STUDY OF SAFETY SYSTEM FOR UNSAFE ACTS / CONDITIONS AT CONSTRUCTION WORKPLACE

BY

AJAY KUMAR SINGH

COLLEGE OF MANAGEMENT AND ECONOMIC STUDIES / ENGINEERING

Submitted

IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY

TO

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
DEHRADUN
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UNDER THE GUIDANCE OF

Dr. Nihal Anwar Siddiqui , Associate Professor & Head ,HSE Department, University of Petroleum & Energy Studies, Energy Acres, PO Bidholi via Prem Nagar Dehradun- 248 001, Uttarakhand, India	**Dr. Ashutosh Gautam ,** Jt General Manager, India Glycols Limited, A-1, Industrial Area, Bazpur Road, Kashipur – 244 713 , Uttarakhand , India

DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

(Signature)

Name : **AJAY KUMAR SINGH**

Date : 01/02/2013

THESIS COMPLETION CERTIFICATE

This is to certify that the thesis on ***STUDY OF SAFETY SYSTEM FOR UNSAFE ACTS / CONDITIONS AT CONSTRUCTION WORKPLACE*** by ***AJAY KUMAR SINGH*** in partial completion of the requirements for the award of the Degree of Doctor of Philosophy (Engineering) is an original work carried out by him under our joint supervision and guidance.

It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other university.

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AJAY KUMAR SINGH

PREFACE

Attention to matters of occupational health and safety is a responsibility of everyone at work but it is of particular importance in the construction industry where accident rate is so high. Effective control measures of workplace safety in the construction industry is one of the means by which safety management can be improved and there was a need for to give sufficient information to take care for its own safety , manage the safe conduct of those employees for whom it is responsible and fulfill its moral and legal duty of care for safety of others, to reduce the number of injuries and fatalities.

The thesis therefore has been written primarily by civil engineer for civil engineers but its contents are relevant for architects, surveyors, builder and professionals and mangers engaged in construction and renovation of work.

Responsibility for safety and health is not only confined to construction work on site. Design engineer, architects and surveryoys are exposed to hazards during the investigatory stage of a project and while carrying out inspection tasks during the construction phase and on completed works.

The part of thesis is carry both a moral responsibility and duty of care for safety construction workers, maintenance staff , in some cases, renovated structure workers, and towards the public in general.

EXECUTIVE SUMMARY

CHAPTER 1 - INTRODUCTION

The first chapter comprises the construction industry covers vast field of activities in engineering, mechanical and civil process. The Indian construction projects have many special features, which adversely influence the safety and occupational health.

As the sector is unorganized and enforcement has not yet started to construction projects fullest extent, no accident reporting system is followed by the construction companies and hence, there is no reliable and accurate accident statistics for the construction *sector*.

Various steps to be followed during the study are as follows:

- Collection & Characterization of unsafe acts and conditions on workplace site activities from the EPCC's Contractors for various parameters.
- Literature collection on job activities for hazards and risk identification.
- Collection of primary and secondary data related to safe construction at workplace, level of technology, safety management practices in various construction industries.
- Ground truth and sample collection and evaluation from EPCC's contractors from plant construction activities related to safety issues.
- Understanding the construction safety viability of selected pockets of construction area .

CHAPTER 2.0 - LITERATURE REVIEW

Chapter 2.0 comprises with exhaustive literature survey carried out on historical background , statuary requirement, construction hazards at workplace in India and abroad, nature and origin of unsafe act and conditions with respect to construction activities with descriptive information regarding analysis of applying method of risk and analysis.

CHAPTER – 3.0 OBJECTIVE SETTING STUDIES REVISED

A Ranking observation Analysis is a procedure which helps integrate accepted safety and health principles and practices into a particular task or construction activities. In a Ranking observation Analysis, each basic step of the construction activities is to identify potential hazards and to recommend the safest way to do the construction activities by setting the target based objective.

The technologies being investigated is the idea of workplace observations on unsafe/ safe acts and conditions. The statistically-significant connection could be made between workplace construction and safety system, than it will provide more accurate measurements of workplace safety managing.

Methodology is based on the idea that workplace safety is an integral part of every construction activities and not a separate entity. In this method, only health and safety aspects will be considered.

CHAPTER – 4.0 OBJECTIVES SETTING FOR WORKPLACE SAFETY

Setting right objectives is critical for effective performance at construction workplace. In Ranking analysis the objectives are sets on the frequency of leading indicators in the form of safety / lapses at construction workplaces activities. During the observations at site, various observations are made on unsafe acts and unsafe conditions. In one activity there are various sub activities. By these sub activities, the unsafe acts and conditions are observed and most of the time repeated unsafe acts and conditions are observed. So here we are converting the Intangible Observations to tangible form ie in Numerical From for control measures preferences by statistical method.(with testing of hypotheses)

CHAPTER – 5 DATA EVALUATION

The data, after collection, has to be processed and analyzed in accordance with the outline laid down for the purpose at the time of developing the research plan. This is essential for a scientific study and for ensuring that we have all relevant data for making contemplated comparisons and analysis. The role of t- test and A- test statistics in research is to function as a tool in designing study, analyses its data and drawing the conclusion there from. In last, a graphic diagram depicting the relationship between two or more variables used, for instance, in visualizing scientific data for conclusion purpose.

CHAPTER 6.0- RESULTS & DISCUSSION

Chapter 6.0 includes ranking observation analysis of construction workplace by collecting the unsafe acts and unsafe conditions and to provides a valuable framework for project monitoring by identifying the unsafe acts and conditions over at any stage of the construction implementation. It uses as frequency measure system based on the project activities rather than on the functional organization of the firm.

CHAPTER 7.0 - CONCLUSION & RECOMMENDATIONS

The chapter concludes with highlighting the ranking method for lagging indication of unsafe act and unsafe condition at construction workplace site. The intangible observations have been converted to tangible form for effective control measures of unsafe act and conditions at construction sites by ranking technique. The Ranking approach is measures the risk and hazards by frequency observations and setting of preferential objectives to reduce the hazards at site. This is very simple approach and can be executed at any level of supervision with similar objective and targets.

CHAPTER 8- REFERENCES

It includes the list of literature / references cited related to construction safety, their workplace unsafe act / condition and health risk , hazards and control measures etc.

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CHAPTER - 1

INTRODUCTION

1.1. OVERVIEW OF CONSTRUCTION INDUSTRY

The largest segment of workforce in the country belongs to the unorganized sector. The Planning Commission set up a working Group and has identified seven sectors, namely, agriculture , construction , shop & establishments , beedi and cigar manufacturing , home work , eating places and waste management, as most common in un-organizing . The main concerns to improving the workplace safety standard in these sector are ; to identified types of hazards and accidents and to bring out documents for drawing action plans in the sectors , awareness among people on workplace safety , scarcity of audio visual exhibits for impact on health due to occupational activities, comprehensive enforcement strategy and guidelines on workplace safety aspects, codes of best practices etc.

Construction sector in our country has significant contribution to GDP and employed around 33 million people; hence, the issue of safety and health assumes importance. This is the second largest contributor to the GDP after the agriculture sector. It generates substantial employment and provides growth impetus to other manufacturing sectors like cement, bitumen, iron and steel , chemicals , bricks, paints, tiles etc. hence the concern for safety needs attention. The industry is characterized by the predominance of migratory and unskilled labor. A few data in respect of the industry in India is given as below:

Table 1.1 Employment in construction industry

Annual Turnover	Rs 3921 Billion
Contribution to GDP	6.2%
Employment	33 million workers
Engineers	04.7%
Technicians & Foreman	02.5%
Skilled Workers	15.3%
Unskilled Workers	73.1%
Annual Growth (Tageted)	08%

Source: CIDC Country Report 2005-06

1.2. THE SAFETY MOVEMENT IN INDIA

In India the history of the safety movement would broadly be the history of the factory legislation. In early stage, factory inspection was essentially a social service. It was one of the earliest pieces of social legislation. As per the Encyclopedia of Sciences (Macmillan Co.) the safety movement developed in five stages:

1. The improvement of the environment or the removal of physical hazards.
2. The improvement of personal practices through a combination of education and supervision.
3. The managements direct involvement at a lower level in safety problems. This lead to the setting up of various departments specifically charged with responsibility of ensuring the safety, health and the efficiency of the workers such as personnel, Medical, Safety, Industrial Hygiene and Training.

4. With the growing complexity of industry and the recognition that safety is an essential element in the profitability and the effective functioning of the enterprise safety was accorded front rank status. It was accepted that safety cannot be viewed in isolation, but has to be considered as an essential element in an integrated approach to the planning organization and operation of an industrial enterprise and not something to be super-imposed on an existing organization. Safety should be considered from the design stage and extended to the product safety and total loss control.
5. It is in fact a co-operative effort on the part of industries to prepare codes and standards to pool and disseminate information of technical aspects relating to safety.

1.2.1. NEED FOR SAFETY TO FRAME ACT:

Exploitation of child labour and the unrestricted employment of women were among the worst features of earlier factories in India. Major Moore, Mr. Ballard and Mr. Alexander Redgrave were some of the earliest to urge the necessity for factory legislation in India on the lines of the British Act to check these evils. Almost simultaneously, the Lancashire Cotton interests, growing apprehensive at the phenomenal growth of the Indian Cotton Industry, also started an agitation for achieving the same object, their aim being directed towards neutralizing the advantages the Indian capitalists had with regard to cheap labour. Such superfluous considerations resulted in the merits of legislation being obscured and a counter agitation was therefore, started by the Indian capitalists against any form of legislative enactment. A commission set up in 1875 by the Bombay Government at the instance 'of the Secretary of State recommended prohibition of employment of children under 8 years and a 12 hours day for adults.

Some leaders like Mr S.S. Bengalee fought for the labour's cause and were mainly responsible for getting a Bill referred to the Indian Legislature in 1879. An organized body of workers also put in a strong plea before the legislature for redress of their grievances. Finally, the Bill of 1881 was as Factories Act 1881. The most important provisions therein were: a)Prohibition of employment of children under 7 years, b)Working clay of 9 hours for children, c)Four holidays in a month, d)Intervals of rest , e)Fencing of machinery, f)Reporting of accidents and g)The Act was made applicable to a factory with mechanical power and workers 100 or more.

The Act, though inadequate from almost all points to the abuses, nevertheless was significant in that it secured recognition of the principle that Government would interfere in the industrial relations to protect the weak and oppressed.

The inadequacy of the 1881 Act led to continued agitation by workers, under the leadership of Mr. Bengalee for its amendment and Mr Meade King in 1882 after investigating labour conditions on behalf of the Bombay Government made recommendations for amending it.

Later on, a commission sat in 1884 and considered the question in detail. During the sitting of the commission, the labour movement was born; the workers met in a Conference and placed their view points before the Commission. Mr. Bengalee and Mr. Lokhanday took a prominent part in the Conference.

The agitation for protecting labour grew in momentum following the publication in 1886-87 in England of the report of Mr. Jones who had studied the factory conditions in Bombay during the period 1883-86. In 1890, a Commission was appointed by the India Government to again review the position and make suitable recommendations. Finally, the Amending Act, 1891 was passed and came into force from 1-1-1892. Its main advances over the 1881 Act were:

1. Inclusion of factories employing 50 or more under its purview.
2. Raising the minimum and maximum ages of children to 9 and 12 respectively and
3. Limiting the hour of work of women to 11 hours in any one day and that during the period 5 AM to 8 PM.
4. Weekly holiday
5. Rest interval of 1/2 hour.

The introduction of electric lights in the factories in 1895 and the devastating effects of plague at about the same time had its repercussions on the availability of labour to meet the increasing capacity for production. Evasions of the Act were widespread. Besides, the ginning factories which were the worst offenders had not been brought within the purview of the 1891 Act, as factories not working for more than 4 months in a year had been excluded.

The safety provisions in the 1891 was also to proved inadequate. This was brought to light by a number of tragic fires in the cotton presses between 1901 and 1905, resulting in over 50 deaths. The Government of India took a serious view and introduced in 1905 a bill for further amending the earlier act and this was circulated for public opinion.

At the direction of the Secretary of State, the Indian Government appointed in 1906 a Textile Factories Labour Committee with Mr Freer Smith as Chairman and again in 1907 a Committed with Hon. Morrison as Chairman to investigate factory working conditions. A bill embodying the recommendations of these Bodies was introduced and enacted the Factories Act of 1911. It came into force from 1-7-1912. Its chief provisions were:

1. Limiting the hours of work of male adults and children to 12 and 6 respectively
2. Children were required to produce certificates as to age and physical fitness and
3. Appointment of full-time inspector for the enforcement of the Act and inspection and certification of factories
4. Prevention and punishment for breaches
5. Power of local government for exceptions
6. Seasonal factories were included

The inauguration of the ILO in 1919 after the First World War lead to adoption of Conventions on hours, minimum age, night work of women and young persons etc, the growth of the labour question in India as a result of a number of strikes led to the ratification in 1921 of most of the Conventions. A

60 hour week conceded and night work for women and children under 14 was prohibited. In 1922 the Factories Act, was amended to include within its scope:

1. Industrial undertakings using mechanical power and employing 20 or more persons.
2. The minimum and maximum age of-children were raised to 12 and 15.
3. A six hours working day for children, a half hour rest interval after 4 hours work and prohibition of employment of a child in two factories on the same day.
4. Working hours 11 per day and 60 per week Control of artificial humidification and
5. No woman employment between 7 pm and 5-30 am.

Minor amendments for administrative purposes were made in 1923, 1926 and 1931. Following serious labour unrest in the country, a Royal Commission was set up in 1929 to review existing law in detail and make suitable recommendations after conducting an enquiry into the labour's living conditions. This resulted in the Act of 1934 in force from 1-1-1935. Its main provisions were:

1. Reduction of working hours
2. improvement of working conditions
3. Adequate inspection and observance of the Act of
4. Applicable to factories employing 20 or more workers and using power
5. Provisions for seasonal factories working for 180 days or less
6. Working hours 10 per day and 54 per week
7. Daily hours for children reduced to 5
8. New category o adolescent (between the age 15 to 17) included
9. Certificate of fitness from certifying surgeon for a child
10. Spread over of 13 hours for adults and 7112 hours for children
11. No women or children employment between 7 pm and 6 am.
12. Overtime wages at the rate of 1.25 times the ordinary rate for Work exceeding 60 hours a week.

13. Provisions for health and safety amplified. Provisions for cleanliness, ventilation, lighting, no overcrowding, drinking water, sanitary facility, washing facility, fencing for dangerous machinery, rest room for more than 150 workers, crèche for more than 50 women and first aid box were made .
14. Penalty up to Rs. 500 and enhanced penalty for repeated breach were provided.

The 1942 Conference was important as being the first attempt at collaboration between Government, employers and workers in matters pertaining to Labour. Arising there from, a Plenary Tripartite Conference and a Standing. New additions were made by section 36A regarding use of portable electric light, section 40A for maintenance of building, 40B for Safety Officers, 88A for notice of dangerous occurrences and section 91A for safety and health surveys.

The Bhopal accident created worldwide safety awareness and moved the governments to require more stringent provisions for health and safety of workers and public.

Therefore the Central and State Governments made necessary amendments in their Acts and Rules. A new Act the Environment (Protection) Act 1986 is passed and the Factories (Amendment) Act 1986 is also passed on 21-3-1987 providing new Chapter IVA on safety, other requirements and severe penalties and imprisonments for breaches.

The government of India has also frame the national policy on safety, health and environment at work place, which is shown in **Appendix A**.

1.3. ROLE OF ILO FOR SAFETY, HEALTH AND WELFARE

International Labour Organization was established in 1919 with its headquarters in Geneva. It has about 150 member countries. The opening words of its Constitution 'Universal and lasting peace can be established only if it is based on is social justice' indicate its main object.

Standard-setting is the ILOs oldest activity and it remains its fundamental task. Between 1919 and 1980, the ILO adopted 153 conventions and 162 recommendations, It carries out technical co-operation, international supervision, ensuring effective application, labour inspection, occupational health services, meeting, symposia, activities in the field of ergonomics, expert consultancy service, employment injury statistics, vocational rehabilitation, International Occupational Safety and Health Hazard Alert System and International Occupational Safety and Health Information Centre (CIS) for regular ILO publication and computerized data.

The last Encyclopedia of Occupational Health and Safety (Third revised edition in 1983) contain in two volumes 1150 articles prepared by 900 specialists from 60 different countries and 20 international organizations. These volumes are the best guide on any matter of health and safety.

1.3.1. CONVENTIONS AND RECOMMENDATIONS:

Since its inception in 1919, the ILO has adopted over 300 international instruments - Conventions and Recommendations. A Convention is a legal document regulating some aspects of labour administration, social welfare or human rights. A Convention creates binding obligations by virtue of its ratification by the Member State concerned.

A Recommendation is complementary to a Convention except that it is not subject to ratification. The very first Convention of the ILO, adopted in 1919, was on working hours in industry, the one, adopted in 1982, is on

Occupational Safety, Health and Working Environment, It reflects the current practices and development in the field of safety.

These international agreements (Conventions and Recommendations) relates to basic rights of labour, employment and training, conditions of work, social security and protection at work and are the result of detailed discussion at the annual International Labour Conference, comprising four delegates (two representing Government, one representing management and one representing labour) from each member country, speaking and voting individually.

The Conventions and Recommendations are not automatically binding, but governments must submit them to their national legislatures.

Reports from the different government on their implementation are examined annually by the Conference and there is also machinery for examination of complaints, including alleged violation of freedom of associations.

Though due to socio-economic conditions in the country and the existing situation it has not been possible for our country to ratify all of these Conventions and accept the Recommendations, most of the requirements are met to some extent in organized sectors of our industries such as factories, mines and docks.

Another form of ILO standards are the Model Codes of Regulations. Amongst these there is the model of regulations for industrial Establishments for the guidance of governments and industry intended to provide information applicable to the majority of industrial undertakings and covering all matters concerning occupational hygiene, welfare and health.

List of instruments concerning Occupational Safety and health and the Working Environment adopted by the international Labour Conference since 1919 is given in **Appendix B**.

1.4. THE CONSTRUCTION INDUSTRY ACCIDENT RECORD

In typical decade about 1500 people are killed on construction sites in Britain (Indian construction industries data not available to us) and 25000 – 30000 more are seriously injured. In addition, 300000 - 400000 suffer injuries sufficient to keep them off their normal work for at least three days.

Table 1.2 Fatal and major injuries in construction

Year	Death	Major Injuries	Total
1981	128	1727	1855
1982	135	1999	2134
1983	150	2232	2382
1984	130	2356	2486
1985	138	2257	2495
1986 Jan/ Mar	26	576	602
1986/7	125	3179	3304
1987/8	143	3328	3471
1988/9	136	3620	3756

Source: Health and Safety Executive

Note:

1. From 1986 the reporting year is April to March.
2. Fatalities and major injuries to the employed and self-employed are included in the table but not the non- employed.
3. The continuity of major injury statistics was disturbed in 1986 by a revised definition of major injury.

Table 1.2 shows the annual deaths and major non – fatal injuries to employees in the construction industry for 1981- 89. In 1985 the procedure for reporting injuries, diseases and dangerous occurrences were revised which disturbed the continuity of major injury statistics. However, the injury rate in construction industry continues at an unacceptably high level.

Unfortunately, it is not only the construction workers themselves who suffer injuries and death. In 7.5 years to march 1988 at least 88 people not employed in the industry, including more than 21 children, were killed on construction sites or because of construction activities and a further 875 were seriously injured. To put accident figure in perspective they must be linked to the number of people at risk. Thus, comparison of incident rates, which are the number of fatalities and major injuries per 100 000 employed, provide a means of assessing the relative danger for people at work in various industries.

Table 1.3 Fatal and major injury rates per 100 000 employees

Year	Fatal		Major Injury	
	Construction	Manufacturing	Construction	Manufacturing
1981	9.7	2.0	155	69
1982	9.7	2.4	188	72
1983	11.6	2.2	213	80
1984	9.8	2.7	225	90
1985	10.5	2.4	225	92
1986/7	10.2	2.1	212	45
1987/8	10.3	1.9	276	142
1988/9	9.8	1.8	282	141

Note:

1. Revised definition of major injury from 1986
2. This table does not include the self-employed.

Table 1.3 compares the injury rates of the manufacturing industry with those of the construction industry for 1981 to 1988-89. In the construction industry the risk of major injury is two to two and a half times grater and the risk of a fatal accident nearly five times greater than in the manufacturing industry.

In India, as the sector is unorganized and enforcement has not yet started to its fullest extent, no accident reporting system is followed by the construction companies and hence, there is no reliable and accurate accident statistics for the sector. **During the period of 2003-05, 8 fatal and 1 major accidents were reported** to the office of Chief Labor Commissioner, Central.

1.4.1. REASON FOR POOR RECORD

There are a number of reasons why the accident record in the construction industry compares poorly with that of manufacturing industry.

Table 1.4 Comparisons of Construction Industry Vs Manufacturing Industry

S No	Construction Industry	Manufacturing Industry
1	In the construction industries the working environment is constantly changing, sites exist for a relatively short time and the activities and inherent risks change daily.	In factories there is controlled environment, with little change in working procedures and equipment for long periods.
2	There is a high turnover in workforce, which means safety awareness is not always as good as it should be	The labor force usually remains fairly constant.
3	Within a short time of hazard being identified and dealt with, the work scene has changed, bringing new hazards.	Hazards once identified can be remedied with relative ease and danger can be overcome
4	The complexity of the construction industry with its many small firms, subcontractors and self-employed labor militates against the establishment of safe working practices.	Mostly employed by the manufacture industry.

5	The financial resources of small firms are generally insufficient to provide the necessary high standard of safety training carried out by many of the larger firms.	The financial resources are fixed after production started. The manufacturing industries are established at one place so safety arrangements are not changing with activities.
6	The managerial knowledge of many small contractors is based on experience and often lacking in theoretical background.	The products production is skilled job based on technical knowledge.
7	Many small contractors do not employ a professional safety advisor and have neither the time nor the inclination to keep abreast of legal requirements and technical development and safety matters.	Manufacturing industry comes under the Factory Act 1948. As the legal requirement, management has deputed the safety officer under the clause of 40B of The Factory Act.

When competition is particularly fierce, some contractors are prepared to ignore safety legislation and good working practices in order to bid competitively. Unfortunately, there are also clients who are not willing to employ these contractors regardless of their competence in safety management.

The majority of accidents can be prevented by dedicated safety management and a disciplined approach to ensure compliance with safety rules and procedures by all involved in construction operations. This should be evidence from the top management down. The tough image which flouts all foreseeable dangers is a major obstacle to be overcome for it not only causes individual causalities but also affects large sections of the industry, resulting in the widespread axiom that ‘If you are not prepared to take risk you should not be in the business.

1.5. IMPORTANT DEFINITIONS

BUILDING OR OTHER CONSTRUCTION WORK: "Building or Other construction work" means the construction, alteration, repairs, maintenance or demolition, of or, in relation to, building, street, roads, railways, tramways, airfields, irrigation, drainage, embankment and navigation works, flood control woks, generation , transmission and distribution of power, water works, oil and gas installations, electric lines, wireless, radio, television, telephone, telegraph and overseas communications, dams canals, reservoirs, watercourse, tunnels, bridge, viaducts, aqueducts, pipelines, tower, cooling towers, transmission towers and such other work as may be specified in this behalf by the appropriate Government, by notification but does not include any building or other construction work to which the provisions of the Factories Act , 1948(63 of 1948), or the Mines Act , 1952(35 of 1952), apply.

As per BOCW Act1996 of Chapter I of 2(d)

WORKPLACE: All places where workers need to be or to go by reason of their work.

HAZARD: A set of conditions which has potential of causing damage to property, injury to person, or to environment.

RISK: The cumulative effect of the chances of predictable/ unpredictable occurrences which adversely affected project objectives.

CONTRACTOR : Contractor means a person who undertakes to produce a given result for any establishment, other than a mere supply of goods or articles of manufacture, by the employment of building worker or who supplies building workers any work of the establishment; and includes a sub-contractor.

EMPLOYER: Employer in the relation to an establishment, means the owner thereof, and includes, -

- In relation to a building or other construction work carried on by or under the authority of any department of the Government , directly without any contractor, the authority specified in this behalf , or where no authority is specified , the head of the department.
- In relation to a building or other construction work carried on by or on behalf of a local authority or other establishment, directly without any contractor, the chief executive officer of that authority or establishment;
- In relation to a building or other construction work carried on by or through a contractor, or by the employment of building worker supplied by a contractor, the contractor.

ESTABLISHMENT : Establishment means any establishment belonging to , or under the control of , Government, anybody corporate or firm, an individual or association or other body of individuals which or who employs building workers in any building or other construction work; and includes an establishment belonging to a contractor, but does not includes an individual who employs such workers in any building or construction work in relation to his own residence the total cost of such construction not being more than rupees ten lakhs.

