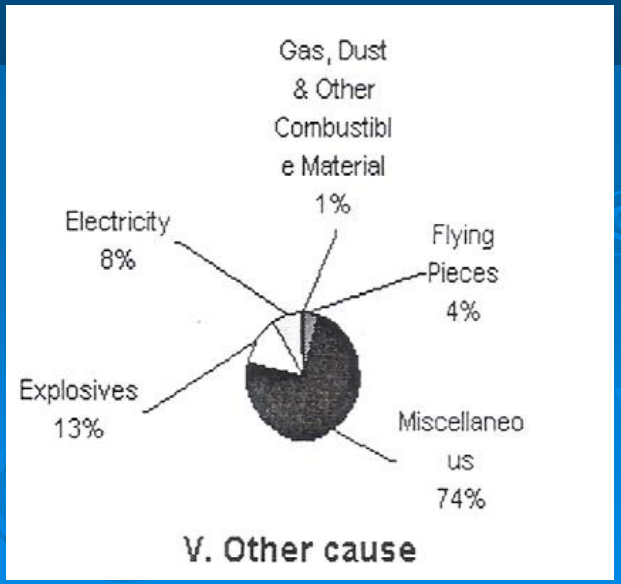


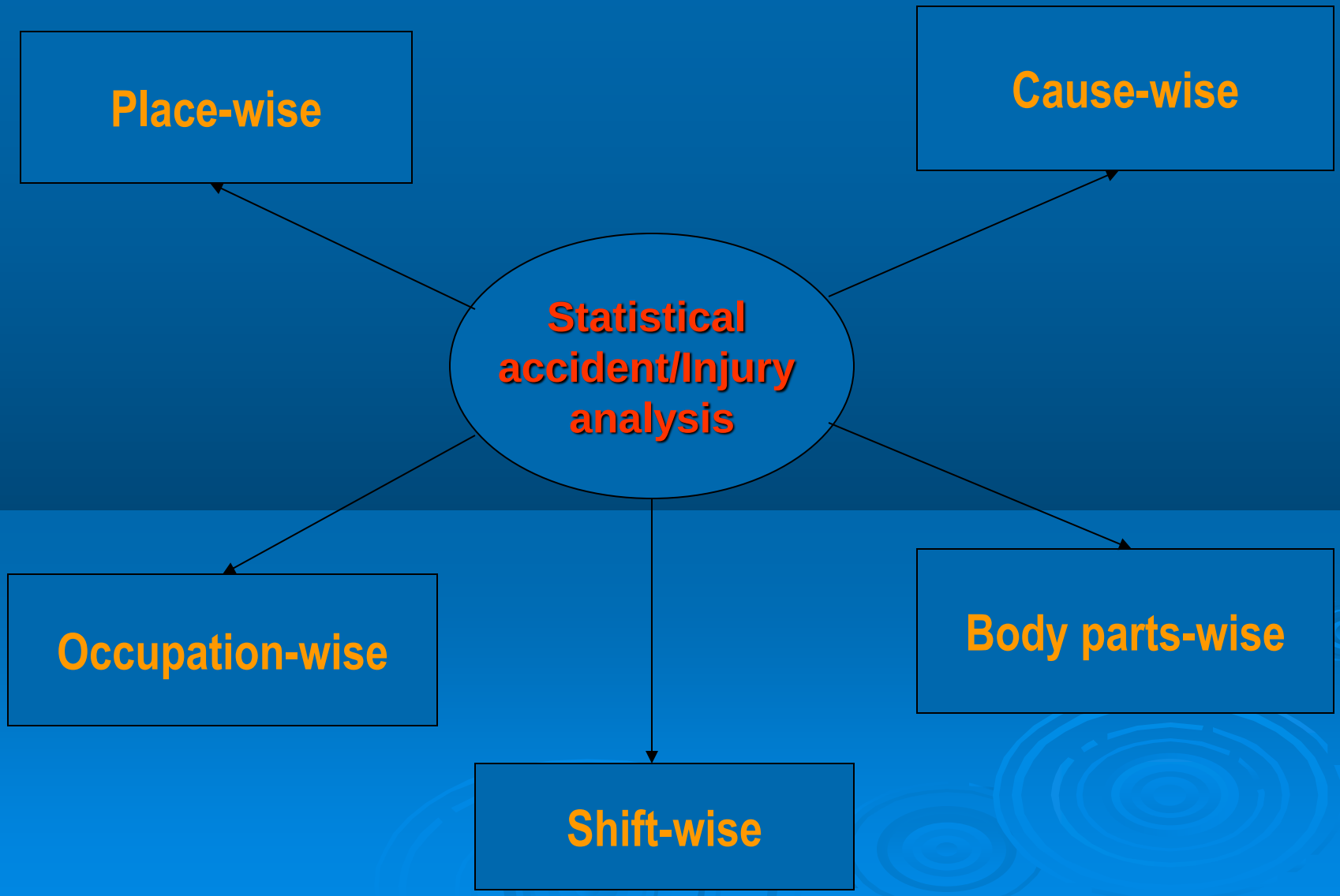
V. Other cause

Statistical accident/Injury analysis

Methods of Statistical accident/Injury Analysis

- **Bivariate analysis**
- **Multivariate analysis**

Statistical accident/Injury analysis



Statistical accident/Injury analysis

Place-wise analysis based on

- Belowground
- Opencast
- aboveground

Shift-wise analysis based on

- Morning Shift
- Evening Shift
- Night Shift

Statistical accident/Injury analysis

Cause-wise analysis based on

- **Fall-of-Object**
- **Fall-of-Roof**
- **Fall-of-Side**
- **Haulage**
- **Loading-of-Coal**
- **Slip-and-Fall**
- **Tools-and-Machines**
- **Transportation of Machine**
- **Others**

Statistical accident/Injury analysis

Body parts-wise analysis based on

- leg
- Finger
- Back
- Hand
- Knee
- Thumb
- Foot
- Head
- Others

Statistical accident/Injury analysis

Occupation-wise analysis based on

- ✓ Miner/loader
- ✓ Haulage-worker
- ✓ Piece-rated-worker
- ✓ Mech./Eeec.-fitter/helper
- ✓ Support –personnel
- ✓ Other-face- worker
- ✓ Driller/exp.- carrier
- ✓ Supervisory-staff
- ✓ Other- worker

Statistical Accident Analysis – A Case Study

By

Dr. P. S. Paul

(Published in IM&E Journal, 2001)

Frequency of mandays lost due to accidents/injuries for the case study mine during 1993-'96.

Mandays lost (day/days)	Frequency	Percent
1	19	8.09
2	93	39.57
3-5	30	12.77
5-15	61	25.96
>15	32	13.62

Mandays lost/injury

Mininmum: 1
Maximum: 172
Average: 10.51
Total mandays lost: 2533

Frequency of injuries and mandays lost based on occupation/job title for the case study mine during 1993-‘96

Occupation/ job title	Frequency	Percent	Mandays lost			Mandays lost per injury
			Minimum mandays lost	Maximum mandays lost	Total mandays lost	
Miner/ Loader	100	41.49	1	172	1230	12.30
Haulage-Worker	28	11.61	1	79	243	8.67
Piece-rated-worker	27	11.20	2	114	298	11.04
Mech./elec.-fitter/helper	18	7.47	1	75	183	10.17
Support-personnel	17	7.05	2	150	180	10.59
Other-face-worker	10	4.15	1	33	99	9.90
Driller/exp. -carrier	5	2.07	1	2	12	2.40
Supervisory-staff	4	1.66	2	3	13	3.25
Other-worker	32	13.28	1	56	275	8.89

Frequency of injuries and mandays lost based on cause of injury/accident type for the case study mine during 1993-‘96

Cause of injury/ accident type	Frequency	Percent	Mandays lost			Mandays lost per injury
			Minimum mandays lost	Maximum mandays lost	Total mandays lost	
Fall-of-object	24	9.96	1	150	386	16.08
Fall-of-roof	20	8.30	2	144	379	18.95
Fall-of-side	10	4.15	2	96	199	19.90
Haulage	26	10.79	1	23	166	6.38
Loading-of-coal	53	21.99	1	114	557	9.94
Slip-and-fall	41	17.01	1	172	406	9.90
Tool-and-machine	33	13.69	1	44	230	6.97
Transport-of-material	12	4.98	1	19	82	6.83
Other	22	9.13	1	25	127	5.77

Frequency of injury based on occupation and cause of injury and their cross-tabulation for the case study mine during 1993-'96

Occupation Group \ Cause of Injury	Fall of object	Fall of roof	Fall of side	Haulage	Loading of coal	Slip and fall	Tool and machine	Transport of materials	Other
Miner/loader	8 (8.00)	12 (12.00)	7 (7.0)	4 (4.00)	48 (48.00)	12 (12.00)	3 (3.00)	1 (1.00)	5 (5.00)
Haulage-worker	3 (10.71)	1 (3.58)	0 (0.00)	7 (25.00)	0 (0.00)	7 (25.00)	7 (25.00)	3 (10.71)	0 (0.00)
Piece-rated-worker	0 (0.00)	0 (0.00)	0 (0.00)	4 (14.82)	0 (0.00)	3 (11.11)	11 (40.73)	5 (18.52)	4 (14.82)
Mech./Eeec.-fitter/helper	2 (11.11)	0 (0.00)	0 (0.00)	5 (27.78)	0 (0.00)	4 (22.22)	6 (33.33)	0 (0.00)	1 (5.56)
Support –personnel	6 (35.29)	1 (5.88)	0 (0.00)	3 (17.65)	3 (17.65)	3 (17.65)	0 (0.00)	1 (5.88)	0 (0.00)
Other-face- worker	2 (20.00)	3 (30.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (20.00)	2 (20.00)	0 (0.00)	1 (10.00)
Driller/exp.- carrier	1 (20.00)	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	1 (20.00)	1 (20.00)	0 (0.00)	1 (20.00)
Supervisory-staff	0 (0.00)	1 (25.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (75.00)	0 (0.00)	0 (0.00)	0 (0.00)
Other- worker	2 (6.25)	2 (6.25)	3 (9.38)	2 (6.25)	2 (6.25)	6 (18.76)	3 (9.38)	2 (6.25)	10 (31.25)

Figures in the brackets indicate the percentage of injuries

Frequency of injuries and mandays lost based on body parts injured for the case study mine during 1993-‘96

Body part	Frequency	Percent	Mandays lost			Mandays lost per injury
			Minimum mandays lost	Maximum mandays lost	Total mandays lost	
Leg	83	34.44	1	172	1264	15.23
Finger	56	23.24	1	33	265	4.73
Hand	20	8.30	1	73	242	12.10
Back	17	7.05	1	114	282	16.59
Knee	14	5.81	1	13	61	4.36
Thumb	10	4.15	2	18	51	5.1
Foot	8	3.32	1	96	208	26
Head	7	2.91	2	3	15	2.14
All other	26	10.79	1	44	145	5.58

Frequency of injury based on body parts injured and cause of injury and their cross-tabulation for the case study mine during 1993- ’96

Body part \ Cause of Injury	Fall of object	Fall of roof	Fall of side	Haulage	Loading of coal	Slip and fall	Tool and machine	Transport of material	Other
Leg	8 (9.63)	8 (9.63)	5 (6.02)	7 (8.54)	27 (32.93)	14 (17.07)	5 (6.09)	3 (3.66)	6 (7.32)
Finger	3 (5.36)	2 (3.57)	1 (1.79)	8 (14.29)	13 (23.21)	1 (1.79)	16 (28.56)	7 (12.50)	5 (8.93)
Hand	0 (0.00)	2 (10.00)	0 (0.00)	6 (30.00)	1 (5.00)	6 (30.00)	3 (15.00)	0 (0.00)	2 (10.00)
Back	4 (23.53)	2 (11.77)	1 (5.88)	1 (5.88)	3 (17.64)	2 (11.76)	1 (5.88)	0 (0.00)	3 (17.65)
Knee	2 (14.289)	0 (0.00)	1 (7.14)	3 (21.43)	0 (0.00)	4 (28.57)	1 (7.14)	0 (0.00)	3 (21.43)
Thumb	3 (30.00)	0 (0.00)	0 (0.00)	1 (10.00)	3 (30.00)	2 (20.00)	1 (10.00)	0 (0.00)	0 (0.00)
Foot	1 (12.50)	3 (37.50)	2 (25.00)	0 (0.00)	0 (0.00)	1 (12.50)	1 (12.50)	0 (0.00)	0 (0.00)
Head	0 (0.00)	2 (33.33)	0 (0.00)	0 (0.00)	1 (16.67)	2 (33.33)	0 (0.00)	1 (16.67)	1 (14.29)
All other	3 (11.54)	1 (3.85)	0 (0.00)	0 (0.00)	5 (19.23)	9 (34.62)	5 (19.23)	1 (3.84)	2 (7.69)

Figures in the brackets indicate the percentage of injuries

Chapter - 5

Investigations into Accident and Accident Report

Investigations into Accident
(Part-I)

The primary purpose of accident investigation is to identify the causes and circumstances leading to the accident so that suitable measures may be taken to further accident of similar type.