As per BOCW Act1996 of Chapter I of 2(d)

UNSAFE ACT: Performance of a task or other activity that is conducted in a manner that may threaten the health and / or safety of workers.

UNSAFE CONDITION: A condition in the work place that is likely to cause property damage or injury.

(Note: Some photographs are attached of workplace at page no 18.)

1.5.1. STANDARDS REQUIREMENTS

CLAUSE 4.3.1: PLANNING FOR HAZARD IDENTIFICATION, RISK ASSESSMENT AND RISK CONTROL: The organization shall establish and maintain procedures for the ongoing identification of hazards, the assessment of risks , and the implementation of necessary control measures. These shall include:

- Routine and non-routine activities;
- Activities of all personnel having access to the workplace
- Facilities at the workplace, whether provided by the organization or others.

(Safety standard OHSAS 18001)

CLAUSE 4.3.3: OBJECTIVES: The organization shall establish and maintain documented occupational health and safety objectives, at each relevant function and level within the organization.

Note: Objectives should be quantified wherever practicable.

(Safety standard OHSAS 18001)

CLAUSE 4.3.4: OH & S MANAGEMENT PROGRAMME (S): The organization shall establish and maintain (an) OH & S management programme(s) for achieving its objectives. This includes documentation of:

- The designated responsibility and authority for achievement of the objectives at relevant function and levels of the organization; and
- The means and time-scale by which objectives are to be achieved.

(Safety standard OHSAS 18001)

GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT (GRIHA): It is India's National Rating System for Green buildings. It has been developed by TERI (The Energy and Resources Institute) and MNRE (Ministry of New and Renewable Energy). It is based on nationally accepted energy and environmental principles, and seeks to strike a balance between established practices and emerging concepts, both national and international.

CRITERION 8: Provide minimum level of sanitation/ safety facilities for construction Worker.

MANDATORY CLAUSE: Compliance with National Building Code norms on construction safety for ensuring safety during construction , as per GRIHA.

1.6. **OBJECTIVE OF THE STUDY:** The objective of the proposed study would be the development of numerical method for unsafe acts and unsafe conditions of construction activities and providing guidelines for effective implementation of workplace safety that are impediment in the construction industries. The study would be designed at every stage in keeping in view of following board objectives;

- To study the workplace safety system and method.
- To ascertain the challenges that the present status of safety to the construction industry ; and
- Intangible Observations to be converted to tangible form ie in Numerical From for control measures.

1.7. **SITE PHOTOGRAPHS:** A few photographs are attached for safe and unsafe practices of acts & condition at different construction work place (From Page No.18-23).

SAFE CONSTRUCTION WORKPLACE

P-1: HT Height Barrier for Vehicles Movement

P-2: Enclosed Batching Plant Materials Bin

P-3: Stack Height of DG set

P-4: Hard Barricading at Hot Mix Plant

P-5: Gunny Bags barricading at Opening

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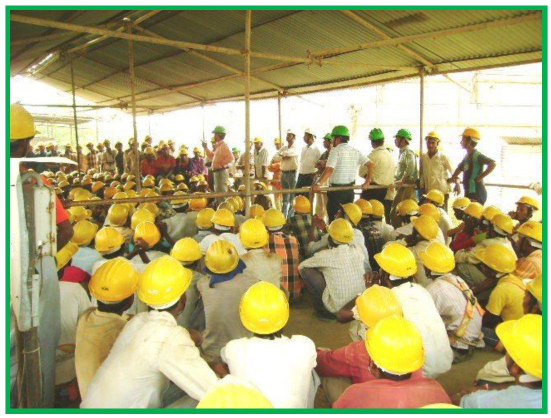

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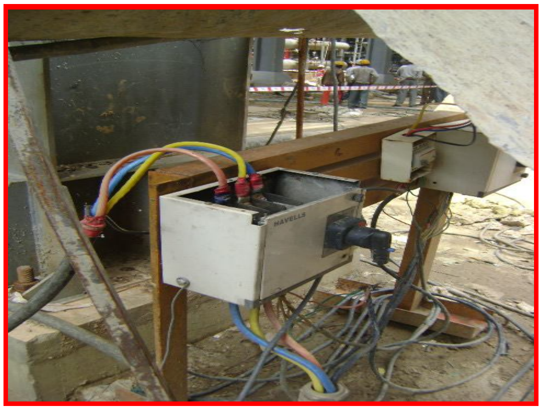

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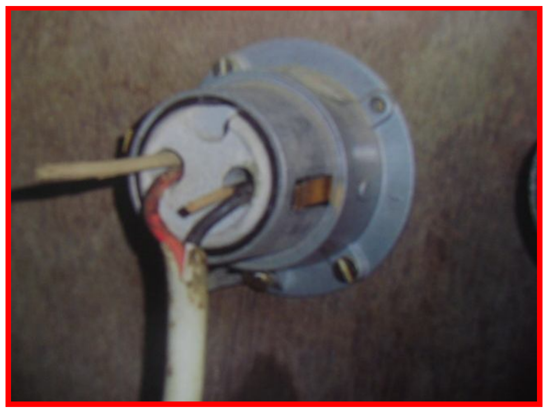

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CHAPTER – 2

LITERATURE SURVEY

2.1. PART A: ACCIDENT PREVENTION

With rapid advances in construction industries activities, newer types of dangers to life limb and health are being increasingly introduced. Construction, Mechanical, electrical, chemical and radiation hazards affect us on all sides, yearly; several lakhs of employees are injured in construction industries due to accidents.

These accidents represent a social loss of great magnitude in the form of pain, loss of hearing capacity and cost due to disturbance to economic efficiency. The pain and suffering of the injured as well as the emotional loss to the victims of the fatalities and accidents causing permanent disfigurements or disabilities are impossible to be summed up or evaluated. The economic cost is more tangible of being computed, though practically, no figures are available in terms of the total cost of accidents in our construction industries.

To the management, it is the direct cost for meeting medical expenses, compensation or disablement benefits to the injured or their families and also the various other indirect costs due to the interference caused by accidents which are generally taken roughly as four times the direct cost. To the society, the economic cost is in terms of loss of productive capacity and the cost of maintenance of the injured and their families through social security schemes or through public or private charities.

In the absence of data relating to total economic losses due to accidents, a very approximate idea can be had by making use of the figures published by the Labour Bureau. Similarly, the claims paid by the Employees State Insurance Corporation in respect of establishments covered by the Employees State Insurance Act. The total cost of payments for temporary and permanent disablements and dependants benefits paid by the corporation during the year 1978-79 in accident cases covered by the Scheme was R14.28 Crore. This forms only one part of the direct costs, in as much as the cost of providing medical care has not been included. No figures are available in respect of the latter. All the same, for our purpose, it can be indicated by using the multiplication factor suggested by Heinrich (Indirect costs 4 times direct costs) that the total cost of the accidents in which compensation was paid by the Employees State Insurance Scheme alone would for exceed R 70 Crore.

Yet is the human consequence of accidents that in the last analysis are most important and should be most real to us. When we quote accident statistics, we should remember that we are not just talking about figures but about individual men and women, and girls with their own aims and aspirations in life, to which society owes its firm responsibilities.

2.1.1. CONSTRUCTION MANAGEMENT'S RESPONSIBILITIES

Let us for a moment look at the place of construction industry in society. Individual men and women enter construction industry for different personal reasons, the predominant reasons being to make money to meet their personal needs. The function of construction industry as a whole is different from the sum total of many individuals search for a livelihood. It is the production of services which society requires with a minimum waste of resources. In this larger context, it is important that production or productivity should not be regarded as an end itself but as a means of attaining the supply of services, income and leisure, in order that all people can improve their standard of living, and enjoy the benefits, which these results can bring, to the creation of fuller and more satisfactory life. If, in the achievement of this, the path becomes tormented with causalities who are killed or maimed, mentally or physically or who are allowed to suffer in other ways from injuries, it indicates failure on the part of the industrial management to discharge its prime social responsibility of producing efficiently.

Construction management's prime duty to the nation is that it should not squander the most precious resources of men. Besides, the heavy cost due to accidents is a waste which, in these days of ruthless competition we can ill afford. Like other forms of waste it is a serious reflection on the standard of overall efficiency of those organizations where the accident rate persists at a high level. Management responsibility to achieve adequate safety performance at construction workplace:

- Make crystal clear to all levels of supervision will be held accountable for safety at construction site.
- Provide a safe and healthy place to work.
- Provide adequate training and supervision to develop safe work habits in all employees.
- Organizing the safety activities as a continuing function.

2.1.2. FACTORS IN AN ACCIDENT: Hepburn amplifies the above theory formulated in the early nineteen twenties by Heinrich and arrives at the principle that an injury accident is the result of the convergence at the same point of time of 4 factors namely, personal factors and the proximate causal factor. The reference to the personal factor by Hepburn, should be indicated, is to the person or persons injured or likely to be injured by an accident and not to the person or persons who might have committed faults to create situation which has led to or are likely to accidents.

The 'proximate factor' is that immediate causative factor such as the failure of brake, which by its reaction causes a sudden closing together or convergence of all the four factors to cause an injury/accident. He emphasizes that the four factors are complementary to one another in causation of an injury/accident such that, if any one or more can be withdrawn by any means during or just before convergence, an injury accident will be averted. "The event of an accident will not be prevented by endeavours to perfect any one of the factors to the exclusion of the others."

"Remedial measures must be considered and adopted, as necessary, for each of the four factors, if a successful campaign is to be conducted." Avoiding too theoretical a discussion on "escape from the accident" convergence, the solutions discussed under the four factors would also lead to the most practicable preventive measures suggested by Heinrich. These are planning and organizing to:

(a) Prevent unsafe actions being committed; and

(b) Removing unsafe mechanical or physical conditions.

2.1.3. UNSAFE ACTIONS OR ACTS: Classification, causes and prevention are generally classified as:

- Operating without authority, failure to secure or warn;
- Operating or working at unsafe speed;
- Making safety devices inoperative;
- Using unsafe equipment, hands instead of equipment; or equipment unsafely;
- Unsafe loading; placing, mixing, combing, etc;
- Taking unsafe position or posture;
- Working on moving or dangerous equipment;
- Distracting, teasing, abusing, startling, etc. and
- Failure to use safe attire or personal protective device

Very often one does not have to study the sub-causes for the unsafe actions of persons before remedial measures can be suggested for prevention of such action. However, in many instances there is a need for finding the underlying reasons for unsafe acts and when these are discovered, they lead to the proper selection and application of effective measures in accident prevention, the reasons or sub-causes that give rise to unsafe actions have been classified by Heinrich, as stated earlier under the four broad headlines of anatomical or physiological unsuitability, improper psychological characteristics, lack of knowledge or skill, and improper mechanical or physical environment. To put if differently, faults on the part of persons which leads to unsafe actions of persons in a working environment are caused due to human limitations in respect of anatomical, physiological, perceptual and psychological characteristics, lack of knowledge or skill, and improper mechanical or physical environment. To put it differently, faults on the part of persons which lead to unsafe action of persons in a working environment are caused due to human limitations in respect of anatomical, physiological, perceptual and psychological characteristics, skills, knowledge and capabilities as well as due to imperfections in the mechanical, physical or social environment. Clearly, human limitations in the context of interface between man and machine or man and his work environment are the ultimate causes of all accidents.

Personal characteristics such as age, job experience, visual functions, perception, motor ability, dexterity, reaction time, cardio-vascular disorders, neuro-psychiatric disorders and physio-pathological conditions have bearing on incidence of accidents. Therefore, it is essential that adequate attention is paid to proper selection, training, placement, education and supervision of workers on the basis of the hazards in the jobs concerned. Further, engineering revision to make the work environment safer to the employees is the most effective ways of controlling unsafe actions of persons and should be taken advantage of whenever possible.

Accident Proneness: In this connection it would be worthwhile to say a few words on the concept of "accident proneness." "Accident Proneness" can be defined in simple terms as a personal idiosyncrasy predisposing the individual who possesses it in a marked degree to a relatively high accident rate. This presupposes that there are only a few people who have many more accidents than the others. There has been a lot of confusion in the use as well as interpretation of the word " Acident Proneness." Great injustice has also been caused to employees due to adoption of a negative approach arising out of wrong convictions regarding accident proneness of individuals. Numerous studies carried out by research workers have failed to prove conclusively that any group of persons in a given sample can be separated as accident prove. Dr. Schulzinger after careful study of 35,000 injury cases has come to the following conclusion.

The currently accepted theory that most accidents are sustained by a small fixed group of "Accident Prone" individuals is open to question. On the basis of clinical experience and studies, the writer suggests that most accidents are due to relatively frequent solitary experience of large number of individuals. The total number of accidents suffered by those who injure themselves year after year, over a period of three or more years, is relatively small. The frequently observed unequal distribution of accidents appears, among other things, to be due to the unequal liability to accidents on the basis of age and sex, to transient or prolonged states of physical, physiological strees, to chronic "accident proneness" and to chances. The evidence indicates that if the period of observation is sufficiently long, the "small group of persons who are responsible for most of the accidents" is essentially a shifting group. It seems to be more nearly correct to speak of varying degrees of "accident proneness" rather than of the presence or absence of proneness.

As Dr. Schulzinger points out, most people move in and out of the so called accident-prone group depending upon age, mental and physical state, environmental factors, and other conditions that vary with the passage of time. Several tests have been advocate in the past to segregate the so called accident prone group. To name a few, sensory motor, manual dexterity, mechanical aptitudes, vocational interests, emotional stability, cultural interests, intelligence, eye, blood and combination of these tests have been recommended by various investigations as a means of predicting accident proneness. However, the reliability of these tests for predicting performance in terms of causation of accidents, it must be limited, has been not found to be significant enough to be useful.

Professor Edwin E. Ghiselli, discussing the errors or interfering factors that could expected to come into studies which have tended to classify persons as accident prone. Which is to diagnose them as having or certain psychopathology, a disordered or abnormal way of thinking or behaving, highlights the unreliability of this concept to predict the accident rate of a worker, much more so when environmental conditions, occupations or activities change. He concludes that accident proneness is not a general characteristic of the individual. He concedes that there are a few people who cannot walk down the stairs without falling, who cut their hands rather than the bread and who bump telephone poles and other cars whenever they drive a car. But the proportion of them is so small as to be quite unimportant in ordinary safety work. It is these few odd people who have many accidents, who maintain their high accident rate year in and year out and who have a high number of accidents of all sorts, who are the concern of the psychiatrists. Professor Edwin in conclusion advises that the term accident proneness should never be used in safety work or in studies of the causes of accidents, as it is according to him "dangerous and misleading and contributes nothing of practical value to our understanding of the causes of industrial accidents and injuries." A more practical method is to consider people in relation to the work they have to do and to prevent the chances of persons performing unsafe actions by the practical methods of selection, training placement and supervision, besides adopting engineering revision or changes in methods of work to make the work place more safe to the employees to work in. This positive approach, is undoubtedly more tangible in terms of achieving results.

2.1.4. UNSAFE MECHANICAL PHYSICAL CONDITIONS: Unsafe mechanical or physical conditions are generally classified under the following heads:

- Inadequately guarded
- Unguarded
- Defective condition, rough, sharp, slippery, decayed, corroded, frayed, cracked, etc.;
- Unsafe design or construction;

- Hazardous arrangement, process, etc. (piling, storage, aisle space, exists, layout, overload, misalignment);
- Unsafe illumination (inadequate or unsuitable);
- Unsafe ventilation (inadequate or unsuitable);
- Unsafe dress or apparel and
- Unsafe methods, processes, planning etc.

Though in majority of the accidents, the direct cause is usually attributed by investigators to unsafe actions of persons, it should be emphasized that the most effective method of prevention of accident is by adopting engineering measures to remove the unsafe mechanical or physical conditions involved in the situations. Knowing of man and his environment on account of the limitations of the man in respect of his anatomical, physiological, psychological and perceptual characteristics, skills and abilities, the reduction in unsafe mechanical or physical conditions can well be appreciated. It is a plain fact 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 role that "engineering revision" (Removal of unsafe mechanical or physical conditions or amending unsafe processes or system 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 with "engineering revision" to the extent practicable.

2.1.5. PREVENTION METHODS: The wall known prevention methods can be summarized as:

- Engineering revision;
- Personal adjustment; and
- Instruction, persuasion, and appeal;
- Discipline

The objective of accident prevention can be achieved only if the top management takes up the responsibility for safety. While the various duties and responsibilities for safety could be delegated, the management's function itself of organisation, planning, directing and controlling for the ultimate objective of obtaining freedom from industrial accidents cannot be delegated. Safety, no doubt, is "everybody's business" but it requires management's sustained efforts to ensure that the accident prevention programme works successfully.

PART B: CONSTRUCTION ACTIVITIES

From the analysis of incidents and causes of occupational health hazards, it will evident that providing safe working places and safe systems of work by effective safety management is the single most important contribution engineers and other professionals can make to reduce the number of deaths and incidents in the construction industry. In this chapter the common causes of accidents are examined and methods suggested for their prevention.

2.2.1. EXCAVATIONS :

Most construction work involves some form of excavation for foundations, sewers and underground services. Excavation or trenching work can be highly dangerous and even some of the most experienced workers have been caught by the sudden and unexpected collapse of the unsupported sides of a trench. Buried under a cubic metre of soil you will be unable to breathe due to pressure on the chest, and quite apart from any physical injury of person will quickly suffocate and die, for even this comparatively small amount of soil weighs over 1 tonne.

Excavation work involves the removal of soil or a mixture of soil and rock. Water is nearly always present, even if only as moisture in the soil, and heavy rain is a frequent cause of soil slip. The possibility of flooding presents an additional hazard which should always be considered. Cracks are caused by pressure release as soil is removed, or from drying out in hot weather.

Soil varies in its nature (e.g. fine sand which flows easily, and stiff clay which is more cohesive). However, no soil can be relied upon to support its own weight and precautions always need to be taken to prevent the collapse of the sides of an excavation of more than 1.2 m in depth.

2.2.1.1. HAZARDS

- Collapse of soil

- Fall of material
- Fall of person

2.2.1.2. CAUSES OF ACCIDENTS : The main causes of accidents resulting from excavation work are as follows:

- Workers trapped and buried in an excavation owing to the collapse of the sides;
- Workers struck and injured by material falling into the excavation;
- Workers falling into the excavation;
- Unsafe means of access and insufficient means of escape in case of flooding;
- Vehicles driven into or too close to the edge of an excavation, particularly while reversing, causing the sides to collapse;
- Asphyxiation or poisoning caused by fumes heavier than air entering the excavation, e.g. Exhaust fumes from diesel and petrol engines.

2.2.1.3. SAFETY PRECAUTIONS

- The sides of the excavation or trench should be sloped or battered back to a safe angle of repose, usually 45°, or be supported by timbering or other suitable means to prevent a collapse.
- The type of support necessary will depend upon the type of excavation, the nature of the ground and the groundwater conditions.
- Make sure that there are enough materials to support the length of the trench to be cut, for the trench support must be installed without delay as the excavation progresses.
- At least random timbering or piling is required in all excavations, but excavations 1.2 m or more in depth should be provided with adequate timbering or sheeting. Close boarding or sheeting is required if the ground is unstable or lacks cohesion.
- Never work ahead of the trench support.
- Shoring should be erected, altered or dismantled only by a competent worker operating under supervision.

- Wherever practicable, it should be installed before excavating to the final depth of the trench – it is necessary to begin when the trench is less than 1.2 m deep.
- The excavation and installation of shoring should then proceed by stages until the full depth is reached. We should be fully aware of the procedures to follow to rescue a fellow worker trapped by a fall of earth.

2.2.2. BURIED OR UNDERGROUND SERVICES: Any digging, either by hand or with an excavator, remembers that there may be underground services below the surface. In built-up areas, always assume that electrical cables, water services and sewers are present. In some locations there may also be gas pipes. Some of these services look alike, so when we find buried services we should always assume the worst. Striking electric cables may cause death or severe injuries by electric shock or severe burns. Broken gas pipes will leak and may cause a fire or explosion. Water and sewer pipes if broken may create sudden risks by flooding an excavation or by causing its sides to collapse.

2.2.2.1. ELECTRICAL CABLES: Every year workers digging on construction sites suffer severe burns when they accidentally hit live buried electrical cables. Always treat buried cables as live. Before to begin excavating, inquire of the electricity authority, the local authority or the site owner if they have any plans of the layout of cables in the area. Even if plans exist, remember that some cables may not be marked on the plan or may not be exactly where the plan shows, for cables rarely follow an exact straight line.

Look around for traffic signs, street lights and substations which are usually supplied by buried cables. Use a cable locator– remember that if cables are close together the locator may not be able to tell them apart. Some types of cable cannot be traced by locators. Once person have found the cable, notify your supervisor and fellow workers. The position of the cable should be marked with chalk, crayon or paint or, if the ground is too soft for this, with wooden pegs. Never use sharp spikes. Once the approximate position of a buried cable is known, use hand tools to expose it. Use spades and shovels rather than forks or pick-axes. Keep a careful watch for evidence of cables during digging work. Power tools should not be used within half a metre of a cable.

2.2.2.2. HAZARDS

- Disturbance of electrical supply
  - Bursting of cable
  - Fire & explosion
  - Electrical shock etc.

2.2.3. OTHER SERVICES LIKE GAS PIPES, WATER PIPES ETC:

- As with electricity supplies, inquire of the appropriate authorities and the site owner if plans are available of the layout of gas pipes, water pipes, sewers and telephone cables, and then use similar working methods.
- Do not use mechanical excavators within half a metre of a gas pipe. If we smell gas, make sure there are no sources of ignition nearby such as a lit cigarette or running vehicle engine. Keep away from the area, keep other people away and summon the gas authority. Do not use heavy plant or equipment over or near a gas pipe, as the pipe may fracture.
- All exposed pipes and cables should be supported when an excavation is open. Do not use them to support equipment or as steps to get in and out of the excavation. Make sure when backfilling a trench with a gas pipe that the fill is adequately compacted beneath the pipe to prevent settlement which could lead to pipe fracture.

2.2.3.1. HAZARDS

- Disturbance of electrical supply

- Bursting of cable
- Fire & explosion
- Electrical shock etc.

2.2.3.2. SAFETY PRECAUTIONS

- Never work ahead of the side supports in a trench even when we are erecting shoring.
- Appearances can be misleading. The shallowness of an excavation or the solid appearances of the ground are not necessarily an indication of safety.
- Deep trenches look dangerous, but most fatal accidents occur in trenches less than 2.5 m deep.
- Always wear a safety helmet when we work in an excavation.

2.2.4. SCFFOLDING: Scaffolding can be defined as a temporary structure made of wooden plans and metals poles supporting one or more platforms and which are used either as a workplace while building repairing or cleaning a building or for the storage of materials in the course of any type of construction work, including both maintenance and demolition work.

Where work cannot safely be done from the ground or from the building or structure being worked upon, then there should always be suitable and sufficient scaffolding. This must be properly constructed of sound material which is of adequate strength to provide working persons with both means of safe access and a safe place of work.

TYPES OF SCAFFOLDING

2.2.4.1. INDEPENDENT TIED SCAFFOLDS: An independent scaffold consists of a platform resting on horizontal tubes, usually called transoms, which are fixed at 90° to the face of the building and which are secured at both ends to a row of uprights, or standards, and to horizontal tubes, often called ledgers, running parallel to the face of the building. An independent scaffold, although it must be tied to the building or structure, does not rely on it for its strength.

2.2.4.2. SINGLE POLE OR PUTLOG SCAFFOLDS: A common type of scaffold for smaller jobs is a single pole or putlog scaffold which consists of a platform resting on horizontal putlogs (called transoms in independent scaffolds) fixed at 90° to the face of the building. The outer ends of the putlogs are supported on horizontal ledgers fixed parallel to the face of the building and secured to a single row of uprights or standards, also parallel to the wall. The flattened inner end of the putlogs rests flat on the wall, or in holes in the wall, rather than on ledgers. It follows that the scaffold cannot stand without the support of the structure

2.2.4.3. TOWER SCAFFOLDS: A tower scaffold consists of a platform resting on horizontal ledgers connected to four uprights, supported on base plates if static or on castor wheels if mobile. It is devised for painters and others who do lightweight work of limited duration mainly in one place.

2.2.4.4. TRESTLE SCAFFOLDS: Trestle scaffolds are simply working platforms supported on "A" frames or a similar type of folding support. The trestles be fixed or folding in type, should be used only for light work of comparatively short duration. Folding trestles should be used only for scaffolds of one tier in height, and the working platform should be at least 430 mm (two scaffold boards) wide. One-third of the height of the trestles should be above the working platform. Fixed trestles should not be used for scaffolds of more than two tiers in height, and where the working platform is more than 2 m high guard-rails and toe boards should be provided. Trestle scaffolds are not suitable for work situations where a person is liable to fall a distance of more than 4.5 m from the platform.

The trestle scaffolds should be set up on a firm and level base and firmly fixed so as to prevent displacement. It should be ensure that the trestles are adequately braced to ensure rigidity and to resist lateral movement. Trestles should be no more than 1.35 m apart when boards 38 mm thick are used, and 2.45 m apart if 50 mm boards are used. Wider spans are possible if proprietary staging is used and such staging is generally preferable to scaffold boards. It should be inspected that the trestles before use and should be rejected if they have defective components such as loose or damaged cross bearers, broken or damaged hinges including missing screws or bolts, or damaged or split stiles.

2.2.4.5. SUSPENDED SCAFFOLDS: Suspended scaffolds are used most frequently for work on tall buildings or structures above busy streets, or in other situations where it is not feasible or economic to build a scaffold from the ground. Suspended scaffolds are of two main types: a) suspended platforms, hinged or independent; b) cradles.

2.2.4.6. HAZARDS

- Fall of person
- Fall of materials
- Unsafe scaffold
- Height phobia

2.2.4.7. CAUSES OF ACCIDENTS

- Falls of persons from a height, and similarly of materials and objects, represent the most serious safety risk in the construction industry.
- Unsafe working places or from unsafe means of access to working places
- The ratio of the height of the scaffold to the width of the base is excessive
- The top working platform is overloaded causing the tower to become unstable
- Scaffold not at as per standard.
- Physical health condition of individual.

2.2.4.8. IN SUSPENDED CRADLE

- Difficulty getting in and out of the suspended cradle;
- Insufficient or poorly secured counterweights;
- Failure of suspension ropes;
- Poor maintenance

2.2.4.9. SAFETY PRECAUTIONS

Scaffolds should be erected, altered or dismantled only by competent persons under supervision

- The uprights of the scaffolding should be placed on firm and level ground and the base plates at their feet should rest on timber sole boards. These help to ensure that the load carried by each upright is distributed over a fairly large area and so prevents the upright from sinking into the ground and affecting the balance of the scaffold.
- Never use material which can shatter or move, such as bricks and broken paving stones, as support for uprights.
- Uprights should be kept equidistant and should be connected and strengthened by ledgers fixed on the inside of the uprights; for strength, joints in ledgers should be staggered.
- Transoms should be set on top of ledgers and at right angles to them and the building or structure.
- Horizontal distances between transoms at working platform level will depend on the thickness of the boards.
- Ledgers and transoms should not project more than is necessary beyond the general outline of the scaffold, or they become a danger to pedestrians or passing vehicles.
- Bracing is essential to stiffen the scaffold and prevent sideways movement, and it should run diagonally from ledger to ledger or upright to upright.
- Braces may run parallel to each other or rise in zig-zag fashion. If bracing has to be removed for the passage of workers and material, this should be only within one lift and it should be immediately replaced.

- A ladder not to be placed on the top platform to extend the height of the tower;
- Work involving percussion tools produces an outward horizontal or lateral force at the top of the tower, than special care to be taken for countering the movement ;
- A mobile tower is moved with persons or materials carried on the top platform;
- The tower is used on firm ground & is tied to the building or structure where this is necessary;
- Confirm the access to the platform is via the inside of the tower.
- A good base for the single row of uprights is essential and the base plates for each upright should again rest on a timber sole board – a sole board should be long enough to support at least two uprights.
- The uprights should be not more than 2 m apart and set at 1.3 m from the wall to allow for a five-board platform.
- Ledgers should be connected on the inside of the uprights, at a vertical distance of not more than 2 m – a lesser distance may be necessary for some types of work – and left in position as the scaffold rises.
- Putlogs should rest on and be secured to the ledgers at horizontal gaps depending on the thickness of the boards used
- Their flattened, or spade, ends should lie on the brickwork, or enter the wall to a depth of at least 75 mm.
- For re-pointing old brickwork, the spade ends can rest vertically in joints in the brickwork. Tying into the building is of even greater importance than with independent scaffolds, as putlogs can easily work loose in brickwork.
- In this type of scaffold, bracing along the face and to the full height of the scaffold is required. Bracing should be at an angle of about 45° to the horizontal and at 30-metre intervals.

2.2.4.10. LOCATION OF SCAFFOLDS USED: Brick structures, Cement plastering, electrical fitting, plumbing fittings.

2.2.5. ROOF WORK: Without proper precautions, roof work is among the most hazardous of construction operations. Although most accidents happen to specialist roof workers, there are many workers engaged simply in maintaining and cleaning roofs. To undertake roof work safely we require knowledge and experience, and special equipment. Before the job begins, a safe system of work must be planned. Precautions must be adopted to reduce the risk of a worker falling or, if it occurs, to prevent the fall being the cause of serious injury.

2.2.5.1. HAZARDS

- Fall of person
- Fall of materials

2.2.5.2. CAUSES OF ACCIDENTS

The most common accidents to workers are due to:

- Falls from the edge of roofs;
- Falls through openings in roofs;
- Falls through fragile roof materials.

2.2.5.3. SAFETY PRECAUTION

The precautions to be taken will depend on the type of roof and the nature of the work to be undertaken.

2.2.5.4. FLAT ROOFS

Flat roofs include those with a pitch of up to ten degree. All the edges and openings on a roof from or through which there is a possible fall of more than two metre should be protected with suitable guard-rails and toe boards.

In the case of openings, the alternative is to provide a substantial cover which will bear our weight, and which is not easily moved. It must be boldly and clearly marked as to its purpose. If there is an up stand at the edge of the roof of sufficient strength, conventional scaffold tubes to support guard-rails and toe boards can be attached to this. Alternatively, a system of simple precast counterweights can be used to support edge protection, or a series of triangular tubular steel frames approximately 2.4 metre apart and using conventional scaffold tubes can be anchored to the roof, again by precast concrete counterweights.

2.2.5.5. SLOPING ROOFS

Edge protection is necessary for all sloping roofs, that is of more than ten degree pitch, or which have a slippery surface and where there is the possibility of a fall of more than two metre from the edge of the roof. It should take the form of barriers or guard-rails high enough and strong enough to stop, if we are rolling or sliding down the roof slope. The roof surface may be slippery because of the material from which the roof is constructed or because of the growth of moss or lichen, or it may quickly become slippery after rain or snow.

Unless tile battens on a roof are of adequate strength and themselves provide adequate handholds and footholds, to use purpose-made crawling ladders or crawling boards , even for inspection or work of short duration.

2.2.5.6. FRAGILE ROOFS

Before to use, any roof as a means of access or a place of work, be ensured that no part is covered with fragile material. Some roof coverings give a false sense of safety and the impression of a surface which is solid enough to bear person weight, but they will not carry a concentrated load such as that applied by the heel of person foot, or if person stumble or fall. A common example is single-thickness asbestos cement sheeting which may shatter without warning. The common mistake should not be believed that it is safe to walk along the lines of sheeting bolts. Other examples of fragile material are wired glass, corrugated plastic sheeting for roof lights, rusted corrugated iron sheeting and unreinforced insulating slabs. Sometimes fragile materials are not easily recognizable beneath paint or tar covering, particularly when they have been used to patch or repair a roof.

Once fragile material has been identified, or if worker are in any doubt, use at least two crawling boards or roof ladders be used, so that one is available to stand on while worker are moving the other.

Special precautions are necessary where a valley or parapet gutter is used as a means of access and the adjacent roof is covered with fragile material. Covering, or guard-rails, should be provided to prevent us from falling through if we slip or stumble. Prominent warning notices should be displayed at the approaches to fragile roofs.

2.2.5.7. CRAWLING BOARDS AND ROOF LADDERS

Crawling boards and roof ladders should be properly designed and constructed, and not made up from odd timber found at the site. Boards should have cross battens at least 32 mm thick and not more than 380 mm apart, and should be secured in position.

The ridge anchorage or ridge iron at the top of the board or ladder should not rely for support on the ridge capping which is liable to break away, but should bear on the opposite slope of the roof or be secured by a rope. Eaves gutters should not be used as a footing or to support a roof ladder, as they are not strong enough.

2.2.6. STEEL ERECTION :

The erection of steel structures and building frames involves work at heights and in exposed positions. The incident rates for injury and death of steel erection workers are much greater than those for workers in the construction industry as a whole, high as these are.

Architects , structural engineers and engineering draughtsman , besides progress and planning engineers on site can do a great deal to design hazards out of steel erection. By carefully going through the motions to be performed by steel erectors and other workers when the work is being designed and planned , risk can be identified and appropriate precautions introduced. This involves close collaboration at the planning stage between the designers , the main contractor and steel erection contractor.

2.2.6.1. HAZARDS

- Fall of person
- Fall of materials
- Instability of partially erected structures

2.2.6.2. CAUSES OF ACCIDENTS

The most common accidents to workers are due to:

- Falls from the edge of roofs;
- Falls through openings in roofs;
- Falls through fragile roof materials.

2.2.6.3. SAFETY PRECAUTION

Sections of steel frames for shed-type building can often be pre-assembled more efficiently and safely.

2.2.7. WORK OVER WATER:

Before work start the work near or over the water by the construction agency prepared a plan. There is required all vehicles to be kept a safe distance from the edge of the bank. When planning for construction work near water, contractors should ensure they have selected the right equipment for the site conditions, particularly where narrow banks and steep slopes leave little margin for error. They should also define haul routes and turning points, mark the edges of the bank and difficult transition points on the routes with 2m poles and tape and ensure the people who work on the job have been trained. The workers are told about them and not left to tackle the work on the hoof. The only way that will happen is with effective supervision and management monitoring.

Personal Protective Equipment must be worn as required by the task being performed. In addition, workers working within four feet of water edge must wear certified floatation device.

2.2.7.1. HAZARDS

- Drowning, hypothermia.
- Falling, tripping.
- Slippery surfaces.

2.2.7.2. CAUSES OF ACCIDENTS

- Falling into water and being drowned or carried away by currents is an ever-present danger when working over or adjacent to water.

2.2.7.3. SAFETY PRECAUTION

- Person working near or over the water may be a good swimmer.
- Make sure that the working platform is secure and has no tripping hazards such as tools, wire, timber or bricks. Surfaces soon become slippery and should be treated immediately by cleaning, gritting or applying industrial salt or sand.
- Check that access ladders, guard-rails and toe boards are firmly fixed in position.
- Wear a safety helmet at all times – if you are struck on the head and fall into water you are at special risk.
- Wear a life-jacket, and ensure that it is properly fastened.
- Use any safety nets or safety harness provided.
- Check that lifebuoys fitted with lifelines are ready to hand for immediate use.
- Make sure that there is a safety boat and that it is manned while you are working above water – if over tidal water or a fast-flowing river, it must have a motor with a self-starting device.
- Ensure that you know the routine for raising the alarm and for rescue drill.

2.2.8. DEMOLITION:

Demolition is one of the high-risk activities of construction industry with a fatal and major injury accident incident rate. Demolition is a very skilled process and , to be carried out safely and correctly, requires a great deal of knowledge of building construction and expertises in demolition methods.

The danger in demolition work varies with the method employed, which itself has a bearing on the number of men at risk and their working time at heights and in and around the structure being demolished. Method of demolition may conveniently be divided into three categories, hand, mechanical and explosive.

2.2.8.1. HAZARDS

- Fall of materials
- Collapse of structure
- Inhalation of toxic gasses, vapours , fumes and dust
- Ingestion of corrosive of toxic liquids and dust
- Reaction with or absorption by the skin of corrosive, toxic or irritant dust, powers, liquids and chemical substances.

2.2.8.2. CAUSES OF ACCIDENTS

- The choice of an incorrect method of demolition;
- An unsafe place of work;
- The unintentional collapse of the building being demolished, or of an adjoining structure, because of lack of temporary support.

2.2.8.3. SAFETY PRECAUTION

Demolition by hand:

- Demolition by hand is progressive demolition, carries out piece small with hand tools such as sledge hammers, jack hammer, concrete breakers and cranes for lifting and lowering purposes.

- It is carried out in reverse order to construction process, ie the roof covering is taken off first, followed by roof trusses and upper ceiling and the building is then demolished storey by storey.
- When this method is used properly protected working stages should be provided where necessary.
- Standing on the wall being demolished is unnecessary and should not permitted.

The aim should be to adopt methods which do not expose we to falls from heights. While in general it is a sound rule gradually to reduce the height of a building and to demolish in the reverse order to construction, a deliberately engineered collapse, the licensed use of explosives, a demolition ball on a crane, or a pusher arm may sometimes be the quickest and most economical method of demolition, leaving work to be completed at ground level. It is dangerous to leave isolated wails or parts of walls standing and liable to collapse from the effect of high winds. Whatever the process adopted, debris should not be allowed to build up against walls or on floors with the consequent risk of the structure being unintentionally overloaded. Make use of debris chutes rather than throwing down material indiscriminately, even on isolated sites be made.

Wherever practicable, avoid working directly from parts of the building or structure we are demolishing, such as standing on the top of a brick wall. This usually means that we have both poor handholds and poor footholds.

When work cannot safely be carried out from a building, a scaffold platform, self-supporting and independent of the part of the building being demolished, should be provided. On brick and masonry structures in particular, much of the work can be done from such scaffolding, the material being dropped to the interior of the building. Person-carrying skips or power-operated mobile work platforms can also be used to work at heights. The use of safety nets or safety harnesses may sometimes be necessary.

2.2.9. CONFINED SPACES :

A confined space is an enclosed or partially enclosed area that is big enough for a worker to enter. It is not designed for someone to work in regularly, but workers may need to enter the confined space for tasks such as inspection, cleaning, maintenance, and repair. A small opening or a layout with obstructions can make entry and exit difficult and can complicate rescue procedures.

Entry into confined spaces can be very hazardous. Unless proper training, equipment, and procedures are in place, workers must not be allowed to enter such spaces. A worker is considered to have entered a confined space just by putting his or her head across the plane of the opening. If the confined space contains toxic gases, workers who are simply near the opening may be at risk. Often the toxic gases are under pressure because of heat inside the confined space or when gases are generated inside the space. As a result, the concentration of toxic gases near the entrance to the confined space can be high enough to cause death.

It is vital to identify all confined spaces in any workplace. Examples of confined spaces include tanks, silos, storage bins, process vessels, pipelines, sewers, underground utility vaults, and vats — in short, any area that can have a “confined” atmosphere. Workers have died because they did not know they were entering a confined space with a hazardous atmosphere and therefore did not take the necessary precautions.

In addition, an enclosed area in which workers do not normally work could have air that may be hazardous to breathe or the work activity could cause a hazardous atmosphere to develop. Even though rescue would not be complicated by the design of the space (and it does not therefore fit the definition of a confined space), the space may still be deadly without air testing and a supply of clean air.

2.2.9.1. HAZARDS

Hazardous atmospheres

- Oxygen: too little or too much

- Toxic atmospheres
- Explosive atmospheres
- Gases that may be in your workplace
- Physical hazards
- Loose and unstable materials
- Slip, trip, and fall hazards
- Falling objects
- Moving parts of equipment and machinery
- Electrical shock
- Substances entering through piping
- Poor visibility
- Temperature extremes
- Noise
- Risk of drowning

2.2.9.2. CAUSES OF ACCIDENTS

The most common accidents to workers are due to:

- Hazardous Atmosphere
- Physical condition of personnel
- Physical condition of confined space.

2.2.9.3. SAFETY PRECAUTIONS

The following precautions are essential before to enter a confined

- Never enter without instructions from a supervisor and without a written permit to enter or permit to work.
- Equipment for monitoring the atmosphere at frequent intervals must be provided and must be used by a competent person. Not enter the confined space until the competent person is satisfied that entry is safe.
- There should be forced ventilation to remove and dilute dangerous gases and provide fresh air.
- Monitoring must continue while work proceeds, and person must leave immediately if told to do so.

- Person should have received proper training and instruction in the precautions to be taken, including the use of emergency breathing apparatus.
- Rescue harnesses should be worn by everyone inside the confined space, with lifelines attached to a point outside the space.
- Not less than two persons should be present when there is work in a confined space. One should be outside the confined space to keep watch and to offer rescue action or assistance. Additional emergency and accident assistance must also be readily available.
- A proper procedure for rescue in an emergency should be laid down, with specific duties allocated to specific persons. If you play a part in this procedure, make sure that you clearly understand what you have to do. Even if person think lives are at stake, person must still follow the procedure and must not take short-cuts.
- When working at a manhole in a road or public area, ensure that guard stands are provided and the appropriate traffic signs displayed.
- Make sure that working person have been trained by a competent person in the use of the safety and rescue equipment.

2.2.9.4. SAFETY AND RESCUE EQUIPMENT : Whenever work is to be carried out in a confined space, the following equipment should be provided:

- An atmospheric testing device (proprietary meters and lamps are available);
- Two rescue harnesses with adequate lengths of rope taking into account the location of the work site;
- Hand torches or lamps safe for use in a flammable atmosphere;
- At least one set of suitable breathing apparatus (cartridge, canister or filter) and an emergency breathing pack;
- First-aid equipment;
- Fire fighting apparatus;
- An audible alarm for summoning help;

- Resuscitation equipment;
- Means of communicating with surface workers.

2.2.10. PILING:

Piling is a type of ground treatment which is driving a pile into the ground below ground level. Except sheet pile, other piles like concrete pile, timber pile, steel pile, bored pile are used to transfer the building load to the ground. It's used to strengthen the soil so that the ground able to support the load of the building. While sheet pile is usually used to support lateral load and act as a supporting wall.

There is a lot of different types of piles in the market, many other type of piles have been occurred in the market and still increasing due to improvement of piling technology. Driving method, type of piling machine, procedure of piling are all take into consideration in choosing type of pile.

Normally the length of the pile can be 3metres, 6metres, 9metres and 12metres. The depth of piling to be driven into the ground is depending on the condition of ground. If a length of 3m, 6m, 9m, or 12m pile is not enough to support the load of building, another 3m, 6m, 9m, or 12m pile will be joint to the first pile and continuously until it's strong enough to support the load of building. Or so, the first pile or we called it as "starter pile" will be driving in until it can't be driven in anymore.

Pile can be done in precast concrete pile or cast-in-situ concrete pile. Normally precast concrete pile is used for building work or known it as spun pile or RC square pile (Reinforcement concrete square pile). While cast-in-situ concrete pile is used for bridge work or we can known it as bored pile because bridge work has a larger load compare to building work.

Nowadays, piling work is an important ground supporter and is a must to be used on construction unless the condition of soil is hard and strong enough to support the load of building.

2.2.10.1. HAZARDS

- Conflict with other parts of the project construction creating unsafe working conditions.
- Personal injury from falling debris, crushing. Unsafe removal of guards or auger cleaners. Risk to third parties.
- Slope failure, rig overturning.
- Access ramps and wall props can impede working space.
- Rig overturning, unsafe working conditions for operatives.
- Personal injury or death, loss of amenity, delay to project.
- Personal injury or death, damage to construction plant and/or surrounding property, delay to project.
- Injury to workforce, electrocution, fire, loss of amenity, delay to project.
- Plant or materials falling onto road or rail
- Dangers of working at height.
- Personal injury.
- Repetitive strain injuries.
- Injury to operatives from falling steel bars.
- Operatives falling into open bore or excavation, injury and possible drowning.
- Instability of heavy plant at surface with potential for overturning.
- Damage to ground servise resources.
- Unacceptable levels of noise and/or vibration, hearing damage to operatives.
- Traffic incidents, personal injury, air pollution, noise.
- Damage to/instability of adjacent buildings.
- Excavation below design depth leading to potential wall failure.
- Wall collapse if props are damaged.
- Collapse of excavation.
- Sudden release of pre-stress energy, personal injury, damage to surrounding area.
- Failure passing beneath toe of retaining wall.

- Failure on slope entirely top of retaining wall.
- Rapid flooding of excavation and potential retaining wall collapse.
- Collapse or distress of retaining wall.
- Damage/instability of adjacent structures.
- Vibration white finger injuries.
- Personal injury from flying debris, vibration white finger injuries, trips and slips.
- Personal injury to integrity testing operatives
- Loss of concrete with cast insitu piles, loss of base support to all pile types, possibly damaged or broken piles.
- Collapse of ground, loss of support to piling plant, delay to project.
- Loss of platform support, loss of concrete, delay to project.
- Inaccurate assumptions about soil parameters & profile leading to inadequate pile performance.
- Excessive pile settlement possible pile failure.

2.2.10.2. CAUSES OF ACCIDENTS

- The most common accidents to workers are due to:
- Sequencing of piling work.
- Piles located in positions with restricted working space, e.g. corners of site and adjacent to public areas outside the site.
- Piling near to the top of slopes.
- Inadequately designed/constructed/maintained working platforms.
- Underground services and Overhead services.
- Working adjacent to major highways or railways
- Static load tests using kentledge as the reaction for loading.
- Hand tying of reinforcement cages.
- Racking of/damage to reinforcement cages while lifting.
- Open pile bores or wall panel excavations, with or without support fluid.
- Diaphragm wall panel instability prior to concreting.
- Excessive vehicle movements on/off site.

- Flighting of soils during pile installation.
- Incorrect retaining wall excavation sequence.
- Temporary wall props.
- Failure of retaining wall props.
- Pre-stressed ground anchors.
- Overall stability of embedded retaining wall.
- Stability of a slope above a retaining wall.
- Base fracture by hydraulic heave or piping.
- Excess surcharge placed behind retaining wall.
- Ground movements behind retaining walls.
- Pile trimming to cut-off level and exposing of reinforcement.
- Scabbling pile surface.
- Exposed ends of reinforcement after pile trimming.
- Inadequate access to piles for integrity testing.
- Congested reinforcement in pile caps around head of pile during integrity tests.
- Voids and collapsed deep mine workings, opencast quarry edges.
- Solution features in weak rocks such as chalk and marl.
- Inadequate or non-existent ground investigation report.

2.2.10.3. SAFETY PRECAUTIONS

There are certain hazards which are common to all types of piling, and the following precautions are necessary:

- Piling machine operators should be over 18 years of age and properly trained;
- Prior to piling, all underground services should be located and made safe. A check should be made to ensure there are no cellars, underground water courses or ground conditions which might cause hazards;
- There should be a firm level base for the crane, or crane mats provided;
- When working on piling operations you must wear a safety helmet, and ear and eye protection where necessary;

- All cranes, lifting appliances and lifting gear must have appropriate certificates of testing and thorough examination, and should be large enough for the job;
- Particular attention should be paid to the risk of damage to lifting gear from sharp edges;
- Cranes used for raising or lowering workers must be fitted with a dead man's handle and lowering should be done under power; you must be carried in properly constructed cages which cannot spin or tip;
- Piling contractors should be asked to provide a written method statement setting out the precautions relevant to the type of piling they are to employ;
- Induction training and information for you as supervisor or operative should be specifically related to the method statement.

2.2.10.4. BORED PILES : Person may need to enter a borehole for inspection or for clearing out in undercuts, and there are certain precautions which must be taken prior to person entry:

- The borehole should be at least 75 cm in diameter;
- The borehole should be treated as a confined space and the precautions which are advised elsewhere to ensure a satisfactory atmosphere must be closely followed;
- Waste material from the borehole should be kept clear of the borehole;
- Descent into a borehole should be in properly designed skips, chains or cages fitted with an anti-spin device. The power source of the lifting appliance should be kept running throughout the time someone is underground;
- While you are working down a borehole you must wear a safety harness;
- All workers concerned must be trained and competent in rescue from deep boreholes, and emergency rescue drills should be carried out at regular intervals;

- A banksman who can see you in the borehole should be present at all times;
- There must be adequate lighting at safe reduced voltage and a means of communication from the borehole.
- Wherever possible, the need for workers to enter pile boreholes should be avoided by the use of television cameras and other techniques for remote inspection.

2.2.11. MOVEMENT OF MATERIALS - MECHANICAL

When objects are heavy and operations are on mass scale, then mechanical material handling should be adopted . In mechanical material handling, chances accident are more and severity is also high due to heavy weight of the objects or rapid frequency of operation. The factors influencing selection of type of mechanical equipment for material handling are depends on unit size , weight , shape , physical characteristics of load . This is also depends on rate of handling , distance to be moved, purpose of moving, horizontal, vertical , inclined movement as well as obstacle , if any , on the path. The mechanical material handling equipments are crane , jib crane (mobile & fixed) , power trucks , forklift truck, conveyors and lifts/ elevators.

2.2.11.1. HAZARDS

- Fall of materials during movement or operation.
- Collision of moving equipment with workplace personnel.

2.2.11.2. CAUSES OF ACCIDENTS

The most common accidents to workers are due to:

- The overturning of a crane or the structural failure of one of its elements.
- The dropping of the suspended load or part of it
- Electrocution
- Trapping of people
- Incorrect erection and dismantling procedure.

- These hazards are considered in respect of crane , jib crane (mobile & fixed) , power trucks , forklift truck, conveyors and lifts/ elevators, which are the types most commonly used on construction sites.
- The weight, size and type of load it will have to lift;
- The maximum reach or radius required of it; restrictions on use such as overhead power lines, the state of the site and the type of ground;
- The need for trained operators and signallers.