Accident Investigation

a successful accident investigation must answer three questions:

1. What happened?
2. How it happened?
3. Why it happened?

and to serve as a basis of prevention, a fourth question:

4. How it can be prevented?

Accident Investigation

Procedure:

- Collection of basic information
- Inspection of the site of accident
- Preparation of accident site plan by the surveyor
- Examination of records, reports, plan etc.
- Examination of materials, equipments etc. and their testing, if required.
- Examination of Witness
- Analysis of evidence: Identification of the unsafe acts and condition

Collection of basic information

- Date and time of accident
- Name, age, sex and nature of job of the victim
- Details of Vocational training undergone by the victim
- Place of accident
- Apparent cause of accident
- Details of the mine working and operations related to the accident
- System of supervision and name of the supervisors

Inspection of the site of accident

- Observation of the minutest details at the accident site
- All materials and objects found at the site should be noted
- The position of the victim(s) and the eye-witness should be recorded
- The enquiry officer should himself draw a sketch plan of the accident site showing all the details

Preparation of accident site plan by the surveyor

The should prepare an accident plan an a scale having an R.F. of 100:1 showing all the details of the accident site

Examination of records, reports, plan etc.

A close examination relating to the accident is essential to ascertain:

- The general system of work
- Awareness of lurking dangers
- Promptness in dealing with defects and dangers
- Status of safety prevailing prior to the accident
- Availability and effectiveness of supervision

Examination of materials, equipments etc. and their testing, if required.

These should be examined by experts, and if necessary, be tested at a reliable laboratory

Examination of Witness

- The witness should be examined in a definite sequence
- The witness should be examined individually and separately
- All eye-witness should be examined at the site of the accident
- The inquiry officer should not disturb the emotional and verbose witness but allow them to speak
- If conflicting statements are made by different witness, the should be re-examined

Analysis of Evidence

- The inquiry officer should analyze systematically all the recorded evidence in the light of his own observations at the accident site.

- He should point out the contravention the contraventions of the statutory provisions and should identify the unsafe acts and unsafe conditions that resulted in the accident

Accident Report
(Part-II)

STRUCTURE OF THE ACCIDENT REPORT

The report should be detailed under the following heads:

- Introduction
- Background information
- Events prior to accident
- Occurrence of the accident
- Rescue and recovery
- Inspection and enquiry
- Analysis of evidence
- Causes of the accident
- Responsibility
- Recommendations

ACCIDENT REPORT

As a safety officer, put up a report of enquiry and investigation into a fatal accident due to fall of roof in a depillaring area killing two loaders on spot.

From : ---------- , Safety Officer,
---------- Colliery.

Dated, 30th November, 2009

To
The Manager,
---------- Colliery,
Sir,

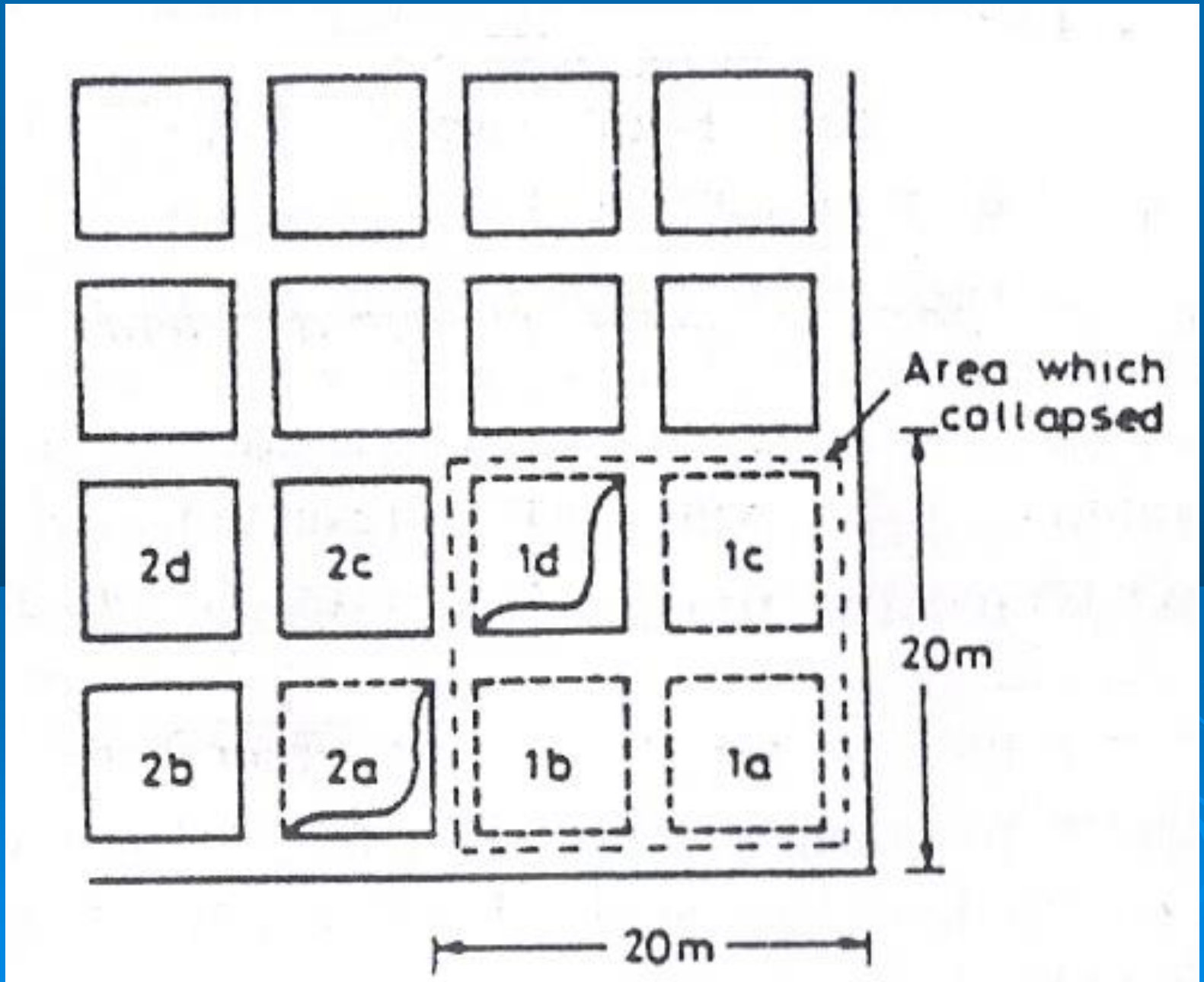
Ref. Your letter No. A/E – 235 dated 17.08.2008