2.2.11.3. CRANES : The cranes are very widely used in construction for material handling. These are of various types and capacities. Material is handled by a crane along with other accessories such rope, chain links, hooks, etc. The safety of lifting operation includes worthiness of these accessories also. The loads handles by crane are generally heavy and may be odd in shape. The chances of accidents are more and potential for injuries is to be severe in nature.

2.2.11.4. SAFETY PRECAUTIONS

- The load lifting capacity of cane or safe working load should be prominently marked on the equipment and necessarily followed.
- The arrangement of chain or wire – rope and pulley is provided for lifting or carrying load.
- The loads handled is heavy or odd in shape , then there will be more chances of accident, The load should be handled within the designed limits of equipment.
- The load should be properly tied with consideration for its shape and centre of gravity.

2.2.11.5. JIB CRANE (MOBILE): It is a crane fitted on a vehicle. This can lift, lower of shift the load within designed limits. The type, size and configuration are as per the job requirements. The main structural member is called boom.

2.2.11.6. SAFETY PRECAUTIONS

- The boom length can be varied so it can rotate about its support and change the inclination as per the requirements.
- As the crane being mobile it is essential to observe the road conditions.
- The limit switches and other vehicle controls should be checked at beginning.

2.2.11.7. JIB CRANE (FIXED): Jib crane is mounted on a column , building wall or pillar. Its arm can rotate about its support. It is normally used to load and unload the material. The available movement of crane is limited.

2.2.11.8. SAFETY PRECAUTIONS

- Swing the load can be checked while loading and unloading.

2.2.11.9. CONVEYORS: There are various types of conveyors and monorail system used for material transfer. These may be located in busy working areas. The construction and layout should be such that material is being moved; it should not strike persons working around or disturb their working.

2.2.11.10. SAFETY PRECAUTIONS

- While loading, shock loading or heavy lumps should be avoided this will damage belt or even deform roll or structure.
- Wet and corrosive material is being handled belt cleaning is necessary to avoid corrosion of rollers and structural members.
- When belt conveyor is employed to carry any combustible material like coal, sulphur, etc there is a danger of fire. Precautions should be taken to avoid ignition due to any friction or spark.
- All maintenance and repair work should be carried out after positively shutting off electric power.

2.2.12. MOVEMENT OF PERSON AT WORKPLACE:

People are most often involved in accidents as they walk around the workplace or when they come into contact with vehicles in or around the workplace. It is therefore important to understand the various common accident causes and the control strategies that can be employed to reduce them. Slips, trips and falls account for the majority of accidents to pedestrians and the more serious accidents between pedestrians and vehicles can often be traced back to excessive speed or other unsafe vehicle practices, such as lack of driver training. Many of the risks associated with these hazards can be significantly reduced by an effective management system.

2.2.12.1. HAZARDS

The hazards faced by people while moving around

- Slips, Trips and falls – same levels, changing levels, from height (including holes).
- Collisions – moving vehicles, falling objects or striking a fixed object.

The hazards involved in vehicles operations in the workplace

- Loss of control – the vehicles is not under full control of the driver.
- Overturning – tipping over of the vehicles, front , back or side.
- Collisions – other vehicles pedestrians or fixed objects.

These risks are increased by

- Speed of travel
- Steepness of the slope
- Centre of gravity
- Height the load is raised to and the stability of the load.
- Increased tyre pressure
- Any external pressure ie wind or colliding objects.
- Pressure and size of , any bump or holes in the surface.

2.2.12.2. SAFETY PRECAUTIONS

- Be aware of workplace walkway patterns where visibility of pedestrian is compromised.
- Be alert to reckless workers/ operators/ supervisors behaviours (e.g. speeding, inattention, disregard, signs and signals)
- At night, wear reflective jackets or carry a light, so that personnel attention will be attracted to person.
- Avoid construction workplace walking where person cannot be easily seen.
- Be just as alert and careful when crossing in groups as when alone, and do not depend on others to watch out for person.
- Avoid crowds when person have to slow down.

2.2.13. WELDING AND CUTTING :

The welding and cutting of metal, using both the electric arc and oxyacetylene methods, is a process widely used in construction.

2.2.13.1. ELECTRIC ARC WELDING

Danger from welding is not only to the welder doing the job but also to those working nearby. The risks include eye damage, skin injuries, burns and the inhalation of toxic gases. The following precautions are necessary:

- The welder and anyone assisting should wear suitable protective goggles or use a face mask or shield to protect the eyes and face from invisible ultraviolet and infrared rays given off by the welding arc.
- Goggles must also be worn when carrying out weld chipping to protect the eyes from flying pieces of slag.
- The welder should wear protective gloves long enough to protect wrists and forearms against heat, sparks, molten metal and radiation. Leather is a good insulator.
- The welder should wear high-top boots to prevent sparks from entering footwear.

2.2.13.2. GAS WELDING

Acetylene and oxygen are normally used in gas welding. The cylinders should be stored separately since any mixture from gas leakages could be highly explosive. They should be kept away from any source of heat and shielded from direct sunlight. If not stored outdoors, the store must be well ventilated. The cylinders in use should be retained upright in a rack or trolley and not left free-standing (figure 46). Flashback arresters should be fitted to the cylinder regulators and non-return valves fitted in the hose connectors at the torch end.

The gas hoses should be in good condition and easily distinguished. They should be protected against heat, sharp objects and dirt, especially oil and grease. These substances can, even in small amounts, cause an explosive ignition in the event of a leak in the oxygen hose. All joints, especially on the cylinders, should be kept tight. If an acetylene cylinder becomes accidentally heated, shut off the valves, raise the alarm, clear the area of personnel, apply water (if possible, totally immerse) and send for the fire brigade.

2.2.14. MATERIAL STORAGE:

In industries some material is stored purely on a temporary basis and some other a fairly on a long-term basis. However, there is always limitation on the storage space. The stored material might be required for further operation within the plant premises or for final dispatch.

Neatly planned and orderly stored material will prevent accidents, save time and energy and keep the area tidy. This will eliminate injuries while stacking or destacking and will allow space conservation.

In day-to-day operations, orderly material storage will achieve following benefits:

- Elimination of unnecessary material handling
- Protection against the damage to material
- Smooth flow of material movement

- Tidiness of work-area
- Enhancing safety

These benefits help to achieve safety and well being of the employees, industrial buildings seldom have enough space to store the material inside the building and under the roof. It is quite common practice to store material either inside or outside the building as per production requirement and the nature of material.

2.2.14.1. INDOOR STORAGE : In the indoor storage area floor surface should be more or less in level. This is essential since a lot of material and manual movement is expected in the premises. It should be hard and made of impervious material. The spillage of material is likely which can be easily wiped out on such floor. For chemical material storage drainage should be provided with a collection sump. Loading capacity of bins and racks should be determined and followed. This will save from any failure due to overloading sufficient provision for illumination by daylight and electric lighting should be made. Walls are generally for partition purposes and not designed to withstand side-loading. Material stacked should not be lean against the walls.

2.2.14.2. OUTDOOR STORAGE : Material stored outdoors is normally large in size and heavy and is usually not affected by sun, rain, etc. It requires mechanical material handling facilities for loading or unloading of such material. Storage area of ground should be firm in all the weather conditions. It should withstand manual and material movement around it or over it. Passages should be wide enough to accommodate outside vehicles. Factors like culverts, waterways, vibration due to rail movement, machinery etc. should be taken into account.

2.2.14.3. STACKING OF MATERIAL

It is normal practice to stack or pile material like boxes, barrels, containers, steel or cast iron pipes, wooden logs, bags, etc.

In the progress of stacking or destacking material likely physical injuries are falling material on limbs or strain in its handling. Stacked material may side down with minor disturbance. The chances of such possibility can be minimised by providing adequate space around for manual movement and keeping orderliness in the operation. People working in the area should not lean on the piled material.

Symmetrical and stable material like empty barrels can be piled in pyramid form with its bottom row blocked with its bottom row blocked with chocks to prevent sliding. It is necessary to bond the stacked material if it is uniform in size or identical in shape. Such material is staggered while pilling to provide internal self locking. If material not uniform, then there is natural bonding. In such case there are less chances of material to get slide down. Usually canvas sheets, wooden battens, etc. are used as bonding material.

While stacking bags orderliness and neatness is essential. Overhanging at lower levels may cause material to spill out from it due pressure from material stacked above it.

Filled drums and compressed gas cylinders requires special care. Different types material should be stacked separately. This eliminates sorting of material while destacking.

Wooden logs or pipes need special precaution while stacking and destacking since there is possibility of rolling down of material with potential for causing major injury. In such eventuality material side cannot be restricted or checked manually or such attempt is potentially dangerous.

2.2.14.4. SPECIAL PRECAUTIONS

Chemical substances may have dangerous properties. Incompatible substances may respect dangerously. Some chemicals are water-reactive and reaction can take place if they come in contact with water or other chemicals. In such cases they should be stored with proper segregation considering their chemical properties and compatibilities. If the substances are shelter then other properties such temperature effect and impact sensitivity should also be considered.

2.2.14.5. MATERIAL HANDLING FACILITIES

Material handling facilities such lifting appliances, trucks, ramps, platforms, etc. should be provided and maintained in good condition. Alteration is essential at loading and unloading areas where material and personnel movement is frequent and chances of accidents are more. These movements have to be standardized and monitored, so that, nobody gets injured by vehicle movements, lifting appliances or material being handled or moved.

2.2.15. STATIC ELECTRICITY

Static electricity is generated whenever there is relative motion or contact and separation between two dissimilar materials. The subjected materials get electro-statically charged. This charge, which is build on the material surfaces, gets conducted along the surface and in the process when there is no good conductive path it gets discharged giving out spark. The surfaces of insulating nature cannot conduct electrical current however; they are capable to retain it.

2.2.15.1. CASES OF STATIC ELECTRICITY

- When non-conducting liquids, i.e. petroleum liquids or organic solvents, etc. are transferred through pipeline. There will be separation and sliding effect between flowing liquid and pipeline surface. This will cause to generate static electricity charge. If speed of liquid flow is high causing turbulence in the liquid the chances of generation of charge will be increased.
- While filling petroleum liquids in a contractor by pipeline entering from top. If pipeline inlet is well above the liquid level in the container the splashes and droplets will be generated at pipeline outlet. These splashes and droplets will get charged while leaving pipeline. Further it will pick up more charge on the way till it reach liquid level. All this charge will get accumulated on the liquid surface.

- Presence of solid particles or immiscible substances in the liquid. When liquid is stored these substances are settled. While transporting or transferring the substances get disturbed which may result in generation of static charge.
- Whenever different petroleum liquid products are mixed, dissolved or filtered there is possibility of formation of two layers having lateral movement between them. In this situation, there are chances to generate static electrical charge on the layer surface. In filtration process, the chances of generation static charge are more than liquid flowing through pipeline.
- When liquid or powder being ejected sprayed or blown, at nozzle a static charge is generated at nozzle tip. Later on power particles or fine liquid droplets collects charge while travelling. These charge get accumulated on the surface of container or vessel.
- Finely divided power or dust when transferred, poured, sieved or mixed accumulates static charge on the particle surface. This charge gets transferred to the container or pipeline.
- When a belt run over a pulley chances generation of static charge at its contact point exists. The generation and accumulation of static charge is more in chase of flat belts than 'V' type of belts.
- When polymer or a paper sheet pass over a roller a static charge is generated at its contact point and will be acquired by paper or film. This acquired static charge will be accumulated at its outside surface when these are wound.

2.2.15.2. HAZARDS

- The accumulated charge may get discharged in flammable or combustible atmosphere providing source of ignition.
- It can give mild electric shock to a person. Normally it gives unpleasant experiences. It may cause an involuntary reaction. In a exceptional case, if person is working at height then this can cause loss of balance and may result in fall.

- Electrostatic discharge will have harmful effect on the integrated circuit. These circuits are rated a very low voltages.

2.2.15.3. SAFETY PRECAUTION

- The tanks and vessels are firmly grounded. The accumulated static charges on its surfaces will discharge to the earth. This will avoid dangerous accumulation of static charge on the surface.
- In petroleum and other non-conductive liquid products some additives are mixed to increase conductivity. These are metallic salts, which will reduce ability of liquid to retain static charge and made the operation safe. The additions being in very small quantity, do not affect the quality or property of the product.
- Jet of dusty air is avoided in powder or dust operation. Metal containers equipment and pipeline are earthed. Floor surface in the operational area and footwear of operators are made up of electrically least semi-conductive material. Sometimes special additives (solutions of certain metallic salts) are speared on the powder or dust to increase its conductivity and reduce accumulation of static charge.
- The pipelines are bounded at flanged couplings and valve connections with copper wire or strip to maintain conductivity and to eliminated potential differential. (Bounding is a method to connect together electrically two or more conductors or metal parts). The pipeline is then earthed. This method is very effective when pipeline is metallic or made up of an electrically conductive material.
- The rate of liquid flow through pipelines is kept sufficiently low (usually I am to 2m per sec.) This will avoid turbulence in flow and will minimize the chances of building-up static charge. When liquid products contain dispersed water the speed is kept as low as 1m/sec.
- While transferring liquid from pipeline to the tanks or vessels, splashing is avoided by leading pipeline connection to the bottom of vessel. Similarly fixed container on the floor is earthed while transferring the liquid or powder to it.

- The belts are coated with electrically conductive material to avoid accumulation of static charge.
- Paper or film will acquire static charge and this will be accumulated at its outer surface when these are wound.
- Precaution is taken static sensitive devices in manufacturing and transport. Unnecessary handling of product is avoided.
- Floor area and tabletops are coated with semi-conductive material.
- Operator clothing are non-synthetic material.
- Finished product is wrapped in metalized material. While in use these devices are housed in earthed metallic containers.

PART C: MAJOR ITEMS USED IN CONSTRUCTION

2.3.1. LIQUEFIED PETROLEUM GASES: Liquefied petroleum gases (LPG) are commonly butane or propane, or a mixture of both. LPG, usually sold under trade names, is widely used on construction sites and is a frequent cause of accidents. A leakage of liquid from a cylinder immediately vaporizes and, because it is heavier than air, flows along the ground and collects in drains, excavations and other low-lying places. As it takes only 2 per cent of the vapour in air to form a flammable mixture, if leakage occurs in a confined space there is a high risk of explosion. Whenever LPG is used indoors, there must be good ventilation.

2.3.1.1. LPG STORAGE: LPG stores should conform to the following standards:

- Where LPG cylinders are stored on site, it should be in an open-air compound at ground level surrounded by a fence at least 2 m high; there should be sufficient shelter to prevent cylinders being exposed to extremes of temperature.
- There should be no excavations, drains or basements nearby.
- The compound floor should be paved or compacted level, and kept clear of flammable material, weeds or rubbish.
- Cylinders should be kept at least 1.5 m from the compound fence and 3 m from the site boundary.
- Cylinders should never be stored below ground level or closer than 3 m to cylinders containing oxygen or materials which are toxic or corrosive, e.g. ammonia or chlorine.
- There should be notices stating “LPG – Highly flammable” and prohibiting smoking and naked lights.
- Cylinders, full or empty, should be stored upright with the valve uppermost.

- The valves of empty cylinders should be kept closed, for if they are left open, air will diffuse into the cylinder and may form an explosive mixture.
- There should be a dry powder fire extinguisher at the store.

2.3.1.2. LPG HANDLING : When handling LPG cylinders, you should take account of the following points:

- A damaged or leaking valve can have serious consequences.
- When cylinders are not in use, valves and regulators should be protected by appropriate caps.
- When moving cylinders use trolleys, skids or mats and never lift by the valve assemblies.
- Before using a cylinder, ensure that all joints are gas tight by using soapy water and a brush.
- If a leak is detected, move the cylinder as soon as possible to an open space and inform your supervisor at once.
- Cylinders used for heating huts should be kept outside the building.
- If, when lighting a burner, the match or taper goes out before the burner ignites, turn off the burner valve before lighting another match or taper.

2.3.1.3. LADDERS: Ladder is structure consisting of series of bars are steps between to uprights, used for climbing up or down. Every year many workers are killed or severely injured while using ladders. Because a ladder is so readily available and inexpensive, its limitations are easily overlooked. A proper working platform can often ensure that the job is performed more quickly and efficiently.

2.3.1.4. HAZARDS

- External services
- Default ladder

2.3.1.5. CAUSES OF ACCIDENTS

- Overhead power lines with which the ladder might make contact.

- Wooden ladders with wire-reinforced stiles should be used with the wired side facing nearer to person. Wire tie rods should be beneath and above the rungs;
- Use of ladder which is too short, and stand it on something such as a box, bricks or an oil drum to gain extra height;
- Not suitably handhold to provide to person with equivalent support.
- The gaps in guard-rails and toe boards as bigger or not provided at work place.
- For extension ladder, an overlap between two ladders is insufficient.

2.3.1.6. SAFETY PRECAUTIONS

- Enables only one person to climb or descend at any one time;
- Enables only one person to work from it at any one time;
- If not lashed at the top, requires two workers for use – one on the ladder and the other at the bottom;
- Leaves only one hand free; carrying tools or loads up a ladder is difficult and dangerous and the weight which can be carried is everely limited. There is also the risk of dropping items on passers-by;
- Restricts movement & has to be safely situated and secured;
- Has a limitation on heights at which it can be used;
- The ladder should extend at least 1 m above the landing place, or above the highest rung on which you have to stand
- Place the ladder at a safe angle of about 75° to the horizontal, that is about 1 m out at the base for every 4 m in height;
- For extension ladders, make sure you leave an overlap of at least two rungs for sections up to about 5 m in length and at least three rungs for sections of more than 5 m in length.
- Facing the ladder when climbing or descending and to ensure that there is sufficient space behind the rungs to provide a proper footing
- It should always be raised and lowered extension ladders from the ground and to ensure be made that hooks or locks are properly engaged before we start to climb.

- To make sure that our footwear is free from mud or grease before we begin to climb a ladder;
- If possible carry our tools in your pockets or in a holster or bag when we climb ladders so as to leave both hands free to grip the stiles.
- It should not be carried materials while we are climbing ladders – be used a hoist line instead;
- A common cause of accidents is overbalancing or overreaching, so we do not be tempted to stretch too far; instead move the ladder.

2.3.1.7. CARE OF LADDERS

- Ladders need to be inspected regularly by a competent person and damaged ladders removed from service. Timber ladders should be checked for splits or cracks, splintering or warping, metal ladders for mechanical damage. Look for missing, loose or worn rungs should be looked upon;
- Ladders should be capable of being individually identified, e.g. by some form of marking;
- Ladders not in use should not be left on the ground so that they are exposed to weather water and impact damage. They should be properly stored on racks under cover and above ground, and ladders over 6 m in length should have at least three support points to avoid sagging;
- A ladder should not be hung from its rungs or from one stile as this tends to pull out the rungs;
- Timber ladders should be kept in areas with good ventilation which are free from excessive heat or dampness;
- Timber ladders and equipment may be coated with transparent varnish or preservative, but should not be painted as paint conceals defects;
- Aluminium ladders should be given an adequate protective coating when they are likely to be subject to acids, alkalis or other corrosive substances.

2.3.2. MANUAL HANDLING: Manual material handling covers the followings actions :

- Pulling or pushing the material
- Lifting or lowering the material
- Carrying the material
- Holding the material
- Application of small frequent forces.

There are many different types of hand tool for different kinds of work used during manual handling , such as shovels, axes, crowbars, chisels, screwdrivers, hammers and wrenches. In many instances these tools are bought from an outside vendor without paying any attention to their design or quality. A good-quality hand tool should be designed to fit the hand and the task. It will earn money and reduce the possibility of accidents. With the proper design of hand tools, work posture can be improved and stress can be reduced, resulting in an improved quality of work.

Accidents with hand tools nearly always arise from some human failing – carelessness, not knowing the right tool for the job ignorance of safety precautions, or failure to maintain tools and to keep them properly. You need to be correctly instructed in how to use tools and how to look after them.

2.3.2.1. ACCESSORIES USED IN MANUAL MATERIAL HANDLING : In manual material handling various types accessories are used to assist lifting and carrying the objects. These accessories are reducing fatigue and enables one to hand material safely. The accessories should be of proper design, strudy in construction and maintained in good condition. These accessories should be inspected periodically for any defects to ensure its safe use. These should be used only for its purpose for which it is designed.

2.3.2.2. HOOKS: The hook is a small handy tool made from steel. It should be stiff and sturdy. While in use it should not lose its shape under the load, causing the material to slip from hook. It is used to pull or glance the heavy objects like boxes, logs, crates and bagged material. These are usually carried in the waist-bank. Its jerky application or efforts should be avoided otherwise may result in material damage or muscle stair. Before applying force the weight of load should be estimated to eliminate excessive stress on the muscles.

2.3.2.3. CROWBAR: A crowbar is used for shifting the load and lifting heavy load through material height. These are made from steel bar. The bar made from weak material or other makeshift arrangement will not give proper service and may cause accident.

Main hazard is slipping of the crowbar. Crowbar may slip from the hands while applying pressure on it or the edge of bar below the load may slip away from the load. This will result in sudden release of the load on the crowbar. There will be unexpected jerk, which may cause injury to hands. Its point should have a good bite and strength to avoid slipping or breaking of its edges. While applying the effort, hands should be properly positioned on the bar. Along with this, the proper body position on the ground in relation to the direction of force should be maintained. This will facilitate application of proper efforts. While applying efforts hand-grip on the bar should be firm and body weight should not be applied to assist efforts. Improper body position may also result in muscle sprain. The slippage of bar may cause one to fall on the floor or hands getting pinched between the object and bar or the floor and bar.The crowbars should be free from oil and dirt. Its periodical checking is essential for proper service.

2.3.2.4. ROLLERS : The rollers are round bars or pipe pieces of smaller diameter. They should be sturdy and of appropriate length. The rollers are used to move heavy and bulky objects through considerable distance. The width of the roller should be a little more than the width of load. If width is small then bar may get slip under the load there will be difficult for insertion also. The diameter of roller should be of appropriate size i.e. not too small or too large. Small size roller or bar will sink in soft floor or it will not roll freely on the floor. The load movement may not be steady on large size rollers. It will be difficult to lift and mount load on large size roller by using crow bar. A crowbar should be used to insert the rollers below the load or to adjust its position while moving the load over the rollers on the floor. It should not be done by bare hands or fingertips. While load being moved the rollers should timely inserted. The load should be supported by at least three rollers. The next or another roller needs to be inserted before earlier comes out. This will keep shifting process under control. When the object is being moved, care should be taken to protect toes and fingers and they should not get pinched or crushed between roller and floor. The object movement on the floor should be smooth and steady.

2.3.2.5. TWO-WHEEL HAND TRUCKS : Two-wheel hand trucks or wheelbarrows are very commonly used to move the material on the shop floor, at construction sites, etc. The applications are many. The design of equipment varies suiting to the material being handled. While pushing the hand cart it is likely that the fingers may get jammed between handle bar and structure or door frame. To avoid such jamming the guards are provided on the handle grip bar. Care should be taken such that toes do not get pressed under the wheels while maneuvering the truck. It should be moved at sale speed as there is no brake provision for checking motion far as possible trucks should be pushed instead of pulled. This wall ……. One to take care of obstruction traffic on the way and also the material being carried. The shop-floor surface should be fairly finished and free from cracks, holes and debris. Load should be well supported and neatly balanced to avoid any possibility to fall out in transit. Large, bulky and odd shape items and especially items like gas cylinders should be firmly tied. While loading the truck the material should be placed forward and near to the wheels such that load will be supported by wheels and not by handle. This will permit the operator just to balance and push the truck while pushing on the shop-floor. The truck is loaded in horizontal position then it raised for pushing. While raising or lifting and later on lowering the truck the principles manual material handling should be observed to avoid any physical injuries.

2.3.2.6. JACKS : Jacks are used to lift heavy load through a small height. These are designed for various load lifting capacities, as such its capacity should be prominently marked on it. This will avoid their use for heavier loads. A jack should be inspected before use for fluid leakage or any other damage. The handle is provided for lifting and shifting the jack. It should not be dragged on the ground while sifting. While lifting the load its bas should be firm on the ground and the lift should be vertical. Hard wooden block is necessary for packing and support if floor surface is uneven or soft. I will avoid tilting or slipping of jack while the load. After raising the load it should be supported by metal or wooden packing. A raised load, should not be allowed to be simply supported by jack alone.