I am submitting herewith a report on roof fall accident that occurred on 15th September, 2008 at about 10 p.m. in the depillaring district in ----------
seam at ---------- colliery and resulted in death of two loaders namely, ---------- and ----------.

Encl. Inquiry Report.

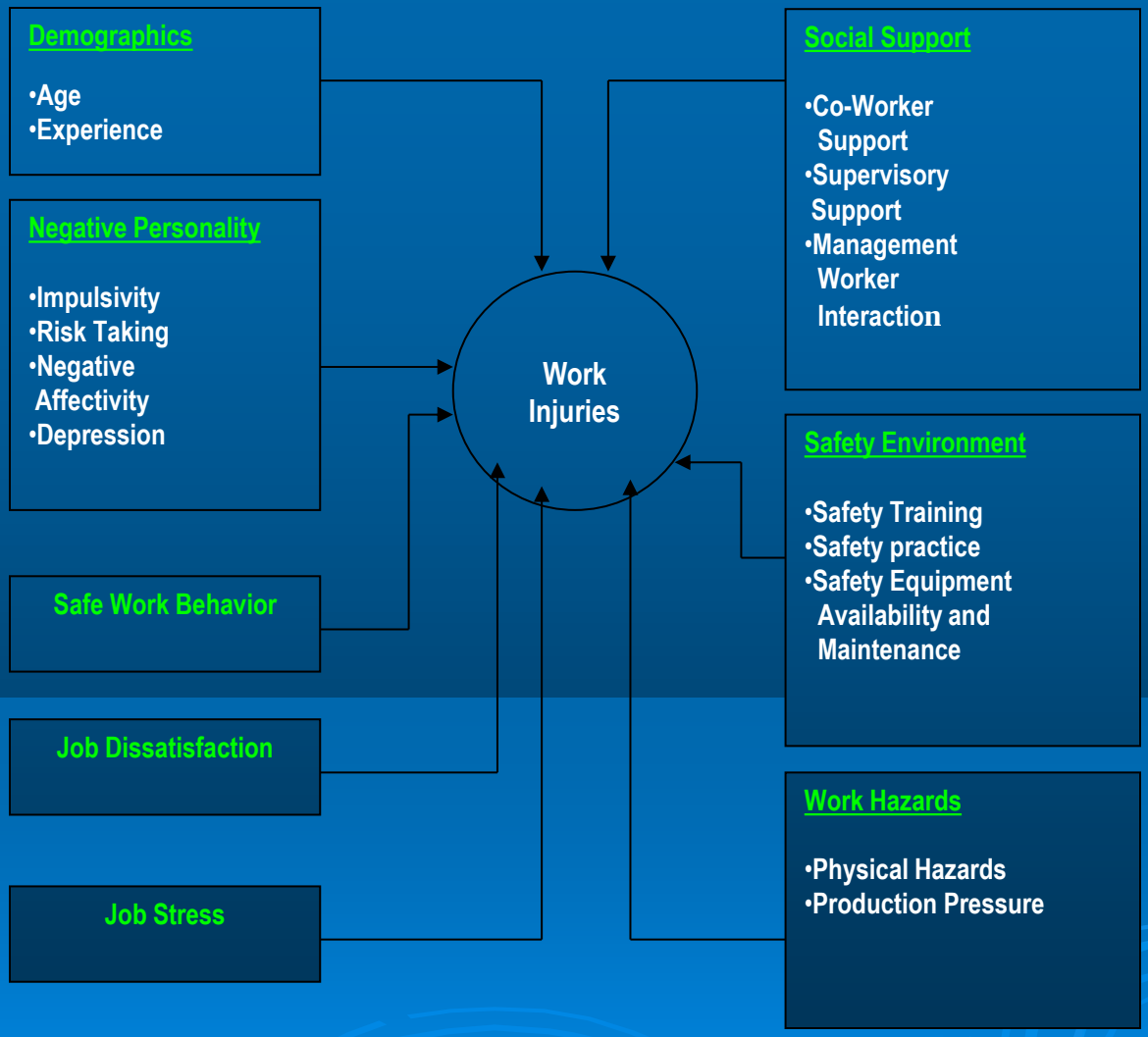
Yours faithfully,
(Signed)