2.3.2.7. FOUR-WHEEL HAND TRUCKS: Material-carrying capacity of four-wheel hand-trucks by weight and volume is more than that of the tow-wheel hand-trucks. Out of flour wheels, two at the front are mounted on fixed casters. Other two wheels on the push-handle bar side are mounted on swiveling castors. Platform is parallel to the floor. There is no braking arrangement. Its movement on the shop floor should be under control. This precaution should be observer-ed when truck is loaded or empty. Travelling distance should be short. The material should be limited in load and value the material should be kept or piled on platform such that it does not fall off or obstruct the sight of the worker while carrying. Loose and heavy material like metal bars, pipes, etc. should be tied together so that ti does fall off while in transit. The loaded material should not protrude outside posing danger for the people working or moving around. Four-wheel hand trucks are available in various froms depending upon the purpose and the kind of operation. In one of its form a platform is not provided and frame is narrow. The wheels are also small in diameter, this enables to pus the frame bellow the standard pallet board. Simple or one stroke lever is provided in the push handle. This mechanism performs both the functions e.g. to raided the pallet from floor and lower it. In raised position pallet is supported by the frame of truck and in lowered position a pallet is rested on the floor. It is essential to ensure that the lever is fully engaged. Since sudden slipping of lever during the operation is likely. This will give jerk and may cause falling of load from pallet or violent jerk to a person or his arm. A hand pallet truck provides a facility for pallet lifting and carrying. This brings safety in operation as it provides ease in loading and unloading activity. Along with other precautions as of two wheel type trucks, these should be operated at a safe speed and taking care at blind corners.

2.3.2.8. PALLETS: The pallets are flat boards of suitable standard size. The boards are rested on supports. The board orgiatform surface is about 15cm above the floor level. With this arrangement the pallet can be conveniently lifted and shifted by four wheel hand truck. This eliminates activity of loading and unloading of articles as well as accident changes in its handling. Design features of pallets are more or less common while material of constriction differs. These made up of wood, metal, high-density plastic, etc.

Drums, cartons, carboys or loose material in pieces can be stacked and whole lot along with the pallet can be shifted. This gives ease in material handling. Care should i.e. taken while piling material on platform such that it does not get disturbed and tumble down in transit. This can damage the material or hurt people. The pallets should be inspected for any damage in use and subsequently repaired or replaced.

2.3.2.9. SELECTION, USE AND MAINTENANCE

There are basic considerations in selecting, using and maintaining hand tools:

- Avoid static load at the shoulder or arm due to the continuous holding of a tool at a raised position or the gripping of a heavy tool;
- Avoid awkward wrist angles while using tools such as snips and pliers;
- Reduce uncomfortable pressure on the palm or joints of the hand, e.g. From pliers that are too small;
- Select the correct weight, size and tool for the job;
- Use only tools of good-quality steel – tools made of inferior steel chip and may even shatter when struck, tool heads mushroom, tool jaws open out and cutting tools lose their edge;
- Handles should have a smooth finish, should be easy to grasp and should have no sharp edges or corners;

- Tools should be firmly fixed and should be regularly checked for splits and cracks; wedges should be checked for tightness of fit;
- Tools should be kept free of grease and dirt, and moving and adjustable parts should be well oiled;
- Cutting edges should be kept sharp for accurate working and to avoid the need for unnecessary pressure;
- For work on or near electrical apparatus only properly insulated tools should be used;
- Tools should be properly stored in boxes, racks, holders or pocket belts and should not be left so that they can fall, roll or be tripped over; cutting edges should be sheathed;
- Damaged tools should be immediately repaired or replaced.

2.3.3. POWER-DRIVEN MACHINERY: Power-driven machinery are intrinsically dangerous. The power driven machinery have caused many serious accidents to the people operating them also to the people around. The causation of accident is respective of size, shape or type of machine.

The use of power-driven machinery on construction sites involves many hazards. Common to many construction machines are in-running nip points where one part rotates against or close to another. Common examples are cog-wheels, chain and sprockets, belts and cylinder drums, and ratchet drives. All nip points should be assumed to be dangerous and should be guarded to prevent approach unless they are enclosed within-the machine. Equally dangerous are rotating shafts of whatever diameter and of whatever speed. A common cause of accident is clothing becoming caught and wrapped around the shaft. If the shaft is not inaccessible within the machine frame, then it must be enclosed – a loose tube covering and resting on the shaft is a cheap, convenient and effective method.

2.3.3.1. HAZARDS:

- Rotary or rotating motions.
- Reciprocating and traverse motions

- In-running nip points
- Cutting action of machine-tools
- Cutting , shearing , bending operations

2.3.3.2. CAUSES OF ACCIDENTS:

- The objects likes rotating shafts , wheels, spindles, flywheels, fans , rollers etc can be hit a body part directly or entangle clothing or hair by just a light contact and forces arm, hand or body into the moving part.
- Moving machines may have rotary, reciprocating or unidirectional linearly transmission motion and if machines are not properly guarded, a person is likely gets struck or caught by the moving parts.
- Body part may get drawn to the in running nip points and get crushed.
- As a part of operation ie while inserting , adjusting or removing the job or r aw material a body part is exposed to a potential hazard because palm , hand or finger are likely to come in contact with moving tool.
- Hand & finger may crushed due to punching , shearing and bending operations.

2.3.3.3. SAFETY PRECAUTIONS: When you use power-driven construction tools and machinery, make it personnel regular practice to check whether:

- All protective devices and safety measures supplied with the machine are in position, adjusted and working;
- The machine appears to be safe to use even for an inattentive worker;
- Safety devices are strong enough to withstand wear from ordinary use; and
- Safety devices do not prevent efficient use of the machine.

2.3.3.4. ELECTRICAL EQUIPMENT: Electrical hazards are different from other types of hazard found in construction work because the human senses provide no advance warning, whereas an approaching vehicle may be heard, the prospect of a fall may be seen, or escaping gas may often be smelt.

About one in every 30 electrical accidents is fatal. The great majority of electrical accidents result in electric shock and burns. Fire and explosion from sparks in flammable atmospheres and radiation from electric arc welding or microwave heating are also possible causes of injury.

2.3.3.5. ELECTRIC SHOCK : The danger from electric shock is directly related to the amount of current that passes through the body and to the time that it takes to pass. At lower levels, the effect may be no more than an unpleasant tingle, though perhaps sufficient to throw a worker off balance and cause a fall from a scaffold or ladder. Medium amounts cause increasing muscular tension, so that anything in the grasp can scarcely be released – a condition which can quickly become dangerous. Higher amounts can cause fibrillation of the heart (irregular contractions of the muscles), which is almost invariably lethal.

The passage of current can also cause burning of the skin at the points of contact. Severe burns can occur, too, from exposure to an electric shock without actual bodily contact. Damp and wet conditions greatly increase the danger of electric shock.

It is the voltage that determines the current through the body. Since reduced voltage reduces the severity of electric shock, it is common sense to use reduced voltage of 110 V wherever possible.

The main causes of electric shock are as follows:

- The earth or ground wire becomes disconnected from its plug terminal and touches a live terminal so that the metal case becomes live;
- Wrong connections are made to terminals on the plug or the equipment;
- Damaged or missing covers on fuse and terminal boxes, or on socket outlets, expose bare live conductors;
- Flexible cables are damaged when they are dragged over sharp surfaces or run over;

- Makeshift repairs are made to flexible cables with insulating tape alone.

2.3.3.6. PORTABLE ELECTRICAL TOOLS AND EQUIPMENT: Double-insulated and all insulated tools are safer than ordinary tools because they incorporate layers of protective insulation to prevent external metal parts from becoming live.

If you use portable power-driven tools, you need to be properly trained in their maintenance and use. Before operating a portable tool, check it to ensure that:

- There is no damage to the portable leads and plugs – they are subject to heavy wear on construction sites ;
- There is a correct fuse;
- The tool is set at the right speed for the job;
- Leads and cables are kept out of the way of other workers and are not in contact with water.

When person finish using the tool, make sure that the moving part is fully stopped before person put it down.

2.3.3.7. : The lifting tackles includes, chain-slings, eye-bolts, grips, pulley blocks, hoods, etc. The safety of material handling operation depends upon the strength and rigidity of these individual units. Proper selection of equipment is also necessary. For specific and particular application such as foundry ladles, long pipes, large containers, etc. the tackles are specially designed and used. Some of the tackles are as below:

2.3.3.8. SLINGS : Sling is an assembly of rope or chain hook, ring and sometimes swivelling coupling. Slings can be of single or multiple leg. These are used to tie and lift the load. The slings are manufactured for some specific load bearing capacity. Usually these are operated near to its rated capacity. But its rated capacity only holds well when slings are vertical. When sling is inclined tension on it increases and for some inclination tension is more than the load. In this situation the jerks or impacts experts excessive stress on the slings should be operated taking into account their safe working loads and keeping some margin. The slings should not be dragged on the floor. Alteration in length by giving knots or inserting bolts should never be done. There will be excessive strain on the links in the knot section. The links will be distorted with such a load pattern.

The periodical inspection for wear, erosion, mechanical defects, elongation, etc. is necessary. Slings or blocks should be stored in dry place away from wet, moist and corrosive surroundings. The slings should not be hammered for adjusting or fastening them around the object. Only standard accessories should be used along with the slings.

2.3.3.9. ROPES: The ropes are in use for material since ancient time. These are prepared from a variety of materials. Broadly there are two types one is natural fibre ropes and other synthetic fibre ropes. Natural fibre ropes are made from cotton, coir, hemp, etc. There are some disadvantages with these ropes as they deteriorate due to weathering effect. Also, they can be damaged by contact with acids and alkalis. In wet condition their strength gets reduced. The ropes may get brittle if dried in the sun.

Precautions should be taken during their use and storage. These are stored under the shed in dry well ventilated area. While handling sharp edged objects soft packing is used. The ropes are kept away from hot and corrosive objects. To ascertain its serviceability the ropes are inspected frequently.

Synthetic fibre ropes are made from Nylon, Polyester, etc. Synthetic fibre ropes have some advantages over the natural fibre ropes. They more capacity to absorb shock loading. Their load withstanding capacity will not get reduced when ropes are damp or wet. They do not rot when stored in moist or wet conditions. These ropes will degrade less after their use with oil and many petroleum products and can resist acidic and alkaline materials. However, synthetic fibre ropes are vulnerable to excessive heat. Sire ropes are made from alloy steel. These are widely used for cranes, hoists, lifts elevators, etc. The size of a rope is identified by its diameter. With the increase in the diameter of a wire-rope, its strength increases. The ropes are made from stands of thin wires to impart them flexibility.

2.3.3.10. PRECAUTION AND CARE:

- Wire ropes should be lubricated to reduce wear and corrosion.
- Rope slings should be prepared by splicing rope strands or by using sockets joints, bulldog clips, swaged ferrules, etc. Use of knots for jointing should be avoided as it gives excessive strain around it.
- As far as possible drums or pulleys used should be of sufficiently large diameter to reduce bending stress on the rope. The drum diameter should be at least twenty times that of rope diameter.
- The drum or pulley should be well aligned.
- Pulley groove size should be proper to assure that the rope is freely in contact with pulley surface and covers more than half of cross sectional area rope. Rope should not hand on leaving gap at its base or should not get locked or wedged in the pulley groove while passing over it.
- While the lifting load cross winding of rope on the drum should be avoided.
- While typing rope around sharp edges or hard corners soft packing should be provided at sharp edges and corners.
- Dragging rope on the shop floor is avoided since it will cause abrasion. The dirt and grit is likely to get embedded on the rope, which is harmful.
- The rope should be handled carefully so as to avoid any kinks or untwisting of strands.
- While handling wire ropes use of hand gloves is necessary, since there is a chance of injury to palm or fingers from broken wire tips.
- After its use these are cleaned and stored in a covered dry place. The standard practice should be to roll the rope in loops and hang the loops

on wooden pegs fixed on the wall. This will eliminate corrosion and kink formation.

- Wire ropes and slings should be periodically inspected for breakage for constituent wires.

2.3.3.11. CHAINS: Chains are made from links. Each link is welded and looped in the other similar link. The strength of chain depends upon each individual link. The chains used for material handling may be made from wrought iron, mild steel or alloy steel. The chains are more flexible than wire ropes but these are heavier also. For the same load-lifting capacity the chains are six times heavier than wire ropes. The chains do not get curled or kinked and other good grip. These can absorb shock better than ropes.

2.3.3.12. PRECAUTIONS IS USE AND CARE: A chain can fail due to breakage of just one of the links. It can give way subjected to load higher than its rated capacity or a shock load, that chain can withstand. The chain or link may not fail due to a single episode but it will cause damage. Subsequently, in its later use, it may fail without any pre-warning. This can be avoided by taking operational precautions and good inspection procedures.
Before lifting load be sure that the chain capacity is adequate to lift the load. Chains should not be extended, shortened or their broken links jointed by bolting or knotting. There can be excess stress around the knot and bolt, which may cause the material failure. The chain should not be use to hood for carrying or lifting load. While lying around the load crossing, knotting, twisting, kinkering, etc. should be avoided.

To avoid accidental failure of chain in its use, each and every link of the chain should be inspected for elongation and wear. Similarly, complete chain length is checked for elongation. This inspection requires some knowledge and experience.

2.3.3.13. PULLEY BLOCKS: Pulley blocks are of rigid construction and made up of shock-resistant material. The pulley is housed on an axle and should be freely rotating over it. If pulley is not freely rotating on the axle then rope or chain will get dragged on the pulley grove. This well cause friction. Both rope and pulley will get damaged. The axle should be regularly lubricated for free movement. The grooves in the sheaves should be smooth. A distorted or worn out groves damages rope when it runs over it. The pulley block from hood side should be adequately guarded. This will prevent injury by drawing in of the fingers or hand. While in operation rope or chain may leave the groove and ride on the pulley edge or housing. Care should be taken to ensure that the rope or chain do get stuck or rub between the pulley and its housing.

2.3.3.14. HOOKS: Hooks are used as terminal fittings to attach chain slings or rope loop. These are usually sturdy and of adequate strength. Hooks are provided with a safety catch or locking pawl such that rope loop does not come off while in operation. Many times instead of providing a catch, a shape is given to the inner surface of hook such that the rope cannot come off easily.

Due to faulty operation or overloading, the hood may get bent or deshaped. This may cause a hook failure resulting in dropping of load. Otherwise the rope may come off violently and may hit the persons working nearby. The hooks are inspected for any damage such as deshaping, hair-line cracks, etc. Doubtful or faulty hooks should not be locally repaired or their use continued. They should be replaced.

PART D: CHEMICAL & PHYSICAL HAZARDS

2.4.1. CONSTRUCTION WORKPLACE CHEMICAL HAZARDS: Dangers from chemicals may arise from contact with the skin, inhalation or ingestion (swallowing).

2.4.1.1. CONTACT WITH THE SKIN: Dermatitis is perhaps the most common occupational skin disease, and can be caused by contact with a number of materials commonly used in the construction field. Cement, particularly when wetted, is an example and if it contains chromates the danger is increased. The slaked lime content in cement is considered to be responsible for cement burns on the legs and feet of operatives where concrete has spilled into their wellington boots.

Certain epoxy resins used in grouts, seals and adhesives are another cause of dermatitis, as are acids, alkalis, solvents, thinners, paints, varnishes, acrylic and formaldehyde resins, brick and stone dust, pitch, tar and bitumen.

To avert this hazard, it is clear that skin contact with chemicals should be avoided. Careful handling, including the prevention of splashing, is called for, together with the use of closed stout containers for distributing and appropriate tools for mixing and applying the products, Protective clothing should be worn, in particular suitable gloves and safety eyewear. Barrier creams on the hands and forearms may be of use but care is needed to select the correct product for the particular operation.

Personal cleanliness is most important and hands must be clean before eating, smoking or using the lavatory. Gloves should be thoroughly washed before they are removed. An individual may become inedical treatment the dermatitis will recur on further exposure to the substance.

2.4.1.2. INHALATION OF HARMFUL CHEMICALS: The inhalation of certain dust, fumes, gases and vapours may give rise to a variety of risks to health, including respiratory disorders, poisoning, asphyxiation and cancer. Safety guidance note EH40 gives occupational exposure limits for many airborne contaminants, it is revised annually. Some of the more common substances are dangerous and breathing them may lead to asbestosis, which is a scarring of the lungs causing shortness of breath. Other hazards are lung cancer and mesothelioma, a rare cancer of lung envelope. Asbestos is present in a number of products used in construction processes, e.g. asbestos cement roofing sheets, decking, cladding sheets, rainwater and soil pipes. Their cutting, handling and breaking gives rise to this dust. It is also found in asbestos insulating board and in sprayed coating for insulation and fire protection purposes. (This process using asbestos-containing material is prohibited under the Asbestos (Prohibitions) regulations 1985). However, stripping out the coating continues to be an operation very hazardous to health. The Asbestos (Licensing) Regulations 1983 are intended to prevent employers and the self-employed carrying out work that involves disturbing asbestos insulation and coating unless they are licensed to do so by the Health and Safety Executive.

Wherever possible safe substitute materials should be used for the building process. Otherwise, exhaust ventilation equipment, approved respirators and appropriate protective equipment must be used when handling and manipulating asbestos or asbestos-containing materials. For operations such as drilling, cutting and cleaning up, the area should be dampened and the operation carried out carefully to minimize the creation of dust.

A particular risk associated with dust on protective clothing is that the dust may be breathed in by anyone handling the garments, e.g. for cleaning. Immediately after use, protective clothing should be carefully placed (so as not to cause dust) in a scaled container appropriately marked ‘asbestos-containing clothing’ and sent for clearing by cleaners competent to carry out the work. Those intending to work with asbestos should refer to the Control of Asbestos at work Regulations 1987 and guidance notes published by the Health and Safety Executive (see chapter 8 and Appendix 4).

2.4.1.3. CARBON MONOXIDE: Carbon monoxide is one of the most dangerous gases likely to be encountered on a construction site. It is odourless and therefore, easily breathed by the unsuspecting. Headache, nausea, dizzianess and loss of co-ordination may result from low levels of exposure, whereas high levels lead to rapid death. Moreover, regular low exposure may lead to repid death. Moreover, regular low exposure may lead to heart disease. Sources include internal combustion engine exhausts, poorly main tainted space heaters (with incomplete combustion of the fuel), code braziers and carbon dioxide welding. The risk is particularly high in confined working areas such as tunnels and excavations. In all cases the need for adequate ventilation is paramount to avoid danger. Where carbon monoxide is likely to be present then appropriate monitoring of the atmosphere must be carried out.

2.4.1.4. CARBON DIOXIDE: Carbon dioxide occurs naturally in chalk and limestone areas. High concentrations in confined spaces result in oxygen deficiency and very dangerous atmospheres. Numerous fatal accidents have occurred when unsuspecting workers have entered manholes fatal accidents have occurred when unsuspecting workers have entered manholes in surface-water drainage systems or boreholes in such areas.

In all shafts, wells, adits, tunnels and excavations in limestone and chalk areas it is particularly important before each entry and continuously during all working time that the atmosphere should be tested for high concentrations of carbon dioxide and for oxygen deficiency. A further most important check is the barometer reading. If it falls during the time workers are in the excavation the atmosphere may change lethally, and therefore immediate oxygen deficiency testing should be undertaken. Again, the necessary precautions are adequate forced draught ventilation and atmospheric testing before entry and throughout the working cycle. Where there is a need to enter a dangerous or unknown atmosphere, appropriate breathing apparatus should be worn.

2.4.1.5. HYDROGEN SULPHIDE: Hydrogen sulphide in high concentrations can cause death, and at low levels, irritation to the eyes, nose and throat, dizziness and headache. It may generally be found in sewage, othe decomposing organic materials and excavations in made-up ground. The necessary precautions are similar to those indicated for carbon dioxide. Workers carrying out maintenance in existing sewers should be particularly on the alert and should not enter manholes etc. without carrying out checks of the atmosphere, and should them undertake periodic checks while working underground.

2.4.1.6. NITROUS FUMES: Nitrous fumes are very toxic; exposure to high con-centrations may prove fatal and exposure to lower concentrations may result in bronchitis. A common source results from the use of explosives in tunneling and excavating, for example. The confined space of the tunnel and excavation is perhaps the area of greatest risk. The main precautions is, if possible, to ensure that personnel are removed from the danger area during blasting and firing operations and that stay away until the fumes have dissipated.

2.4.1.7. CADMIUM: Breathing cadmium fumes would almost certainly result in cadmium poisoning, which occurs suddenly, causing drowsiness, vomiting, loss of muscular control and possibly death. Cadmium fumes are released during cutting, welding and brazing operations with cadmium plated steel.

The main danger occurs when the operations are carried out in confined spaces such as tanks and fabricated structures, and the necessary precaution to take is the provision of good ventilation, it will often be necessary to provide local exhaust ventilation, especially in confined spaces, or to ensure the use of air line breathing apparatus.

2.4.1.8. LEAD: Lead poisoning may arise from breathing either lead dust or lead fumes and results in fatigue, anaemia, colic or wrist drop. The cutting and burning of old structures covered in lead-based paint releases lead dust and fumes and therefore the highest risk area is probably demolition work.

Where possible the process should be segregated and appropriate (possibly local exhaust) ventilation provided. Good protective clothing should be worn (i.e. a type that does not hold dust), and in some cases respiratory protective equipment should be sued. An essential precaution is personal hygiene – hands should be thoroughly washed before workers eat, drink of smoke.

Overalls or other protective clothing should be removed before meals are taken and not taken into areas where food and drink are consumed. It is also important that users should wash immediately following the removal of all protective clothing. Similar standards of personal hygiene should be followed by operatives before they smoke etc.

2.4.1.9. WELDING FUMES: In welding operations the parent metal and its coatings, together with the weld metal and rod coating, release a variety of complex fumes which, if breathed, may give rise to metal-fume fever – a flu-like illness. The necessary preventive measure is the provision of local exhaust ventilation and for short periods, respiratory provision of local exhaust ventilation and, for short periods, respiratory protective equipment of the type that supplies fresh air. Moreover, as with lead, good personal hygiene is very important.

2.4.1.10. ZINC: Zinc fumes are evolved from the welding, brazing and flame cutting of galvanized steel and breathing them may cause zinc-fume fever exhaust ventilation and respiratory protection are the precautions to be taken if this hazard is to be avoided.

2.4.1.11. SOLVENTS: Various types of solvent are contained in a wide range of products used in the construction industry, e.g. adhesives, sealers, paints, lubricants and lacquers. Not only may they cause dermatitis through skin contact but they may also be a source of vapors which, when inhaled, can cause a variety of illnesses including headaches, dizziness and vomiting, and, in severe cases, unconsciousness preceding death. They are particularly hazardous when used in confined spaces (e.g. basements) because of higher concentrations and poor natural ventilation. A good standard of ventilation and appropriate protective clothing should be adopted to minimize these hazards.

2.4.2. INGESTION (SWALLOWING) OF HARMFUL CHEMICALS:

The swallowing of harmful chemical by mistake or through lack of personal hygiene is an ever-present risk in construction and demolition activities. The hazards and precautions against the ingestion of harmful chemicals are largely covered by the commentary above on dangers arising from contact with the skin and inhalation. The promotion of good personal hygiene, the provision of correct protective clothing, equipment, toilet and washing facilities, accompanied by training and supervision, are also essential to prevent the transmission of chemicals to the mouth from hands, arms gloves, etc. In addition, there is a need for clear correct labeling of harmful substances with special attention paid to liquids not in their original containers, to against accidental swallowing.

2.4.3. CONSTRUCTION WORKPLACE PHYSICAL HAZARDS: In the second main category of hazard danger results from the general environment experienced by the workers or from their particular occupation.

2.4.3.1. COLD: Construction workers may be exposed to conditions of extreme cold and to biting winds accompanied by rain over long periods. Such prolonged exposure without adequate protection may have serious effects on their health. The effects may range from a dulling of mental facilities and slower muscle reaction to possible bronchitis and arthritis. Furthermore, errors and accidents are likely to increase when the hands of operatives are particularly cold.

The first line of defence against the cold is to wear suitable protective clothing, supplemented by sensible undergarments and warm footwear. Moreover, if possible, overall general protection to the work area should be provided, e.g. the use of reinforced plastic sheeting in the form of screens. The provision of warm accommodation where hot drinks and food are available is essential.

2.4.3.2. HEAT: Although not as prevalent in Britain as in countries with much hotter climatic conditions, heat strees in construction workers should not be totally discounted. The likely occurrence depends on the ambient air temperature, the relative humidity, radiant heat and the amount of air movement. Thus hot humid weather, especially for people carrying out heavy manual work in confined spaces with little air movement, provides the conditions for this hazard.

Another are may be underground, during tunneling operations where heavy manual work is being undertaken in the vicinity of heavy machinery, and where the ventilation standard is not as good as it should be. The symptoms are headache, giddiness, fainting or muscular cramps, and victims should be taken to a cool place, provided with fluid to drink and allowed to rest. Where the case is severe and the casualty appears to be ill, develops a high temperature and does not perspire, urgent medical attention is necessary.

2.4.3.3. NOISE: Damage to hearing, usually irreversible, may be caused by exposure to high noise levels from plant and machinery on site or in a workshop. Sound levels are measured by meters that indicate the characteristics of the human ear quoted as dE(A). The generally acceptable sound level upper limit is 90dB(A) where the sound is reasonably steady and exposure is continuous for eight hours in any one day. Where the sound level fluctuates of the exposure period is other than eight hours, the daily personal noise exposure may be calculated by the use of formulae given in the Noise at Work Regulations at work place.