ACCIDENT REPORT



Chapter - 6

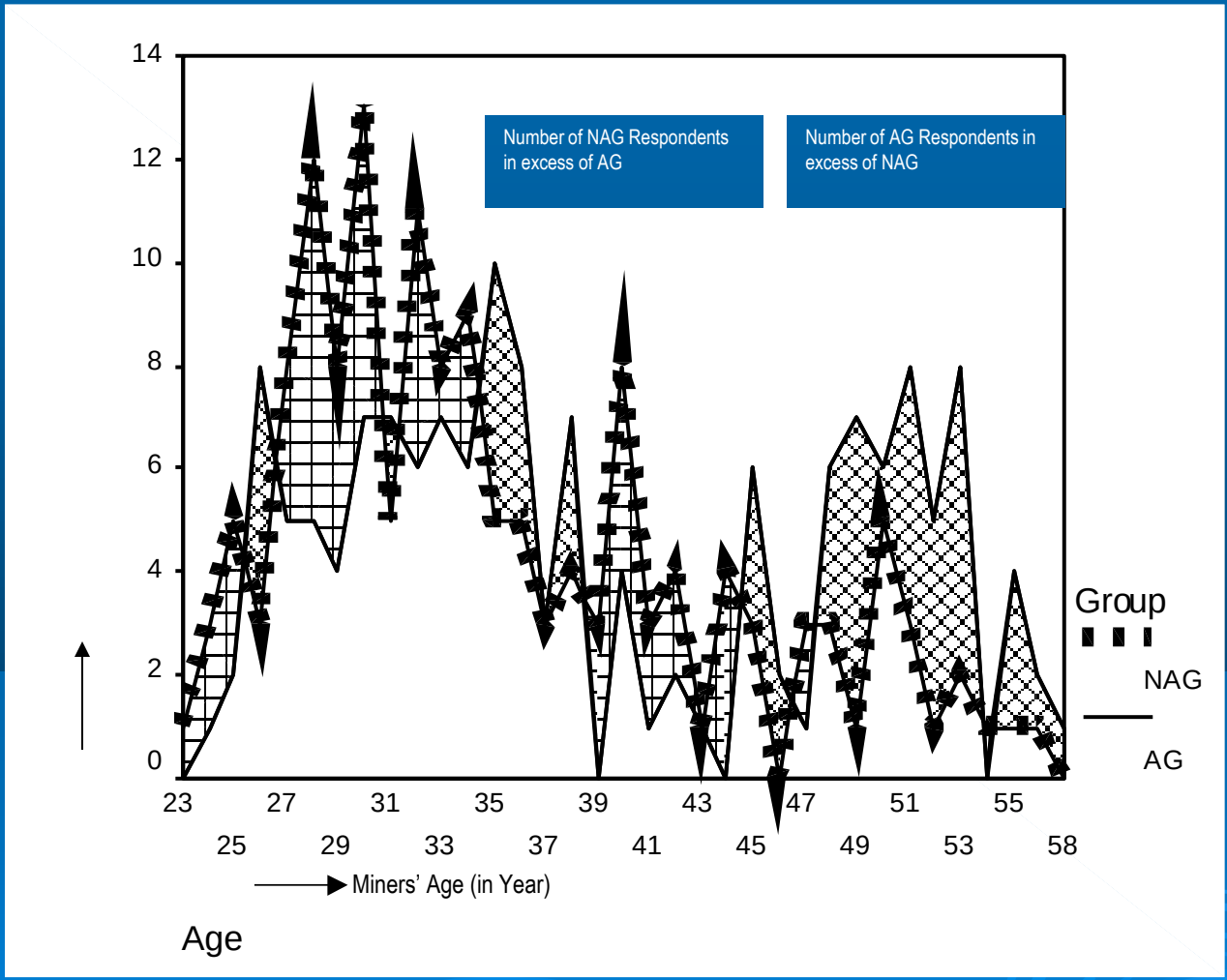
In-depth Study of Accidents due to Multivariate Cause (with case study)