In addition to the continuous exposure limits there is a requirement that the unprotected ear should not be exposed to a peak sound pressure level exceeding 200 Pa. Noise reduction should in the first instance be made by engineering control, e.g. more efficient silencers to the exhaust systems of air-cooled diesel or petrol-engine plant and pneumatic powered equipment sound reducing covers for compressors, careful and regular maintenance of plant and machinery with particular attention given to the prevention of unnecessary vibration, and the use of acoustic screening of noisy fixed equipment where possible. Ear protectors should be a last resort and when they are used they must be carefully selected to suit the noise levels expected. Employers must provide protectors to all workers likely to be exposed to 90 dB(A) or 200 Pa and ensure that they are used employees must wear them. Furthermore, protectors must be provided to employees who are exposed to between 85 and 90dB(A) if they ask for them.

2.4.3.4. VIBRATION: A most common injury is caused by continued exposure of the hands to high frequencies of vibration from tools such as pneumatic hammers concrete breakers, drills and chipping hammers. It is usually known as vibration white finger. It starts with a slight tingling or numbness in the fingers and eventually causes whiteness to the tips. Attacks may last about an hour and end with a sudden rush of blood to the affected tips, often causing considerable pain.

This occurrence can be reduced by the use of vibration isolators, by the operator exerting the lightest pressure on the tools commensurate with proper control and the provision of breaks from the work on to non vibration work for the operator. The maintenance of good circulation and warm hands is also helpful and the wearing of comfortable gloves can be an asset.

2.4.3.5. IONISING RADIATION: Sealed radioactive sources are widely used in the industry to check welded joints in pipelines, for example and for other non destructive testing. Experience has shown that site radiographers are more likely to receive serious overdoses of radiation than are their factory based counterparts. Those working in nuclear power stations, processing plants and laboratories may also be exposed to ionizing radiation. The effects of exposure to ionizing radiation may be radiological dermatitis, skin burns, loss of hair and bone cancer. Compliance with the Ionising Radiations Regulations 1985 together with the safety's approved code of practice the protection of persons against ionizing radiations arising from any work activity is, of course, essential, and this should obviate the likelihood of persons receiving excessive exposure.

In brief, only classified persons are allowed to undertake site radiography and their work must be carried out under the supervision of an appointed radiation protection advise who should ensure that the work is carried out in accordance with the requirements of the regulations and that any local rules relevant to the work are observed. Other workers (not involved with the radiography) and even the public may be at risk from scattered radiation. This may be reduced by the work being carried out within a suitable enclosure from which all but the classified workers are excluded. Where this is not reasonably practicable a designated area must be established, the boundary of which should be a safe distance from the exposed isotope. The boundary must be clearly indicated with warning signs or lamps at appropriate intervals and consideration should be given to posting sentries along the boundary as ap extra precaution to ensure that no unauthorized person enters the danger area.

2.4.3.6. COMPRESSED AIR: Working in air at pressures above atmospheric pressure, for example on diving activities, tunneling or caisson construction may result in compressed air illness. In its mildest form (type-I) this may take the form of skin irritation, slight pains in the joints and tightness of the chest, but with the more serious form (type II) severe pains develop in the joints, and dizziness, unconsciousness and even death may occur. A particularly distressing type of compressed air illness is aseptic bone necrosis, which affects the ends of the long bones in the body at the shoulder, hip and knee joints, for example. It leaves the affected person with symptoms similar to arthritis, varying from extreme discomfort to total disablement.

The cause of the illness is associated with too-rapid decompression and to reduce the likelihood of its occurrence, compliance with acceptable decompression procedure and tables is necessary. The work in compressed Air Special Regulations 1958 include decompression table for use in tunneling and caisson work, but subsequent research has identified a decompression procedure which gives better protection than the 1958 tables, as they are know. This is incorporated in decompression tables know as the 1966 Blackpool tables and the Health and Safety Executive advise their use. Since the 1958 tables are the statutory requirement, contractors wishing to use the Blackpool tables must first obtain official approval from the health and safety executive. Decompression procedures in respect of diving operations are covered by the Diving Operations at Work Regulations 1981.

2.4.3.7. LASERS: Lasers are used in the construction industry as an aid to setting out works which involve straight lines as, for example, in tunnels, runways and dredging work.

Eye injury, which could be severe, may occur if someone looks directly it to the beam of a laser in the direction of the source. Moreover, contact may cause skin burns. It is important to select safe instruments and where possible to ensure the separation of personnel and the beam by means of effective barriers; furthermore, notices should be displayed to warn people against looking down the beam. Where people need to approach the beam, appropriate eye protection against the particular type of laser must be provided.

2.4.4. BIOLOGICAL HAZARDS: Biological hazards experienced in the civil engineering and construction industry are likely only to affect those engaged on waste land sites or sewer cut falls or in sewers contaminated by vermin. The disease that is sometimes caught by these workers, is leptospiral jaundice of Well's disease. This is a feverish condition caused by ingestion of food or water contaminated with the urine of rats. Where not treated early and properly the disease can be fatal. The contaminated sludge in sewers may also enter the skin or be absorbed through mucous membranes of the eyes, nose and mount.

2.4.5. LIGHTING: Light and colour , their quantity and quality are the important factors for any visual perception and work performance . The light is most important, because without light the things have no colour , no shape , no perspective. Light and colour affect much on human efficiency, accident-proneness and on his general well – being , morale and fatigue. Lighting includes both day lighting and artificial lighting and they should be in the requisite proportion.

2.4.5.1. HAZARDS:

- Bad light causes glare, shadows, darkness, eye strain.
- Unhealthy eyes causes restriction of vision, fatigue.

2.4.5.2. CAUSES OF ACCIDENTS:

- The eyesight of the person
- The quantity and quality of light on the object to be seen.
- The size shape, speed and distance of the object
- The degree of colour contract between the object and its bankground
- The obstructions transparent or non – transparent , in the path of the light rays between the eye and the object.

2.4.5.3. SAFETY PRECAUTIONS:

- Adequate, rational or good illumination needs sufficient quality of illumination necessary fro avoiding discomfort to the worker and undue strain on eyes.
- Balance the effects upon the position of the light source in the field of view and on the contract in brightness between the light source and its background.
- The distribution of light with a maximum and minimum illumination at any point should not be more than one sixth above or below the average level in the area.

- Shadows should be avoided, but some shadows effect may be desirable from the general lighting system to accentuate the depth and form of object.
- During night time ie in the absence of daylight, artificial light is the only remedy. Even during day time where the day lighting is insufficient to provide prescribed illumination due to obstructed locality or weather effect.

2.4.6. VENTILATION AND EXHAUST SYSTEM: Human body cannot tolerate excessive temperature. Heat stresses produced by heat exposure cause adverse effects on heat and safety of work people. Therefore environmental temperature control is also permanently needed for well functioning of human body. Carbon dioxide is continuously exhausted by all human beings. Much more contaminations are added by manufacturing processes to pollute air. Therefore cleaning of air and supply of fresh air with sufficient oxygen are also necessary. This is possible by good ventilation and exhaust system technique only.

2.4.6.1. HAZARDS :

- Heat or Sun stroke
- Muscle Cramps
- Fainting, Dizziness ,Fogging & Fatigue
- Heat Rush or pickly heat

2.4.6.2. CAUSES OF ACCIDENTS

- Excessive rise in core temperature resulting from failure of thermo regulatory mechanism.
- Loss of body fluid with salt in sweating.
- To profuse sweating and salt loss, drinking much water and failure to replace body's salt loss.
- To more blood in the skin and lower part of the body , less return to the heart for pumping to the brain.

- Heat fatigue due to prolonged heat exposure.
- Heat rash or prickly heat likely to occur in hot and humid environments where sweat is not easily removed from skin surface and sweat glands plugged.

2.4.6.3. SAFETY PRECAUTIONS:

- To reduce heat of metabolism, high air temperature, radiation temperature, high air temperature, and humidity.
- To provide ample supplies of cool water, flavoured drinks and / or salt, if required.
- To ensure light weighted, loose fitting clothing.
- Not to deployed the person if they are suffering from cardiovascular disease or suffering from febrile illness etc.
- Rest periods should be taken in cool surrounding.
- Train in first – aid for heat strain symptoms.
- Analyse working situations for estimation of heat load through various channel.

2.4.7. FIRE: For fire to start four elements are essential :

- Fuel (Combustible material and reducing agent)
- Oxygen or oxidant or oxidizer (from the atmosphere)
- Heat or source of ignition (necessary to start the fire initially, but maintained by the fire itself once it has started)
- Maintenance of chain reaction through free radicals.

These four sides constituent a fire pyramid. If any one of above four elements is removed, the fire goes out. Therefore methods of fire extinguishment are dependent on

- Removing or shutting off the source of fuel.
- Excluding oxygen or decreasing it below 14 to 18% by adding inert gases
- Removing heat from the fire faster than its librations; and

- Removing free radicals to discontinue chain reaction and flame propagation.

- Thus fire is rapid chemical oxidation reduction reaction. It is an oxidation of a substance accompanied by heat , light and flame.

2.4.7.1. SAFETY PRECAUTION: Routine maintenance, inspection and testing of fire extinguisher in respect of their mechanical parts, extinguishing media and expelling means should be carried out by properly trained personnel at frequent intervals.

- To use any fire extinguisher, training is necessary for handling and operating any fire equipment. The frequency and nature of training will depend on the size and type of industry.
- All fire equipments should be in ready working condition. The defective equipment may prove dangerous in the event of fire.
- Hydrants, monitors, hose reels, hoses nozzles , couplings, foam making equipment etc should be regularly inspected, tested under pressure and kept in good repair and working condition.
- Smoking area clearly indicated. Ashes kept in metal containers.
- Gas connections closed when not in use. No gas leaks. Hot pipes are clear of combustible materials.
- Premises free of combustible materials, metal containers for oily rags, safe storage of flammables, accumulations of rubbish and clear of obstacles.
- No bare wiring or badly worn insulation. Ground connections clean and tight.Fule and control boxes clean and closed. No make shift wiring to be prefer.
- Fire protection equipment are in proper place, unobstructed, clearly marked and in working order.

2.4.8. ERGONOMICS

The technical development of the construction industry has led to reliance on machines and technical equipment for much heavy work previously done by hand. Although there are still many tasks on site which are carried out using manual labour, it is difficult to envisage high-rise building construction without cranes, excavators, concrete mixers or pile drivers. Mechanization has, however, brought new problems to the workplace.

Technology changes faster than people and technological change often exceeds people's ability to adapt. As a construction worker, you know the difference between a tool that is well suited for you and for the job, and one that is not. Person also soon become aware of the difference between a comfortable working posture and one that is uncomfortable. Ergonomics is a multidisciplinary way of looking at the interrelationship between the worker, the workstation and the working environment. Ergonomics plays a key role in the humanization of work, in increasing productivity, and in improving workplace safety and health.

Even with new and modern technologies a lot of heavy work is still done by hand. Tools, machines and equipment are in many cases old-fashioned, poorly designed or badly maintained. Many operatives on construction sites are unskilled. Heavy loads frequently have to be carried up and down stairs, ladders and scaffolds, and people working on construction sites often suffer from low back pain or injury to muscles and joints.

The construction industry has a wide range of jobs and processes. These change according to the stage of the project. They involve consideration of:

- Working positions, both standing and sitting;
- Work which is especially strenuous;
- The use of hand tools and equipment.

2.4.8.1. STRENUOUS AND HEAVY PHYSICAL WORK : Continuous heavy manual work increases the rate of breathing and the heart. If you are not in good physical shape, you will tire easily. There are risks involved in working at maximum physical capacity. The use of mechanical power to replace heavy work helps reduce these risks. Mechanical power also helps increase the work opportunities for people with less muscle power. On the other hand, jobs that require no physical effort are often mentally tiring and boring. It is important that the workload is not too heavy and changes during the day. Effective rest periods should always be included in the day's work.

2.4.8.2. Static loads: The most natural way to work is rhythmically. When sawing with a handsaw, the hand holding the saw is doing dynamic work and the other hand static work. This "dynamic" load enables the muscles to alternate between contraction and relaxation. If an object is lifted up and held in this position, this puts the muscles under a uniform "static" load. Muscles under static load become tired because they are continually contracted, and after a short time the muscles feel painful. A static load on the muscles over a long period will also increase pressure on the heart. The pulse increases because the blood remains in the muscles.

On building sites there are many jobs where the worker is exposed to heavy static loading. Finishing work on walls and ceilings, painting and electrical wiring work frequently require you to work with arms above your shoulder line, and frequent changes of posture are desirable.

2.4.8.3. Working postures: On construction sites people work in a variety of different positions. Some workers are climbing up scaffolds, others are using hammers while on their knees, while others are working on surfaces above their heads. Until recently, little attention has been paid to good working positions. It is frequently argued that construction work unavoidably requires many different and changing postures, but it is clear that the principles developed for good working positions in industry apply also to construction.

Difficult working positions lead to spending longer over tasks and lead to fatigue. For example, working with one's arms raised rapidly tires the shoulder muscles and work requiring bending or twisting can easily cause back strain (figure 39). A poor working posture translates into a gradual increase in operation time and an increased possibility of injury or damage to material or equipment.

2.4.8.4. SITTING AND STANDING POSITIONS: Posture is defined by the working method applied and by the tool in use. When considering posture, you have to take into account the reach and muscular power of the worker involved. Where possible, work should be done in a sitting position. However, a standing position is often unavoidable in construction work where high muscular power, greater reach or considerable movement is involved.

A well-designed workstation provides possibilities for the worker to carry out the operation in many positions and postures, both sitting and standing. It also allows the worker to walk a little during the working day.

Although there are very few fixed sites in the construction industry, there are many operations where difficult postures can be improved by simple, low-cost measures. For example, welders often have awkward working postures and a simple, light three-legged stool or chair is useful.

2.4.8.5. WORK IN CABINS : Machines with cabins for the operator are frequently used on construction sites. Examples include excavators, tower cranes, bulldozers and trucks. In recent years manufacturers of these machines have paid a great deal of attention to the working conditions of the operator. Regular checking and maintenance are needed if these conditions are to remain intact over the working life of the machine.

PART E: PERSONAL PROTECTIVE EQUIPMENT (PPE)

2.5.1. USE OF PERSONAL PROTECTIVE EQUIPMENT (PPE): The personal protective equipments are considered to be one of the primary control measures to tackle many problems. The effective use of personal protective equipment , wherever it is required as a pre-requisite for accident prevention programme, need not be over emphasized. However, it becomes problematic when the given personal protective equipments are not used by the workers concerned.

Personal Protective Equipment, such as respirator or hearing protectors must be considered as the last line of defence for workers. Every attempt should be made to eliminate the potential exposure to hazards to the individual workers through administrative/engineering control measures like job rotation or ventilation. There are, of course many tasks that are infrequent in nature and often associated with servicing, maintenance or installation of equipment, where administrative or engineering controls are not practicable or feasible. It is in those instances that personal protective equipments can play the key role of protecting the workers from exposure to hazardous substance or physical agents, such as 'vibration'.

Studies have shown significant increase in time required to assemble small parts while wearing protective gloves over the time required bare handed. This could directly translate into loss of productivity, wages and social problems for affected workers. Human factors need to be considered in design and administration of personal protective equipments.

Personal protective equipments design and administration should ensure the following factors for effectiveness in use of personal protective equipments for safety:

- To provide adequate protection against the particular hazard for which they are designed.
- Reasonably comfortable when worn under the designated conditions.
- Fit properly and shall not unduly interfere with movements of the uses

- Personal protective equipments shall be durable, easily cleanable and designed that it can be disinfected
- To kept clean and in good repair to minimize the degree of risk

From the analysis of industrial accidents, it is often observed that causal/contract laborers contribute a major share of accidents. It is also observed that in many hazardous process and high risk jobs in industries, contract labourers are often engaged. Ensuring safe working environment, therefore, is often viewed as an important factor in the case of contract labourer.

A study conducted by the Industrial Psychology Division of the Central Labour Institute in Mumbai stated the reasons (perceived by the manager) as factors responsible for non-use of Personal protective equipments by the workers. The rank order of importance of factors, identified by the managers, are presented in table below:

Table 2.1: Important factors responsible for non-use of PPE's

Rank Order	**Perceived Reasons**
1	Uncomfortable
1.5	Lack of concern for own safety
1.5	Lack of education and training
4	Over confidence
5	Poor quality of PPEs
5.5	Habits
5.5	Decrease in efficiency/productivity
8	Resistance to use/indifferent
9	Lack of proper enforcement agencies
10	Selling out of financial gains
11	Improper size/fittings

12	Lack of proper maintenance
13	Equipment non-available/short supply
13.5	Inappropriate/Ineffective equipment
13.5	Inadequate storage facilities
15	Lack of supervision
16	Non-use of PPE's by the supervisor/management personnel.

Managerial strategies adopted for lapses on the part of workers for not using personal protective equipments .

Table 2.2: Reasons for non-use of PPE's

Strategies	Mean value of responses 4 = Max. 1 = Min.	Percentage of Response in each scale point			
		Always	Often	Some times	Never
Warn the concerned employee	3.10	53%	8%	36%	3%
Initiative disciplinary action against the person	2.81	53%	8%	8%	31%
Stop work/operation	2.18	26%	8%	24%	42%
Advice/counsel	2.50	34%	8%	24%	34%
Reporting the management/safety Department	2.39	24%	19%	31%	25%
Initiate/conduct objective study of the problem	1.63	8%	3%	34%	55%

Indifferent	2.39	31%	8%	30%	31%

The most preferred strategy by the management personnel is to warn the concerned employee about the lapses on his part in using PPEs. The second preferred strategy of the management group represented in the study was to initiate disciplinary action against the erring employee who fails to use personal protective equipments at his work place. The least preferred strategy as suggested by the group (on the basis of obtained mean value) for the lapses in using personal protective equipments is to initiate and conduct objective study to find out why personal protective equipments are not being used by the workers.

2.5.1.1. PERSONAL PROTECTIVE EQUIPMENT AND ITS HAZARDS:
The working conditions in construction are in most cases such that, despite all preventive measures in project planning and work design, some personal protective equipment , such as a helmet, hearing and eye protection, boots and gloves, are needed to protect workers. However, there are disadvantages in using PPE:

- Wearing some forms of personal protective equipments may involve discomfort to the user and slow down the work.
- Extra supervision is called for to see that personal protective equipments is worn.
- Personal protective equipments costs money.

Wherever possible, it is better to try to eliminate the hazard rather than providing personal protective equipments to guard against it. Some personal protective equipments such as safety helmets and footwear should be used on all construction sites. The need for other personal protective equipments will depend on the sort of work.

2.5.2. NON RESPIRATORY EQUIPMENTS

2.5.2.1. HEAD PROTECTION: Head protectors are head bats, caps and helmets made of aluminium, PVC fibre glass, laminated plastic or vulcanized fibre. They may be fitted with brackets for fixing welding masks, protective face screen or a lamp. The hats and caps are provided with replaceable harness which provides sufficient clearance between the top of the head and shell. Selection is as follows:

Table 2.3: HEAD PROTECTION

Material	**Hazard**
Asbestos	Sparks, hot materials, heat.
Plastic rubber	Hot liquids, moisture, acids, alkalis, electric shocks, dermatitis.
Cotton wool	Sparks and heat, dermatitis, machinery.
Meal	Falling objects, flying particles, electric shock, cuts abrasions.

Soft caps and hoods are also used for protection against heat, spark and other dangerous materials and are made of appropriate materials. Sometimes hoods are made with rigid frame which is held away from the head.

2.5.2.2. EYE AND FACE PROTECTION: Eye injuries can be caused by dusts, flying particles, splashes and harmful, radiations. Eye protectors are safety spectacles, mono googles, impact googles, welding googles, foundry goggles, chemcical googles, gas tight goggles, face shields, welding helmets etc. Selection is as follows:

Table 2.4: EYE AND FACE PROTECTION

Material	**Hazard**
Flying particles	Chipping, fettling revetting, sledging, chalking.
Dust and small flying	Sealing, grinding, stone dressing, wood-working.
Splashing of metals	Purging of lead joints, casting of metals, galvanizing and dipping in molten metal's.

Splashing of liquids, gases and fumes	Handing of acids and other chemicals.
Reflected light, glare and radiant energy	Foundry work, glass furnaces, gas welding and cutting, are welding.
Large flying particles	Chipping, fettling revetting, sledging, chalking.

2.5.2.3. EAR PROTECTION: Noise level above 90 dBA is hazardous for an exposure more than 8 hrs/day or 48 hrs/week. It may cause deafness, fatigue, loss of efficiency, irritation and also loss of hearing. Noise level can be measured by a noise average meter or a noise dose meter. Ear plugs or Ear muffs reduce to @ 25 to 40 dBA. Ear plug is made of plastic, rubber or polyurethane foam. Ear muffs covers external ear and provides better attenuation than ear plug.

2.5.2.4. HAND AND ARM PROTECTION: Protection of hands and arms are required when workers have to handle materials having sharp end, sharp edges, not and molten matals, chemical and corrosive substances. The protective equipment may be gauntlet gloves, wrist gloves, mittens, hand pads and thumb and finger guards and sleeves. Selection is as follows:

Table 2.5: Hand and Arm Protection

Material	**Hazard**
Asbestos	Sparks, hot materials, heat.
Chrome leather	Spakrs, hot materials, hot lequids, flying particles, cuts, abrasions.
Flame proofed duck	Sparks, hot materials heat, flying particles, machinery.
Plastic	Hot liquids, moisture, acids and alkalis,

	dermatitis.
Rubber	Hot liquids, moisture, acids and alkalls, dermatitis.
Chemical resistant materials	Acids and alkalis.
Reflective fabric	Hot liquids.
Plastic rubber coated fabric	Hot liquids, moisture, acids and alkalis,
Metal mesh	Cuts and abrasions.
Canton canvas	Cuts and abrasions.

2.5.2.5. FOOT AND LEG PROTECTION: Some typical risks are handling of heavy materials, caustic and corrosive liquids, wet conditions, molten metal's, etc. Common foot and leg protective equipments are safety shoes and boots, leggings, foot-guards and leg guards. Selection is as follows:

Table 2.6 : Foot and Leg Protection

Material	**Hazard**
Asbestos	Sparks, hot materials and heat.
Chrome leather	Sparks, hot materials, hot liquids, flying particles, cuts, abrasions.
Flame proofed duck	Sparks, hot materials heat, flying particles, machinery.
Plastic	Hot liquids, moisture, acids, alkalis.
Rubber	Dermatitis, hot liquids, moisture acids, alkalis, electric shock, dermatitis.
Chemical resistant fabric	Acids and alkalis.
Steel toe caps	Falling bodies
Non-skid shoes	Moisture
Wooden soles	Hot materials, beat, hot liquids, moisture,

	acids and alkalis, slip and falls, cuts, abrasions.
Conductive rubber	Explosive

2.5.2.6. BODY PROTECTION: Body protectors are coats, waist, aprons, overalls, jackets and complete head to toe protective suits. Nature of potentials hazard, degree of the hazard involved and nature of activities of the wearer are important in the selection of safety clothing. Although complete coverage of the body and legs is not needed in may cases, unnecessary safety clothing may hamper the efficiency of the wearer. No compromise should be made with strict safety requirements. Selection is as follows:

Table 2.7: Body Protection

Material	**Hazard**
Asbestos	Sparks, hot materials, heat.
Chrome leather	Spakrs, hot materials, hot lequids, flying particles, cuts, abrasions.
Plastic or Rubber	Hot liquids, moisture, acids, alkalis, electric shock, dermatitis, machinery.
Canvas	Flying particles, cuts, abrasions, machinery.
Chemical resistant fabric	Acids and alkalis.
Reflective fabric	Hot liquids.

2.6.1. RESPIRATORY EQUIPMENTS: Atmospheric contaminants include harmless substances to toxic dusts, funes, smokes, mists, vapour and gases. Processes which present hazards of exposure to harmful substances should be closed or ventilated to eliminate or minimize the hazard. If enclosure, ventilation or other engineering means of control are not possible, respiratory equipments should be provided to the workers exposed to hazard. Even though engineering means of control are not possible, respiratory equipments should be provided to the workers exposed to hazard. Even though engineering means of control are applied satisfactorily, supply of appropriate protective equipment should be readily available for use, as there may be plant breakdown or repairs may have to be carried out in contaminated environments, Respiratory protective equipment should be considered a last resort, or as stand-by protection and never a substitute for effective engineering control.