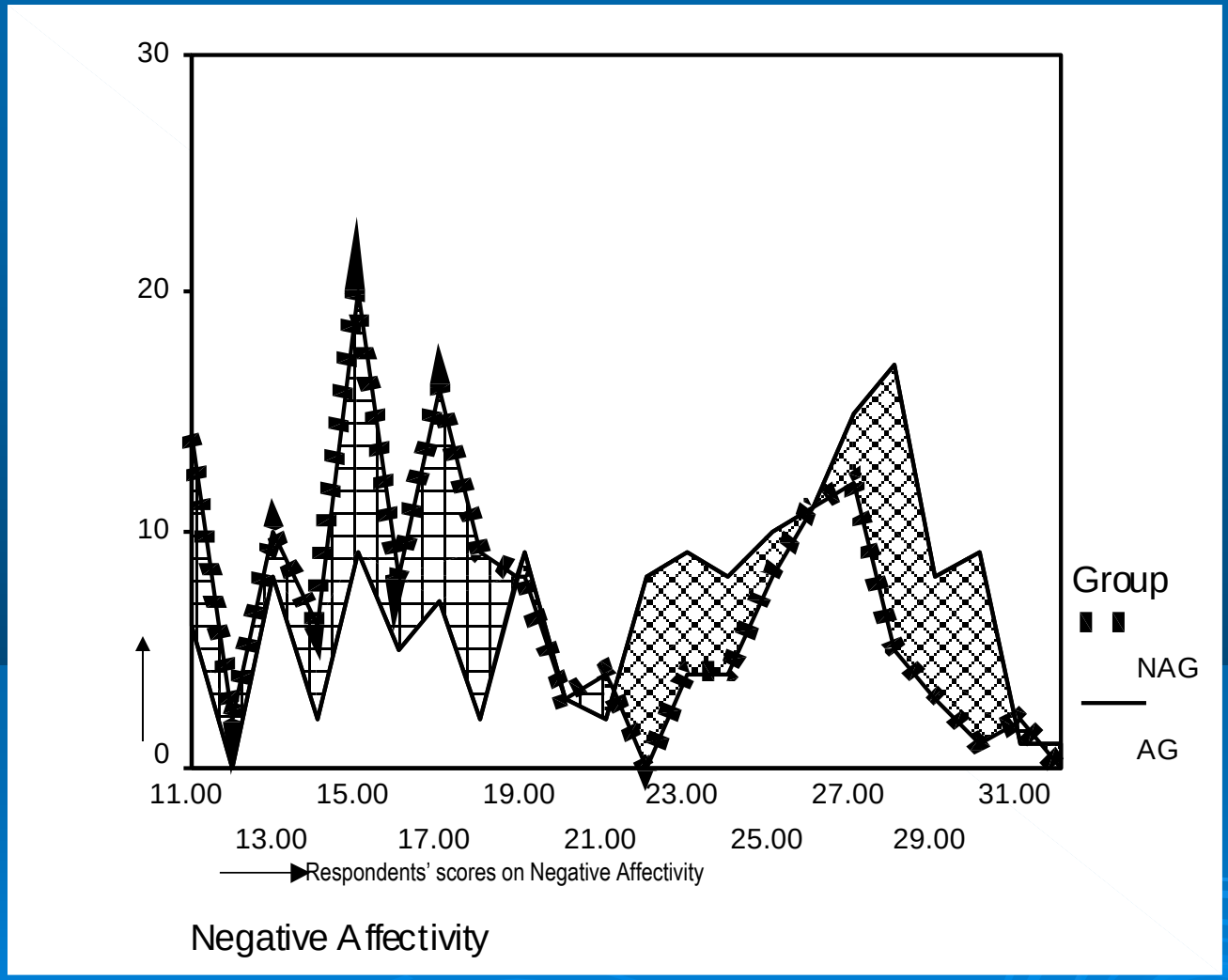
Determinants of work injuries in mines

Reliability and Validity Test of the Collected Data

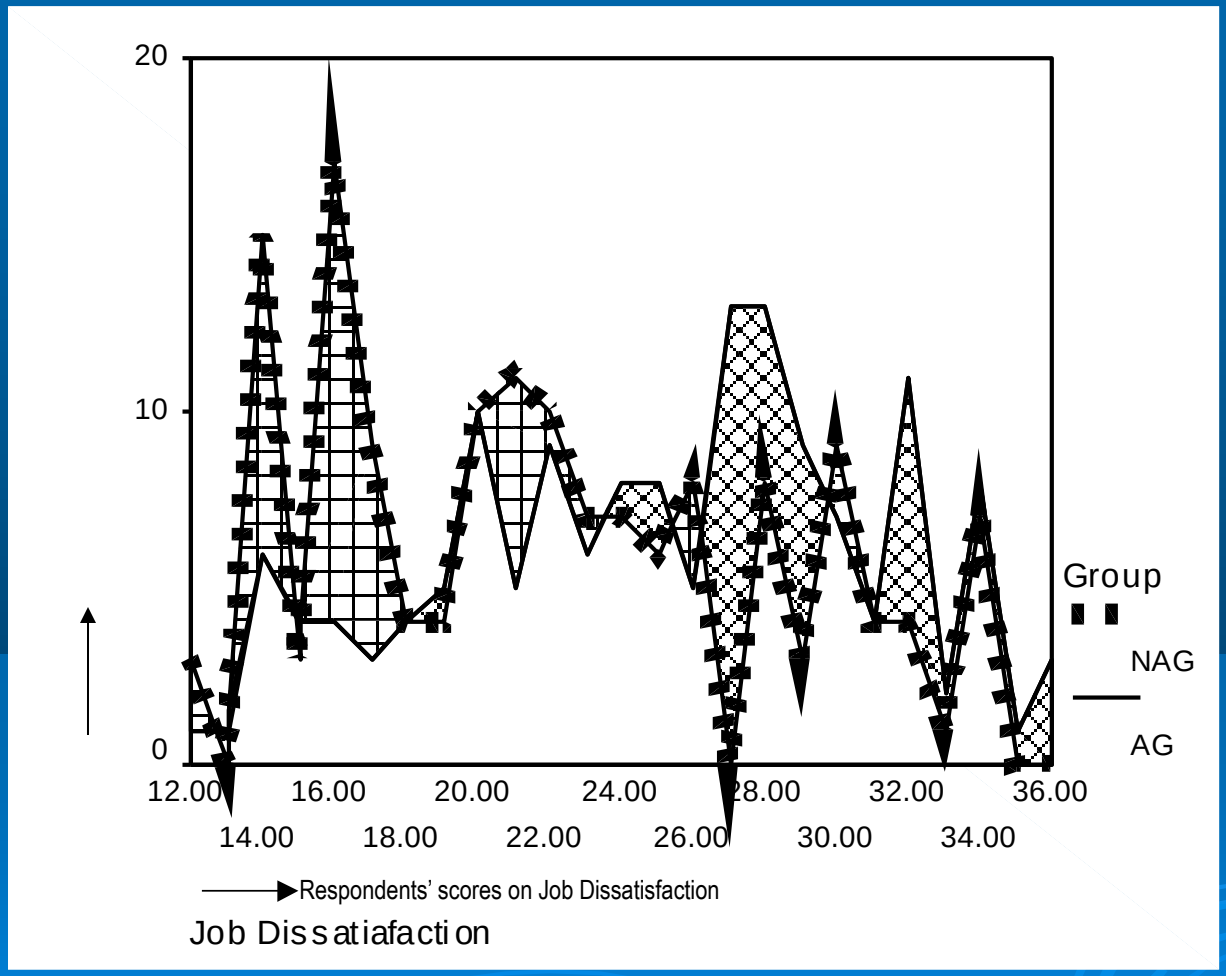
Identified factors	No. of questions asked to the mine workers	No. of questions retained after reliability and validity test	Reliability
Risk taking	11	9	0.82
Negative affectivity	15	11	0.83
Job Dissatisfaction	13	12	0.83
Impulsivity	12	8	0.71
Depression	5	5	0.65
Job stress	12	8	0.67
Safety training	8	6	0.66
Safety practice	27	19	0.80
Safety equipment availability and maintenance	9	8	0.72
Co- worker's support	7	5	0.64
Supervisory Support	7	7	0.71
Management worker interaction	14	10	0.84
Production pressure	4	4	0.79
Physical hazards	15	11	0.65
Safe work behavior	8	8	0.67



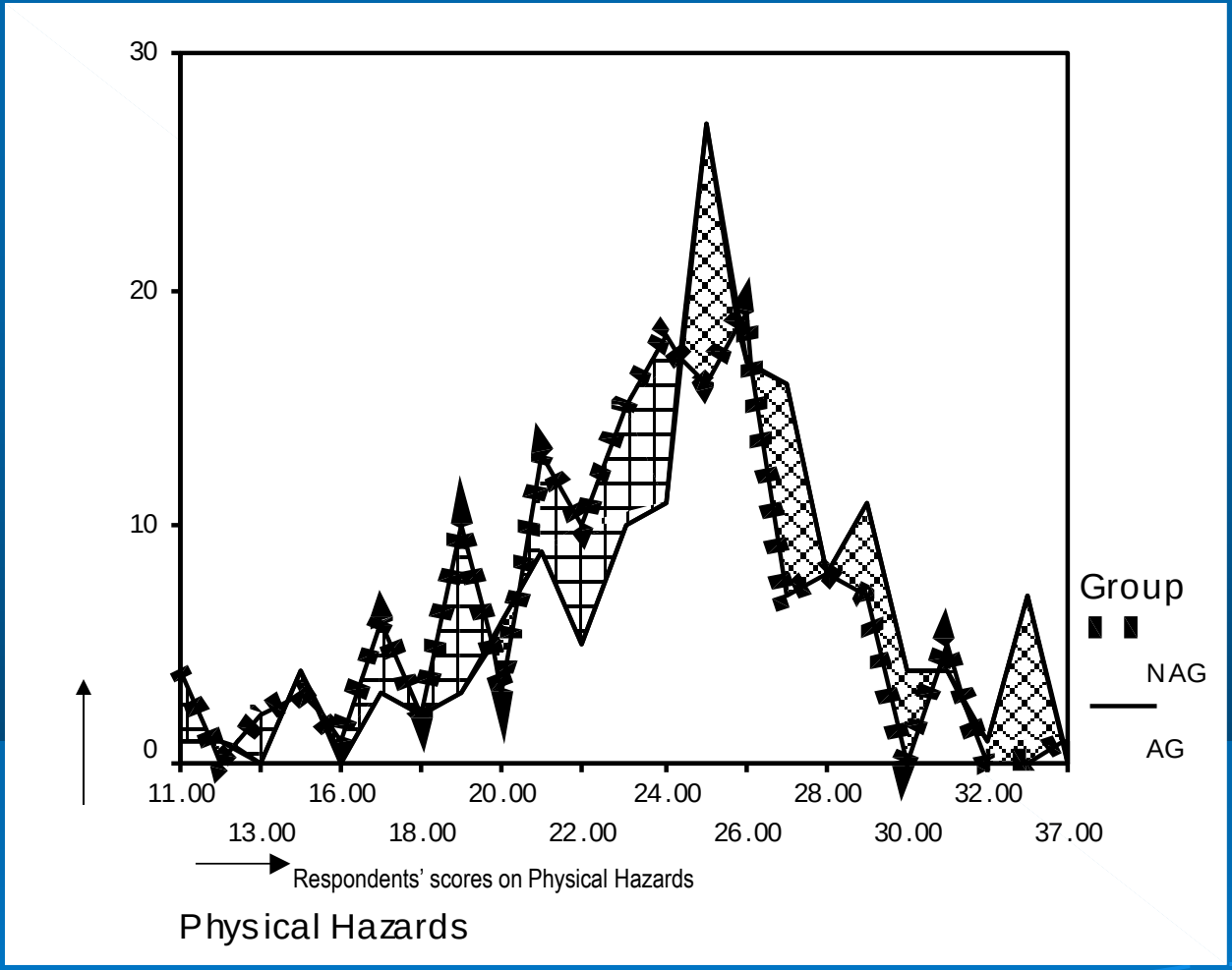
High-Low Plots between AG and NAG Workers



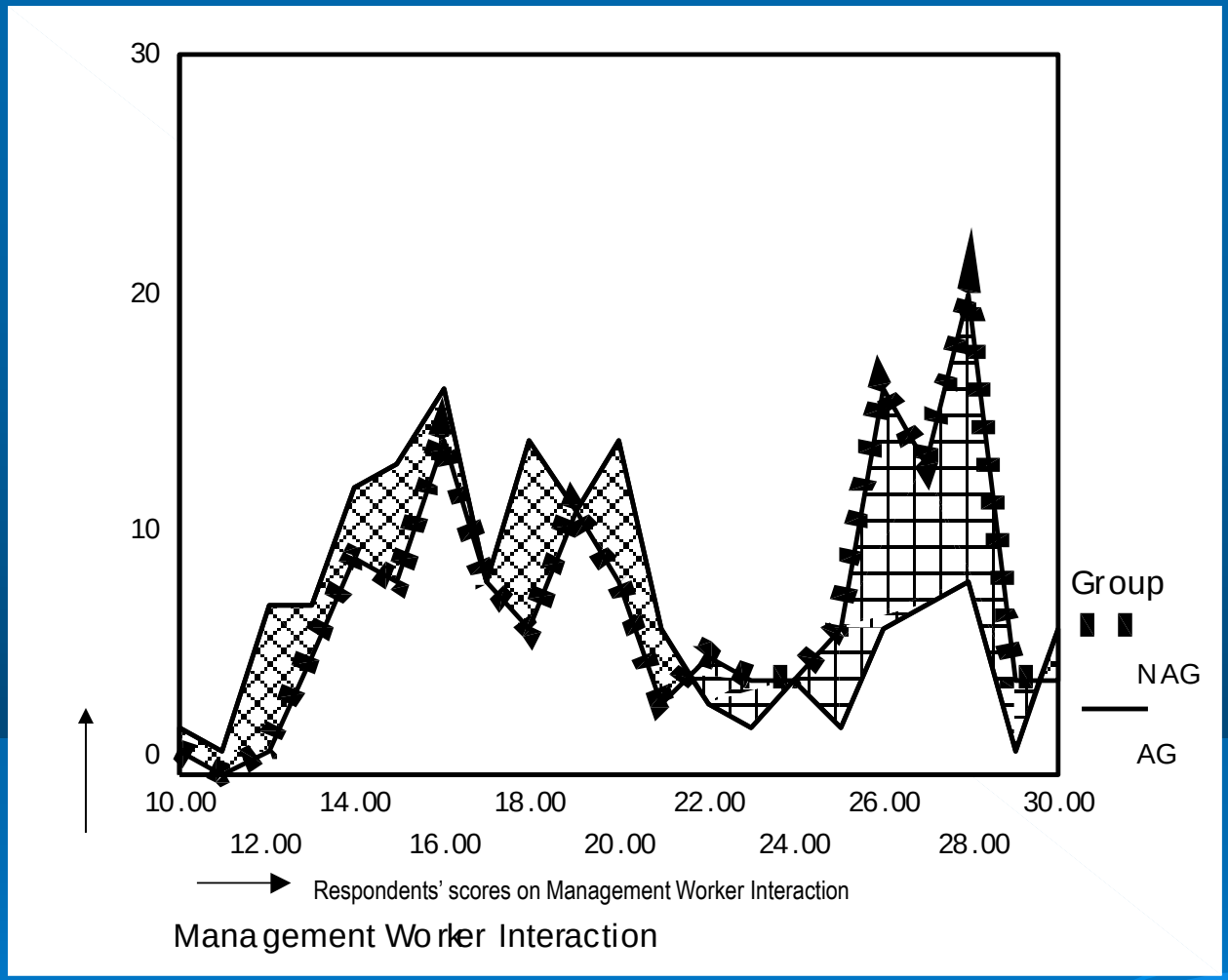
High-Low Plots between AG and NAG Workers (Contd.)