2.5.3.1. CLASSIFICATION OF HAZARDS: Type of hazards to which a worker is exposed is the basis of selection of the right type of reparatory protective equipment. The hazards may be classified as under:

2.5.3.2. OXYGEN DEFICIENCY: Atmospheres in confined spaces such as vasts, tanks, holds of the ships, etc. may contain air with oxygen content much lower than normal (21% by volume). This may be due to dilution or displacement of the air by other gases or vapours or because of loss of oxygen due to decay of organic matter, chemical reaction and natural oxidation over a long period of time. A person breathing air with oxygen content of 15% or less may exhibit symptoms ranging from increased rate of breathing, acceleration of pulse rate to unconsciousness and death such oxygen deficiency condition can easily be detected as the flame of a safety lamp will be extinguished in such atmosphere. The respiratory protective equipment in such conditions should either supply normal air or oxygen to the wear. Self contained or combination breathing apparatus is suitable.

2.5.3.3. GASEOUS CONTAMINANTS: These may be toxic or inert gases. The toxic gases may produce harmful effect even if they are present in relatively low concentrations. The inert gases produce undesirable effects primarily by displacement of oxygen.

2.5.3.4. GASEOUS CONTAMINANTS IMMEDIATELY DANGEROUS TO LIFE: These contaminants are gases present in concentrations that would endanger life of a worker breathing them even for a short period of time. In other words, a gas is immediately dangerous to life if it is present in certain concentration. Where it is not possible to determine the extent of concentration or the kind of gas, all gases should be considered as immediately dangerous to life. IDLH values of many gases and dusts are available. Positive pressure self-contained or combination breathing apparatus is suitable.

2.5.3.5. GASEOUS CONTAMINANTS NOT IMMEDIATELY DANGEROUS TO LIFE: These contaminants are gases present in concentration that could be breathed by a worker for a short time without endangering his life but which may cause possible injury after a prolonged single exposure of repeated short exposures. But even after the concentrations of the contaminant is know, no exact formula can be applied to determine if the contaminant is immediately dangerous to life or not. Air-line respirator, hose mask with or without blower and chemical cartridge respiratory are suitable.

2.5.3.6. PARTICULATE CONTAMINANTS (DUSTS, FUMES, SMOKE, MISTS, FOGS): Majority of particulate contaminants are not immediately dangerous to life. They may be solid, liquid, or a combination of solid and liquid, or a combination of solid and liquid and may be classified into there broad groups. Dust, mist or fume respirator, air-line respirator and abrasive blasting respirator are suitable.

2.5.3.7. TOXIC PARTICULATE CONTAMINANTS: There when inhaled may pass from the lungs into the blood stream and are then carried to the various parts of the body. The effect may be chemical irritation, systematic poisoning or allergic reactions, Common contaminants in this group are antimony, arsenic, cadmium, chromic acid and chromates, lead and manganese.

2.5.3.8. FIBROSIS-PRODUCING DUSTS: These may dissolve and pass directly into the blood stream or may remain in the lungs neither producing local or systematic effects.

2.5.3.9. COMBINATION OF GASEOUS AND PARTICULATE CONTAMINATES: The gaseous and particulate contaminants may be entirely of different substances like carbon monoxide and oxides of nitrogen produced by blasting or volatile liquids, for contaminants immediately dangerous to life air line respirator, hose masks with or without blower and chemical cartridge respirator with special fitter are suitable.

PART F: CONSTRUCTION TRADE HAZARDS

To satisfy his duty to provide for the safety of employee and others from risks arising out work trade activities, it is necessary for worker to recognise the hazards and manage his operations to eliminate them as far as the reasonably can.

2.6.1 BRICKLAYERS: Bricklayers work is mainly out of doors. Much of their work is done on or around scaffold platform. Thus they are exposed to the hazards of falling and being hit by falling objects. Bad weather, especially winds, the strength of which increases with height, adds to these hazards. Bricklayers are also exposed to:

- Bruises, contusions and cuts from the materials they handle:
- Eye injuries from dust and chippings when grinding, cutting and chipping bricks;
- Dermatitis and skin ailments from contract with some of the mortars they handle;
- Slipped disc and other back and muscle injuries from handling heavy and awkward loads, often in cramped or unnatural postures.

In spite of these hazards, bricklaying appears to be one of the safer building trades. Furnace construction bricklayers workers who work with high silica-content bricks in rather confined spaces are particularly prone to silicosis.

2.6.2 STONEMASONS: The craft of bricklaying evolved from that of the stonemason. Today in most countries there are fewer stonemasons than compare to bricklayers workers. Much of their work is now concerned with the maintenance of old buildings. There are two main sub-categories craft:

- Banker masons who shape the stone, both with traditional hand tools and modern power tools, usually at ground level and under cover and ;
- Fixer masons who lay the stones on site with mortar.

Both banker masons and fixer masons face the hazards of bruises, contusions and back and muscle injury through handling heavy objects. Banker masons are more exposed to the hazards of dust (including silicosis) and flying chips. Fixer masons are more exposed to the hazards of weather, insecure scaffolding and contact with mortar and injurious constituents in (lime, chromium compounds).

2.6.3 CARPENTERS AND JOINERS: Carpentry is carried out on site. It consists of cutting, shaping and fixing the wooden structural parts of a house, e.g. floor beams and boards, staircases, banisters, sills, lintels and mullions of windows and door openings, hanging doors and windows, etc. In some countries, where timber is cheap, the whole carcass of the house may be built out of wood by the carpenters. Whilst some craftsmen are exclusively carpenters and other are exclusively joiners, many craftsmen combine both trades and are known as carpenter-joiners.

- They are constantly exposed to the hazards, including noise and vibration, using hand and powered woodworking tools, as well as the hazards of wooden splinters, nails and other sharp objects.
- Both are also exposed to respiratory hazards from the dust of some the materials cut or otherwise shaped, including asbestos, polyurethane plastics and many woods.
- Their skins may be exposed to dermatological hazards from solvents and chemicals used in adhesives and treating woods.
- Wood treated against rot, mildew and insect and rodent infestation often contains highly toxic compounds of copper, chromium, zinc, arsenic and tin, as well as phenols. Woods such as pitch pine are poisonous. Thus splinters of wood which enter the skin may cause septic wounds and wood dust may cause pneumoconiosis.

The carpenter working outside on scaffolding is exposed to similar hazards as bricklayers and masons.

2.6.4 FORM WORKERS (SHUTTERING CARPENTERS): The form worker is a joiner-carpenter who specializes in the construction of timber moulds for pouring concrete on site. He may also have to erect wooden supports or false work to support the formwork and the concrete in it until the

structure is self supporting. The formwork is exposed to most of the hazards common to carpentry and joinery. His skin may also suffer from contract with timber impregnated with cement and release agents.
Designers of formwork must ensure that their designs comply with recognized IS standards for false-work. The form worker must work in accordance with instructions and design requirements. Many serious accidents involving death and injury to other building workers arise from the collapse of formwork and false-work under load.

2.6.5 BUILDINGS FITTERS: The shop fitter is a carpenter-joiner who specializes in the fitting out of display counters and windows in buildings. He may also combine the crafts of glazier, lighting engineer, electrician and decorator. Thus he is exposed to the many hazards of all these trades.

2.6.6 PAINTERS: Painters, particularly on outside work, are exposed to the hazards of falling from heights, often from ladders or inadequate scaffolds or improvised temporary structures. A high proportion of their outside work consists of maintenance.

Most buildings have to be repainted may times during their lives the short time that the ladder or scaffold is needed in any one place results in many risks being taken. Painters are also exposed to toxic and dermatological hazards both through the solvents, pigments and other constituents of their paints and from the fumes of the chemicals used in removing old paintwork.

2.6.7 PLUMBERS AND ALLIED CRAFTS: Traditionally the plumber was involved with lead piping. Now he works with variety of materials-copper, steel and several plastics. He is generally responsible for the installation and maintenance of all systems handling water, inside buildings. Sometimes he required to weld steel. Plumbers in former times were exposed to the toxic hazards of lead fumes. Today, when little lead is employed in plumbing, the plumber faces respiratory hazards of other toxic materials, e.g. PVC, polyurethanes and the vapors formed from them when they are heated. He may also he exposed to dermatological hazards from the solvents and jointing compounds he has to use. Much of the plumber's work has to be carried out in confined spaces in cupboards or beneath floorboards where it may be difficult to provide adequate ventilation to remove toxic fumes and vapors resulting from the work. Plumbers are required to use a wide variety of hand tools and portable powered tools, including blow lamps and soldering irons. Plumbers in construction are generally less exposed to the risks of falling than, say, roofing workers, although the installation and maintenance of roof guttering and occasionally lead flashing on roof-wall intersections carries these risks.

2.6.8 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) TECHNICIAN: Much the work of these crafts men consists of fitting air ducting in new buildings to provide clean air at a controlled temperature to the difference rooms. The work involves the use of hand, and sometimes portable, power tools and spot welding equipment. Today it is probably no more hazardous than the work of the carpenter, although severe respiratory risks may arise where an old heating system with asbestos insulation is being removed. The hazard is especially serious in countries which still use asbestos insulation.

2.6.9 GAS SERVICES TECHNICIAN: The gas services engineer is usually a trained specialist employed by the company to install piped fuel gas and gas burning appliances in buildings. In many cases, the work is done by plumbers. The work itself is not particularly hazardous, but unless it is done properly and in accordance with relevant codes, there will be serious risks to the users of the building. As well as the danger of explosions from leaks, there is also the danger of carbon monoxide poisoning through incomplete combustion, inadequate flues and poor ventilation. Similar hazards exist where liquefied petroleum gases supplied in transportable containers are used. The point to be emphasized here is the need to ensure that only trained men should be allowed to do this work.

2.6.10 WELDERS AND GAS CUTTERS: Site welding is used for structural steelwork. Balustrading and pipe work such as gas transmission and distribution mains, a great deal is done on offshore platforms, process and power plant. Some welding of steel reinforcement may be found on site, but this is generally done in factory conditions off-site.

Both electric and oxyacetylene gas welding are used for steel. Oxyacetylene and oxy-arc gas cutting of steel is also widely used, particularly in demolition work. Welding and gas cutting are also carried out under water by divers, but acetylene cannot be used in deep water because it explodes spontaneously under pressure. Hydrogen is used in these situations.

Site welders are subject to all the usual hazards of welding for which proper eye and skin protection is essential, as well as those of working at heights and in bad weather. Accidental damage to gas cylinders and fitting gas hoses and electric leads and cables is far more difficult to control on a building site than in a permanent welding bay. Unless their work is carefully controlled they can be a source of fire hazards and personal injuries (e.g. sparks globules of molten metal, explosions and ultra violet radiation) to other workers.

Gas cutters and welders employed in demolition and repair work may be exposed to the toxic, fumes of lead (from old lead paint) and other metals (such-as cadmium, chromium, cobalt, nickel, vanadium and zinc). The respiratory protection needed for such work needs careful assessment; regular medical examination of athese workers is also needed. The physical and chemical health hazards of welding are discussed in Chapter 2.

2.6.11 ELECTRICIANS: The main hazards of electricians are electric shock and flash burns through contact with, or short-circuiting of, electric cables. They have a heavy responsibility to other construction workers and to the ultimate users of their appliances in protecting them from similar risks. Virtually all electrical hazards can he eliminated or reduced to negligible proportions by thorough training of electricians by compliance with the appropriated codes and regulations and by the use of materials and appliances which conform to these codes.

The present position in many developing countries faced with the need to expand electrical supply with inadequate resources is often very hazardous. Sometimes the standards of the buildings themselves, make it difficult or impossible to electrify them safely, even assuming that safe wiring and fittings could be afforded and provided.

Installation electricians have to be jacks of all trades, cutting holes in walls, floors, etc. and making good afterwards. They are also exposed to the risk of falling when working on ladders, temporary platforms and supports. A sudden electric shock (though slight and otherwise harmless) may cause a man to lose his hold on the ladder, etc. so that he falls and injures himself.

Temporary electric wiring on building sites for the portable power tools used by other craftsmen has been the cause of many electrical accidents. A reduced supply voltage of 110 volts with the midpoint earthed be used for all such temporary wiring. This greatly reduces the risk of fatal electrocution injuries.

2.6.12 PLANT OPERATORS AND RELATED TRADES: The term plant operator covers the operation of cranes, trucks, excavators, bulldozers, dumpers, road rollers, fork lift trucks, and other mobile machines used in construction. Most of these jobs have considerable hazard potential to other workers and property, as well as to the operators themselves. Because of this, operators themselves, Because of this, operators of most of these machines require special training with the emphasis on safety. In most cases the operator should be above a minimum age and be tested and certified as competent to use the particular machine before he is allowed to start work on it. For vehicles which have to use roads, care is needed to ensure that all road Traffic Regulations are complied with.The main hazards are those of:

- Collision, tipping and overturning:
- Over-stressing, with damage to the machine:

- Dropping loads being carried:
- Contact of cranes with overhead live electrical cables;
- Contact of excavators with underground services.

Some machines are excessively noisy and/or vibrate severely causing health hazards to their operators from which they must be protected. Some concreting machines lift, transport, spread and apply concrete pneumatically under compressed air pressure. They can cause serious injury to anyone in the path of the emerging stream of wet concrete. Since concrete sets fairly quickly, these machines are subject to blockages, serious accidents have occurred by trying to clear these while the machine was still under pressure.

2.6.13 PILE DRIVING OPERATORS: Operators of percussive types of pile driving machines deserve special mention if only because of the intolerable noise they often have to endure. This is not only a hazard to the hearing of the operator, but also to others who are obliged to be in the proximity. The operator should be protected by ear muffs. Nose as a health hazard and quieter methods of piling are discussed.

These men are exposed to the hazards of falls and falling objects, and other injuries arising from the fastening and release of loads from slings, hooks and ropes. Mistakes may cause injury to other and property damage, Thus it is essential that they be well trained and experienced. They usually work as members of a team with crane drivers, banksmen and other workers. Their own safety is dependent on the skill of other in the team, especially the crane driver.

2.6.14 CONCRETERS: The main responsibility of the concrete is to mix and place the concrete, though in industrialized countries today most mixing is done by machine, often some distance from the site, Sometimes he has also to make and assemble the formwork and reinforcement. He uses special tools such as vibrating pokers and shuttering vibrators which act on the site wet concrete. This allows trapped air bubbles to escape and ensures that the concrete fills the mould completely and leaves no voids round the reinforcement. He also has to level and tamp the concrete. The work involves may critical factors which affect the setting and subsequent strength and integrity of the concrete. These are essential to the subsequent load-bearing capacity of the building or works. The concreter needs to be thoroughly trained in all these aspects or must work under close, trained supervision. The work has many typical construction hazards – falls, material handling, vibration exposure. It also has distinct dermatological hazards since cement is strongly alkaline and usually contains small quantities of chromium compounds which are harmful to the skin.

2.6.15 PLASTERERS: The plaster works mainly indoors on walls and ceilings and is less exposed to the weather and height than the bricklayer or roofing worker. Sometimes, however, he may do structural concrete work or apply rendering on outside walls. This can involve the risk of falling from a temporary work place. The same risk arises when working indoors on high walls and ceiling in halls, lobbies, etc. The plaster's work is arduous and requires continuou s muscular exertion. This is often in very cramped and unnatural bodily positions. Slipped discs, hernias and strained muscles and ligaments are hence common.

The plasterer carries out partition work as well as plastering, using various types of artificial boarding. Worker has to rip out old and defective plastering which may contain asbestos and other injurious material. The plaster is exposed to respiratory, dermatological and eye hazards from the materials he works with. These include a variety of proprietary plasters. Whose composition is often unknown. Eye protection is frequently necessary for plasters.

2.6.16 GLAZIERS: The glaziers handle, cuts and fits glass panes and in windows, doors, partitions, showcase, screens, etc. He is exposed to the risk of injury from the material he handles which has sharp edges and is easily broken. Cuts may be deep and sever veins and arteries. Fatal wounds from glass are however fairly rare.

The glazier is also exposed to falling hazards, especially when replacing broking window panes at first storey level and higher. One reason for this is that windows are normally made so that the panes can only be fitted from the outside. The carrying and holding of large window panes on a ladder on a windy day is also very risky.

The glazier is sometimes exposed to toxic hazards through splinters of glass containing lead, arsenic and other toxic elements which may penetrate and lodge in his skin. He may run dermatological risks from the putties and other materials which he handles. Finally, he may also injure himself with the tools he uses.

2.6.17 CLADDERS: Cladders are mainly engaged in fixing panels of concrete, aluminium, asbestos cement, glass, glass reinforced plastics, stainless steel and other materials to the outside walls of buildings. The work is potentially quite hazardous and requires careful planning, proper equipment, and well-trained and experienced workers, often essential parts of the scaffolding used for construction the carcass of the building interfere with the cladding operation. They thus have to be removed or modified before the cladding can be applied. The panels are often quite large and until secured in position they must be carefully braced, propped or temporarily supported to counteract wind pressures. Sometimes cartridge-operated fixing tools are used to secure panels to walls or frameworks by harp hardened-steel pins.

2.6.18 WALL AND FLOOR TILERS: Wall and floor tilers work mainly indoors with ceramic or plastic tiles and tile adhesives. The work is fairly arduous and sometimes has to be dope in cramped or unnatural body positions, with risk of back or muscular disorders. Most of the work is done at fairly low levels, where the falling risk is low. There may sometimes be toxic or dermatological hazards from the materials handled, which include dirt and fragments of old surfaces and tile adhesives.

Some tile adhesives contain flammable solvents whose vapors are heavier than air and accumulate at low levels in poorly ventilated rooms and spaces. These have caused a number of flash over fires in which tillers and others have been badly injured. Such tire hazards are discussed further in Part 3.

2.6.19 LIFT TECHNICIAN/ ENGINEERS: The engineer who installs and maintains lifts in building is usually highly trained and employed as a sub contractor. Thus he should be thoroughly familiar with the hazards of his work. These include the risks of falls, being trapped between the lift and counterweights or crushed under them, as well as those of lifting heavy objects. The safety of the ultimate users of the lift depends critically on the soundness of his work.

2.6.20 STOREKEEPERS: Most construction sites other than the very smallest have a store for construction materials and tools used, with a storekeeper in charge. His duties involve a great deal of manual handling of different materials, some of which may he toxic or inflammable. He is principally exposed to the hazards of manhandling loads. He is also at risk of being struck from falling objects which are being unloaded from trucks and lorries or placed on or removed from high shelves or racks in the store.

Store-men are responsible for checking and inspecting building materials delivered to site, as well as tools and equipment returned to the store and re-issued later. They sometimes have to repair them before re-issue. The store-man has a heavy responsibility for the safety of workers who have to use the tools, equipment and materials issued.

2.6.21 GENERAL WORKERS & LABOURERS: Much of the manual handling and unskilled manual work (e.g. digging) involved in the aforementioned activities is carried out by labourers. They are exposed to all the hazards of the activities concerned, often without any proper appreciation of them.

CHAPTER - 3

OBJECTIVE SETTING STUDIES REVISED

3.1 **RANKING OBSERVATION ANALYSIS:** A Ranking observation Analysis is a procedure which helps integrate accepted safety and health principles and practices into a particular task or construction activities. In a Ranking observation Analysis, each basic step of the construction activities is to identify potential hazards and to recommend the safest way to do the construction activities by setting the target based objective.

Methodology is based on the idea that safety is an integral part of every construction activities and not a separate entity. In this method, only health and safety aspects will be considered.

The major advantages of this method include that it does not rely on individual memory and mental status and that the construction activities based prompts recognition of hazards. In this method is that more people are involved in a wider base of experience and promoting a more ready acceptance of the resulting work procedure

Initial benefits from developing a Ranking observation Analysis will become clear in the construction stage. The analysis process may identify previously undetected hazards and increase the job knowledge of those participating. Safety and health awareness is raised, communication between workers and supervisors is improved, and acceptance of safe work procedures is promoted.

A Ranking observation Analysis, or better still, a written work procedure based on it, can form the basis for regular contact between supervisors and workers. It may be used as a standard for health and safety inspections or observations. In particular, a Ranking observation Analysis will assist in completing comprehensive quantity based setting of objectives.

A Ranking observation Analysis is a method that can be used to reduce , improve and maintain the safety record :

- the steps involved in performing a construction activities,
- the existing or potential safety and health hazards associated with each construction activities, and
- to set the objective with the recommended action(s)/procedure(s) that will reduce , improve and maintain the safety hazards and the risk of a construction workplace.

Ideally, all construction activities should be subjected to a Ranking observation Analysis. In some cases there are practical constraints posed by the amount of time and effort required to do a Ranking observation Analysis. Another consideration is that each Ranking observation Analysis will require revision whenever equipment, raw materials, processes, or the environment change. For these reasons, it is usually necessary to identify which construction activities are to be analyzed.

The following associated hazards Factors to be considered in setting a priority for analysis of construction activities include a Ranking observation Analysis:

- Construction activities Hazards

- Construction Trade wise hazard
- Chemical hazards
- Man made hazards at site
- Workplace environment hazards.

3.1.1 CONDUCTING THE ANALYSIS:

1. Prepare the table for observations of unsafe acts and conditions with respect to construction activities and leading indicator of safety lapses at site.
2. Find out the maximum frequency of hazards indentified in column and row respectively.
3. Set the target based objective to reduce , improve and maintain the safety.
4. Repeat the same procedure for setting the new objectives.

3.1.2 Requirement for conducting analysis:

1. Select an experienced employee who is willing to be observed and to involve the employee and his/her immediate supervisor in construction workplace activities.
2. Identify and record each step necessary to accomplish the construction workplace activities.
3. Identify all actual or potential safety and health hazards associated with each construction workplace activities.
4. to set the objective with the recommended action(s)/procedure(s) that will reduce , improve and maintain the safety hazards and the risk of a construction workplace (i.e. engineering changes, job rotation, PPE, etc.).

3.1.3 BASIC STEPS: A construction activities are defined as a segment of the operation necessary to advance the work. Care must be taken not to make the steps too general. Missing specific steps and their associated hazards will not help. On the other hand, if they are too detailed, there will be too many steps.

An important point to remember is to keep the construct in their correct sequence. Any step which is out of order may miss serious potential hazards or introduce hazards which do not actually exist. Observation of unsafe acts and conditions are noted as shown below:

Table 3.1: OBSERVATION FORMAT

Location	**Construction Activity**	**Date and Time**	**Observing By**
Observations			

This part of the analysis is usually prepared by knowing or watching a worker do the work. The observer is normally the immediate supervisor or worker itself.

The work observer should have experienced and be capable in all parts of the job. To strengthen full co-operation and participation, the reason for the exercise must be clearly explained. The worker's experience contributes in making work and safety improvements.

The work should be observed during normal times and situations. For example, if a work is routinely done only at night, the construction activies review should also be done at night. Similarly, only regular tools and equipment should be used.

3.1.4 IDENTIFY POTENTIAL HAZARDS: Once the basic steps have been recorded, potential hazards must be identified. Based on observations of the work, knowledge of accident and injury causes, and personal experience, list the things that could go wrong at construction actvities.

A second observation of the work being performed may be needed. Since the basic steps have already been recorded, more attention can now be focused on each potential hazards. At this stage, no attempt is made to solve any problems which may have been detected.

Potential hazards are listed in the left column of the worksheet, numbered to match the corresponding work step. For example:

Table 3.2 : Ranking analysis format

Leading Indicator of safety lapses	**Construction Activities**
	Frequency

Listing the maximum frequency in row and column for setting the objective which may causes for leading safety lapses at workplace site.

3.1.5 OBJECTIVE SETTING FOR CONTROL MEASURES: The final stage in a Ranking Observation Analysis is to determine ways to eliminate or control the hazards identified. The generally accepted measures, in order of preference, are:

3.1.6 ELIMINATE THE HAZARD: This is the most effective measure. These techniques should be used to eliminate the hazards:

- Choose a different process
- Modify an existing process
- Substitute with less hazardous substance
- Improve environment (ventilation)
- Modify or change equipment or tools

3.1.7 CONTAIN THE HAZARD: If the hazard cannot be eliminated, contact might be prevented by using enclosures, machine guards, worker booths or similar devices.

3.1.8 REVISE WORK PROCEDURES: Consideration might be given to modifying steps which are hazardous, changing the sequence of steps, or adding additional steps (such as locking out energy sources).

3.1.9 REDUCE THE EXPOSURE: These measures are the least effective and should only be used if no other solutions are possible. One way of minimizing exposure is to reduce the number of times the hazard is encountered. An example would be modifying machinery so that less maintenance is necessary. The use of appropriate personal protective equipment may be required. To reduce the severity of an accident, emergency facilities, such as eyewash stations, may need to be provided.

In listing the objective setting, do not use general statements such as “be careful" or "use caution". Specific statements which describe both what action is to be taken and how it is to be performed are preferable.

3.1.10 IMPLEMENTATION OF OBJECTIVES: Ranking Observation Analysis is a useful technique for identifying hazards so that workers can take measures to eliminate or control hazards. Once the analysis is completed, the results must be communicated to all workers who are, or will be, performing that work. The side-by-side format used in Ranking Observation Analysis worksheets is not an ideal one for instructional purposes only. Better results can be achieved by using a narrative-style communication format. For example, the work procedure based on the partial Ranking Observation Analysis developed as an example in this document might start out like this:

- Objective1. Park vehicle**:** Drive vehicle off the road to an area well clear of traffic, even if it requires rolling on a flat tire. Turn on the emergency flashers to alert passing drivers so that they will not hit you.