High-Low Plots between AG and NAG Workers (Contd.)



High-Low Plots between AG and NAG Workers (Contd.)



High-Low Plots between AG and NAG Workers (Contd.)

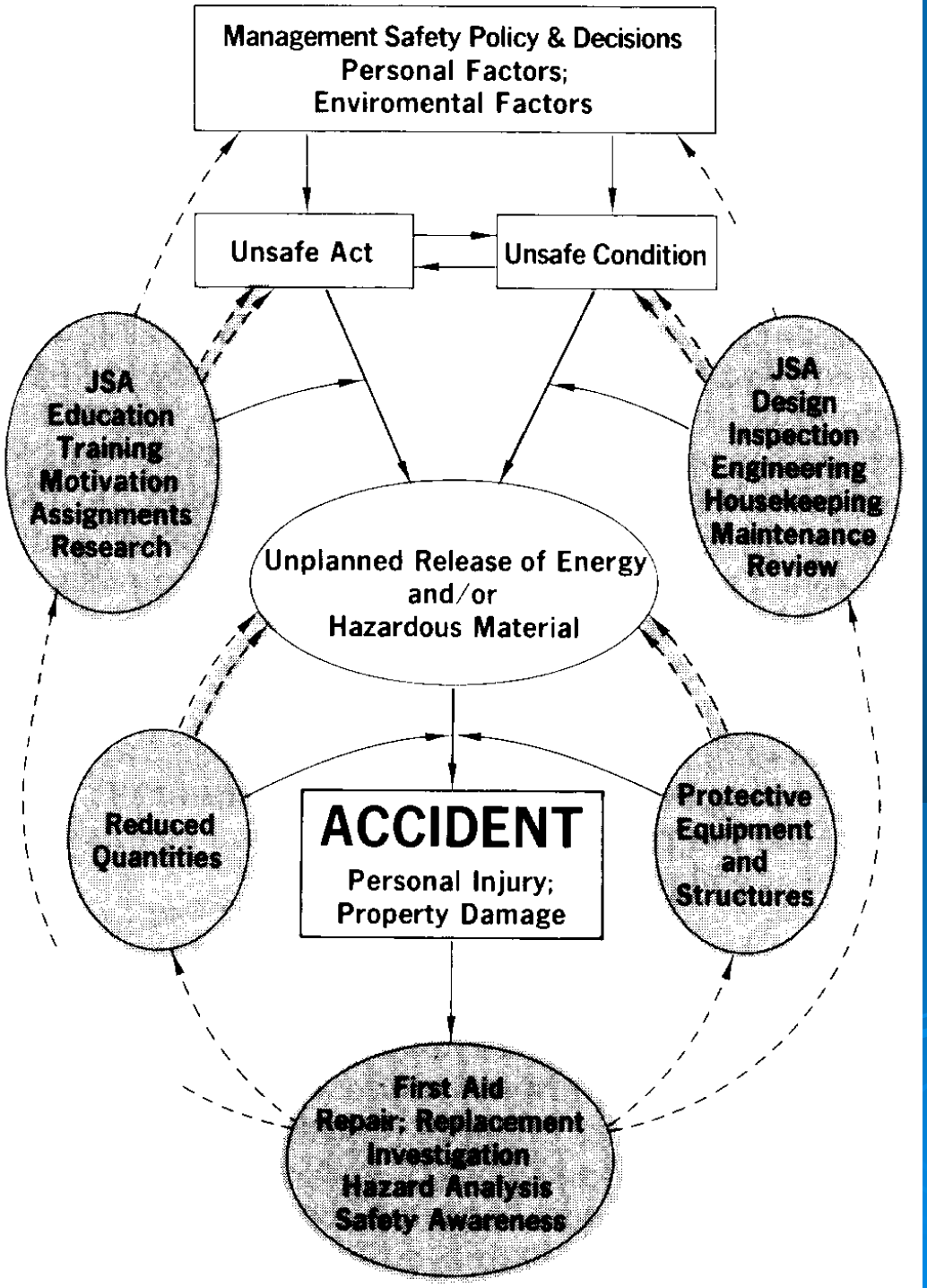
Chapter - 7

Measures for Improving Safety

Chapter - 8

Cost of Accidents

Chapter - 9
Introduction to Safety Management


Management Safety Policy & Decisions
Personal Factors;
Enviromental Factors
Unsafe Act
Unsafe Condition
JSA
Education
Training
Motivation
Assignments
Research
JSA
Design
Inspection
Engineering
Housekeeping
Maintenance
Review
Unplanned Release of Energy
and/or
Hazardous Material
Reduced
Quantities
ACCIDENT
Personal Injury;
Property Damage
Protective
Equipment
and
Structures
First Aid
Repair; Replacement
Investigation
Hazard Analysis
Safety Awareness

Risk

This is a measure of the likelihood and severity of a negative effect to environment, equipment/property, or the health.

The phase of evaluation is realized by estimating the probability of an unwanted event occurring (P) and the consequences of that event (D). Mathematically,

$$\text{Risk (R)} = P \times D$$

The sign x expresses the function according to the kind of evaluation. It can be a matrix or product. The risk index, particularly when estimating human risk to safety and health may vary according to human exposure to specific sites or sources.