- Choose a firm and level area for parking. You can jack up the vehicle to prevent rolling.

- Apply the parking brake, leave the transmission in PARK, place blocks in front and back of the wheel diagonally opposite the flat. These actions will also help prevent the vehicle from rolling.

Table 3.3: SAMPLE FORM FOR RANKING OBSERVATION ANALYSIS

Location	Construction Activity	Date and Time	Observing By
Sub Station	Paining	11.06.2010	Ajay Singh
Observations			
1	Unsafely personnel shifting the location while painting.		
2	Unsafe ladder being used by painter.		
3	Painters are found without nose mask and hand gloves		
4	Hanging of paint unsafely on ladder.		
5	No cordon off location nearby area of painter while painting work in progress.		

Table 3.4: SETTING OF OBJECTIVES FOR CONTROL MEASURES

Leading Indicator of safety lapses	Construction activities			
	Earth Work	Brick Work	Painting	Frequency
Movement	5	7	9	9
Stacking	3	3	7	7
PPE	5	3	6	6
Frequency	5	7	9	Max 9

Setting the objective for Movement during painting activitiesCo

3.2 TESTING OF HYPOTHESIS: Hypothesis is usually considered as the principle instrument in research. Its main function is to suggest new experiments and observation. Infect many experiments are carried out with the deliberate object of testing hypotheses. Decision-makers often face situations wherein they are interested in testing hypotheses on the basis of available information and then take decision of the basis of such testing. The hypothesis may not be proved absolutely but in practice it is accepted it has withstood a critical testing.

When one talks about hypothesis, simply means a mere assumption or some supposiotn to be proved or disproved. But for a researcher hypothesis is a formal question that he intends to resolve. Thus a hypothesis may be defined as proposition or a a set of proposition set fourth as a an explanation for the occurrence of some specified group of phenomena either asserted merely a provisional conjecture to guide some investigation or accepted as highly probable in the light of established facts. Research hypothesis is a predictive statement, capable to being tested by scientific method, that relates an independent variable to some dependent variable.

3.2.1 CHARACTERISTICS OF HYPOTHESIS: Hypothesis must possess the following characteristics:

- Hypothesis should be clear and precise; the inferences drawn on its basis can be taken as reliable.
- A hypothesis is testable if other deduction can be made from it which, it turn, can be confirmed or disproved by observation.
- Hypothesis should state relationship between variables, if it happens to be a relational hypothesis.
- Hypothesis should be limited in scope and must be specific & stated as far as possible in most simple terms so that the same is easily understandable.
- Hypothesis should be consistent with most know facts and be amenable to testing within a reasonable time.

3.2.2 BASIC CONCEPTS CONCERNING TESTING OF HYPOTHESIS: Basic concepts in the context of testing of hypothesis need to be explained.

3.2.3 NULL HYPOTHESIS AND ALTERNATIVE HYPOTHESIS: In the context of statistical analysis, we often talk about null hypothesis and alternative hypothesis. If we are to compare observations of location A with observations of location B about its superiority and if we proceed on the assumption that both observations are equally good, then this assumption is termed as the null hypothesis. A against this, we may think that the Observation A is superior or the observation B is inferior, we are then stating what is termed as alternative hypothesis. The null hypothesis is generally symbolized as H0 and the alternative hypothesis as Ha.

The null hypothesis and the alternative hypothesis are chosen before the sample is drawn (the researcher must avoid the error of deriving hypotheses from the data that be collects and taken testing the hypotheses from the same data). In the choice of null hypothesis, the following considerations are usually kept in view:

- Alternative hypothesis is usually the one which one wishes to prove and the null hypothesis is the one which one wishes to disprove. Thus, a null hypothesis represents the hypothesis we are trying to reject, and alternative hypothesis represents all other possibilities.
- If the rejection of certain hypothesis when it is actually true involves great risk, it is taken as null hypothesis because then the probability of rejecting it when it is true is α (the level of significance) which is chosen very small.
- Null hypothesis should always be specific hypothesis i.e. it should not state about or approximately a certain value.

3.2.4 THE LEVEL OF SIGNIFICANCE: This is a very important concept in the context of hypothesis testing. It is always some percentage (usually 5%) which should be chosen with great care, thought and reason. In case we take the significance level a 5 percent then this implies that H0 will be rejected when the sampling result (i.e. observed evidence) has a less than 0.05 probability of occurring if H0 is true. In other words, the 5% level of significance means that researcher is willing to take as much as a 5% risk of rejecting the null hypothesis when it (H0) happens to be true. Thus the significance level is maximum value of the probability of rejection H0 when it is true and is usually determined in advance before testing the hypothesis.

3.2.5 DECISION RULE OR TEST OF HYPOTHESIS: Given a hypothesis H0 and an alternative hypothesis Ha we make a rule which is known as decision rule according to hypothesis which we accept H0 (i.e. reject Ha) or reject H0 (i.e. accept Ha). For instance, if H0 is that a certain lot is good (there are very few defective items in it) against Ha that the lot is not good (there are very few defective items in it) against Ha that the lot is not good (there are too many defective items in it), then we must decide the number of items to be tested and the criterion for accepting or rejecting the hypothesis.

3.2.6 TWO-TAILED AND ONE-TAILED TESTS: In the context of hypothesis testing, these two terms are quite important and must be clearly understood. A two-tailed test rejects the null hypothesis if, say, the sample mean is significantly higher or lower than the hypothesized value of the mean of the population. Such a test is appropriate when the null hypothesis is some specified value and the alternative hypothesis is a value not equal to the specified value of the null hypothesis. Symbolically, the two-tailed test is appropriate when we have H0:μ=μH0 and H0:$\mu \neq \mu$H0 which may mean $\mu >$ μH0 or $\mu <$ μH0. Thus, in a two – tailed test, there are two rejection regions, one on each tail of the curve.

One-tailed test would be used when we are to test, samy, whether the population mean is either lower than or higher than some hypothesized value. For instance if our H0:$\mu = \mu H0$ and Ha: $\mu<\mu H0$ ten we are interested in what is known as left-tailed test (wherein there is one rejection region only on the left tail).

It should always be remembered that accepting H0 on the basis of sample information does not constitute the proof that H0 is true. We only mean that there is no statistical evidence to reject it, but we are certainly not saying that H0 is true (although we behave as if H0 is true)

3.2.7 PROCEDURE OF HYPOTHESIS TESTING: In hypothesis testing the question is: to accept the null hypothesis are not to accept the null hypothesis. Procedure for hypothesis testing refers to all those steps that we undertake for making a choice between the two actions i.e., rejection and acceptance of a null hypothesis. the various steps involved in hypothesis testing are stated below:

3.2.8 MAKING A FORMAL STATEMENT: The step consists in making a formal statement of the null hypothesis (H0) and also of the alternative hypothesis (Ha). This means that hypotheses should be clearly stated, considering the nature of the research problem.

The formulation of hypotheses is an important step which must be accomplished with due care in accordance with the object and nature of the problem under consideration. It also indicates whether we should use a one tailed test or a two-tailed test.

Selecting a significance level: The hypothesis are tested on a pre-determined level of significance and as such the same should be specified. Generally, in practice, either 5% level or 1% level is adopted for the purpose. The factors that affect the level of significance are: (a) the magnitude of the difference between sample means; (b) the size of the samples; (c) the variable of measurements within samples; and (d) whether the hypothesis is directional or non-directional (A directional hypothesis is one which predicts the direction of the difference between, say, means). In brief, the level of significance must be adequate in the context of the purpose and nature of equiry.

3.2.9 DECIDING THE DISTRIBUTION TO USE: After deciding the level of significance, the next step in hypothesis testing is to determine the appropriate sampling distribution. The coice generally remains between normal distribution and the t-distribution. The rules for selecting the correct distribution are similar to those which we have stated earlier in the context of estimation.

3.2.10 SELECTING A RANDOM SAMPLE AND COMPUTING AN APPROPRIATE VALUE: Another step is to select a random sample(s) and compute an appropriate value from the sample data concerning the test statistic utilizing the relevant distribution. In other words, draw a sample to furnish empirical data.

3.2.11 CALCULATION OF THE PROBABILITY: One has then to calculate the probability that the sample result would diverge as widely as it has from expectations, if the null hypothesis were in fact true.

3.2.12 COMPARING THE PROBABILITY: Yet another step consists in comparing the probability thus calculated with the specified value for α, the significance level. If the calculated probability is equal to or smaller than the α value in case of one-tailed test (and $\alpha/2$ in case of two-tailed test), then reject the null hypothesis (i.e., accept the alternative hypothesis), but if the calculated probability is greater, then accept the null hypothesis. in case we reject H0, we run a risk of (at most the level of significance) committing an error of Type I, but if we accept H0, then we run some risk (the size of which cannot be specified as long as the H0 happens to be vague rather than specific) of committing an error of type-II.

3.3 STUDENT'S T-TEST: T-test is based on t-distribution and is considered an appropriate test for judging the significance of a sample mean or for judging the significance of difference between the means of two samples in case of small samples(s) when population variance is not know (in which case we use variance of the sample as an estimate of the population variance). In case two samples are related, we use paired t-test (or what is known as difference test) for judging the significance of the mean of difference between the two related samples. It can also be used for judging the significance of the coefficients of simple and partial correlations. The relevant test statistic, t, is calculated from the sample data and then compared with its probable value based on t-distribution (to be read from the table that gives probable values of t for different levels of significance for different degrees of freedom) at a specified level of significance for concerning degrees of freedom for accepting or rejecting the null hypothesis. it may be noted that t-test applies only in case of small sample(s) when population variance is unknown.

Population normal, population infinite, sample size small and variance of the population unknown, H_a may be one-sided or two-sided than such situation t-test is used and test statistic t is worked out as under:
Hypothesis testing for comparing two related samples:

Paired t-test is a way to test for comparing two related samples, involving small values of n that does not require the variances of the two populations to be equal, but the assumption that the two populations are normal must continue to apply t-test, it is necessary that the observations in the two samples be collected in the form of what is called matched Paris i.e., "each observation in the one sample must be paried with and observation in the other sample in such a manner that these observations are somehow "matched" or related in an attempt to eliminate extraneous factors which are not of interest in test." Such a test is generally considered appropriate in a before and after treatment study. For instance, we may test a group of certain students before and after training in order to know whether the training is effective, in which situation we may use paried t-test. To apply this test, we first form out the difference score for each matched pair, and then find out the average of such differences, D, along with the sample variance of the difference score. If the values from the tow matched samples are denoted as X_i and Y_i and the differences by D_i ($D_i = X_i - Y_i$), then mean of the differences i.e.

3.3.1 PROCEDURE FOR USING T-TEST : Assuming the said difference to be normally distributed and independent, we can apply the paired t-test for judging the significance of mean of differences and work out the test statistic t as under:

3.3.2 Construct a null hypothesis - an expectation - which the experiment was designed to test. For example: If we are analysing the unsafe acts and unsafe conditions in two different locations, a suitable null hypothesis would be that there is no difference in unsafe acts and unsafe conditions between the two locations. The t-test will tell us if the data are consistent with this or depart significantly from this expectation. (Note : The null hypothesis is simply something to test against. We might well **expect a difference** between unsafe acts and unsafe conditions , but it would be difficult to **predict** the scale of that difference - twice as high? three times as high? So it is sensible to have a null hypothesis of "no difference" and then to see if the data depart from this.)

- List the data for sample (or treatment) 1.
- List the data for sample (or treatment) 2.
- Record the number (n) of replicates for each sample (the number of replicates for sample 1 being termed n1 and the number for sample 2 being termed n2)
- Calculate mean of each sample Xi and Yi.
- Subtract the hypothesized mean of the population from each individual score Xi & Yi and calculate sum of difference Di = Xi – Yi

- Calculate the $\overline{D}$ value as follows:

$$\overline{D} = \frac{\sum D_i}{n}$$

- Calculate the variance of the difference between the two means (σ_{diff}) as follows

$$\sigma_{diff} = \sqrt{\frac{\sum Di^2 - (\overline{D})^2 \ * n}{n-1}}$$

- Calculate □d (the square root of □d2)
- Calculate the *t* value as follows:

$$t = \frac{\overline{D} - 0}{\sigma_{diff}/\sqrt{n}}$$

- Read the table of t-statistic for (n-1) degrees of freedom at a given level of significance (using one –tailed or two-tailed values depending upon H_a) to find the critical value of T.
- If the calculated t value exceeds the tabulated value we say that the means are *significantly different* at that level of probability.
- A significant difference at p = 0.05 means that if the null hypothesis were correct (i.e. the samples or treatments do not differ) then we would expect to get a *t* value as great as this on less than 5% of occasions. So we can be reasonably confident that the samples/treatments do differ from one another, but we still have nearly a 5% chance of being wrong in reaching this conclusion

Table 3.5: Critical Values of Student's t-Distribution

d.f.	Level of significance for two-tailed test					d.f.
	0.20	0.10	0.05	0.02	0.01	
	Level of significance for one-tailed test					
	0.10	0.05	0.025	0.01	0.005	
1	3.078	6.314	12.706	31.821	63.657	1
2	1.886	2.920	4.303	6.965	9.925	2
3	1.638	2.353	3.182	4.541	5.841	3
4	1.533	2.132	2.776	3.747	4.604	4
5	1.476	2.015	2.571	-3.365	4.032	5
6	1.440	1.943	2.447	3.143	3.707	6
7	1.415	1.895	2.365	2.998	3.499	7
8	1.397	1.860	2.306	2.896	3.355	8
9	1.383	1.833	2.262	2.821	3.250	9
10	1.372	1.812	2.228	2.764	3.169	10
11	1.363	1.796	2.201	2.718	3.106	11
12	1.356	1.782	2.179	2.681	3.055	12
13	1.350	1.771	2.160	2.650	3.012	13
14	1.345	1.761	2.145	2.624	2.977	14
15	1.341	1.753	2.731	2.602	2.947	15
16	1.337	1.746	2.120	2.583	2.921	16
17	1.333	1.740	2.110	2.567	2.898	17
18	1.330	1.734	2.101	2.552	2.878	18
19	1.328	1.729	2.093	2.539	2.861	19
20	1.325	1.725	2.086	2.528	2.845	20
21	1.323	1.721	2.080	2.518	2.831	21
22	1.321	1.717	2.074	2.508	2.819	22
23	1.319	1.714	2.069	2.500	2.807	23
24	1.318	1.711	2.064	2.492	2.797	24
25	1.316	1.708	2.060	2.485	2.787	25
26	1.315	1.706	2.056	2.479	2.779	26
27	1.314	1.703	2.052	2.473	2.771	27
28	1.313	1.701	2.048	2.467	2.763	28
29	1.311	1.699	2.045	2.462	2.756	29
Infinity	1.282	1.645	1.960	2.326	2.576	Infinity

3.4 SANDLER'S A-TEST: Joseph Sandler has developed an alternate approach based on a simplification of t-test. His approach is described as Sandler's A-test, that serves the same purpose as is accomplished by t-test relating to paired data. Researchers can as well use A-test when correlated samples are employed and hypothesized mean difference is taken as zero i.e., $H_0:\mu_D=0$. Psychologists generally use this test in case of two groups that are matched with respect to some extraneous variable(s). While using A-test, we work out A-statistic that yields exactly the same results as Student's t-test .

A-statistic is found as follows:

$$A = \frac{the\ sume\ of\ squares\ of\ the\ differences}{the\ square\ of\ the\ sum\ of\ the\ differences} = \frac{\sum D_i^2}{(\sum D_i^2)^2}$$

The number of degrees of freedom (d.f.) in A-test is the same as with student's t-test i.e., (d.f.) = n-1, n being equal to the number of pairs. The critical value of A, at a given level of significance for given degrees of freedom (d.f.), can be obtained from the table of A-statistic. One has to compare the computed value of A with its corresponding table value for drawing inference concerning acceptance or rejection of null hypothesis. If the calculated value of A is equal to or less than the table value, in that case A-statistic is considered significant where upon we reject H0 and accept Ha. But if the calculated value of A is more than its table value, then A-statistic is taken as insignificant and accordingly we accept H0. This is so because the two test statistics viz., t and A are inversely related. We can write these two statistics in terms of one another in this way:

(i) 'A' in terms of 't' can be expressed as

$$A = \frac{n-1}{n.t^2} + \frac{1}{n}$$

(ii) 't' in terms of 'A' can be expressed as

$$t = \sqrt{\frac{n-1}{A.n-1}}$$

Computational work concerning A-statistic is relatively simple. As such the use of A-statistic results in considerable saving of time and labour, specially when matched groups are to be compared with respect to a large number of variables. Accordingly researchers may replace student's t-test by Sandler's A-test whenever correlated sets of scores are employed.

3.4.1 PROCEDURE FOR USING A TEST: Sandler's A-statistic can as well be used "in the one sample case as direct substitute for the Student t-ratio" This is so because Sandler's A is an algebraically equivalent to the Student's t test. when we use A-test in one sample case, the following steps are involved:

- Construct a null hypothesis - an expectation - which the experiment was designed to test. The A-test will tell us if the data are consistent with this or depart significantly from this expectation and to interference is just the same as drawn using paired t - test.
- List the data for sample 1.
- List the data for sample 2.
- Record the number (n) of replicates for each sample (the number of replicates for sample 1 being termed n1 and the number for sample 2 being termed n2).
- Subtract the hypothesized mean of the population from each individual score Xi & Yi and calculate sum of difference Di = Xi – Yi and difference square i.e. $\sum D_i^2$ of sample 1 and sample 2.
- Calculate the *A* value as follows:

  $$A = \frac{\sum Di^2}{\sum (Di)^2}$$

- Read the table of A-statistic for (n-1) degrees of freedom at a given level of significance (using one –tailed or two-tailed values depending upon Ha) to find the critical value of A

- If the calculated A value exceeds the tabulated value we say that the means are significantly different at that level of probability.

- A significant difference at $p = 0.05$ means that if the null hypothesis were correct , then we would expect to get a Avalue as great as this on less than 5% of occasions. So we can be reasonably confident that the samples/treatments do differ from one another, but we still have nearly a 5% chance of being wrong in reaching this conclusion.

Table 3.6 Critical Values of A Statistic

(*A* is significant at a given level if it is ≦ the value shown in the table)

$n-1$	Level of significance for one-tailed test				
	.05	.025	.01	.005	.0005
	Level of significance for two-tailed test				
	.10	.05	.02	.01	.001
1	2	3	4	5	6
1	0.5125	0.5031	0.50049	0.50012	0.5000012
2	0.412	0.369	0.347	0.340	0.334
3	0.385	0.324	0.286	0.272	0.254
4	0.376	0.304	0.257	0.238	0.211
5	0.372	0.293	0.240	0.218	0.184
6	0.370	0.286	0.230	0.205	0.167
7	0.369	0.281	0.222	0.196	0.155
8	0.368	0.278	0.217	0.190	0.146
9	0.368	0.276	0.213	0.185	0.139
10	0.368	0.274	0.210	0.181	0.134
11	0.368	0.273	0.207	0.178	0.130
12	0.368	0.271	0.205	0.176	0.126
13	0.368	0.270	0.204	0.174	0.124
14	0.368	0.270	0.202	0.172	0.121
15	0.368	0.269	0.201	0.170	0.119
16	0.368	0.268	0.200	0.169	0.117
17	0.368	0.268	0.199	0.168	0.116
18	0.368	0.267	0.198	0.167	0.114
19	0.368	0.267	0.197	0.166	0.113
20	0.368	0.266	0.197	0.165	0.112
21	0.368	0.266	0.196	0.165	0.111
22	0.368	0.266	0.196	0.164	0.110
23	0.368	0.266	0.195	0.163	0.109
24	0.368	0.265	0.195	0.163	0.108
25	0.368	0.265	0.194	0.162	0.1[illegible]

1	2	3	4	5	6
26	0.368	0.265	0.194	0.162	0.107
27	0.368	0.265	0.193	0.161	0.107
28	0.368	0.265	0.193	0.161	0.106
29	0.368	0.264	0.193	0.161	0.106
30	0.368	0.264	0.193	0.160	0.105
40	0.368	0.263	0.191	0.158	0.102
60	0.369	0.262	0.189	0.155	0.099
120	0.369	0.261	0.187	0.153	0.095
∞	0.370	0.260	0.185	0.151	0.092

***n = number of pairs**

Source: The Brit. J. Psychol, Volume XLVI, 1955, p. 226.

CHAPTER – 4

OBJECTIVE SETTINGS FOR WORKPLACE SAFETY

This chapter includes the detailed setting of objectives of unsafe acts and unsafe conditions for workplace construction activities. Setting right objectives is critical for effective performance at construction workplace. Objectives are a form of motivation that set the standard for safe workplace with performance.

Objective setting for unsafe acts and unsafe conditions involves specific, measurable, achievable, realistic and time-targeted objectives. Workplace safety for unsafe acts and conditions for objective-setting suggests that it's an effective tool for accomplish a targeted goal. Setting objectives involves a continual process of workplace safety study and decision making.

In Ranking observations analysis the objectives are sets on the frequency of leading indicators in the form of safety / lapses at construction workplaces activities. During the observations at site, various observations are made on unsafe acts and unsafe conditions. In one activity there are various sub activities. By these sub activities, the unsafe acts and conditions are observed and most of the time repeated unsafe acts and conditions are observed. Here we have prepared the table on safety lapses based on frequency at workplace and construction workplace activities.

After preparation of table, each hazard observations are analyses. For hazard observations, we set the objectives than observed the unsafe acts and conditions after implementation of objectives.

4.1 Construction Activities Vs Safety Shortfalls/ Lapses

Site Location: Construction Site at Panipat (Haryana)

Table 4.1 OBJECTIVE SETTINGS

S No	Construction Workplace Activities	Safety Shortfalls / Lapses	Hazards Frequency
1	Electrical services Viz Fire, HVAC, BMS, Electrical wiring	Stacking of Materials / Housekeeping	46
2	Movement of materials	Stacking of Materials / Housekeeping	43
3	Brick Work & Plastering	Walkway / Grating / Handrails / Openings	43
4	Electrical services Viz Fire, HVAC, BMS, Electrical wiring	Unsafe electrical Equipment/ Earthing / Guards	43
5	Electrical services Viz Fire, HVAC, BMS, Electrical wiring	Ladder/Fall Arrester / life Line / Access	38
6	Electrical services Viz Fire, HVAC, BMS, Electrical wiring	Walkway / Grating / Handrails / Openings	38
7	Electrical services Viz Fire, HVAC, BMS, Electrical wiring	PPE's	33
8	Storage of Materials	Walkway / Grating / Handrails / Openings	32
9	Brick Work & Plastering	Stacking of Materials / Housekeeping	31
10	Electrical services viz Fire, HVAC, BMS, Electrical wiring	Scaffolding related	29
11	Excavation	PPE's	29
12	Excavation	Walkway / Grating / Handrails / Openings	29
13	Lifting of materials Ereaction pipe, steel etc	Erection Methodology / Work permit / SOP	28
14	Confined Space	Work in cramped and unnatural position	27
15	Movement of materials	PPE's	27
16	Excavation	Noise	27

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Maximum Out-come of row	Rank Order
		Frequency of unsafe acts and unsafe conditions at different construction activity Location												Ranking Method	
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	46
2	PPE's	16	18	29	13	15	12	27	19	7	5	16	33	33	46
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13	38	38	46
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	46
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	46
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	46
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	46
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	46
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	46
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15	29	29	46
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13	43	43	46
13	Walkway / Grating / Handrails / Openings	11	8	29	14	43	12	19	17	21	32	14	38	43	46
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	46
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	46
16	Stacking of Materials / Housekeeping	9	17	18	18	31	9	43	15	17	16	5	46	46	46
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	46
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	46
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	46
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	46
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	46
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	46
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	46
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	46
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	46
	Maximum Out-come of colomn	23	21	29	18	43	19	43	28	21	32	27	46	46	
	Rank Order	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**46**		

4.2 OBJECTIVE SETTINGS

Location Observation: 1

Construction Activity : Electrical services Viz Fire, HVAC, BMS, Electrical wiring

Safety Lapses / Shortfall : Stacking of Materials / Housekeeping

Onsite observations:

Electrical cable/wire on ground = 27

No of cable drums = 49

Moulded HVAC sheets = 100 sqm

Electrical stand = 6

Observations of Unsafe acts and conditions – Before setting the objectives

Table 4.2 Stacking of Materials / Housekeeping during electrical services

S No	Safety Shortfalls/ lapses	Before
1	Electrical cable/wire on ground	**14**
2	No of cable drums	**16**
3	Moulded HVAC sheets	**07**
4	Electrical stand	**05**
5	Others	**04**
	Total	**46**

Objectives:

1. Route the electrical line through tabular pole to avoid scattering of cable on ground.
2. Provide clear access at stacking of electrical cable drums.
3. HVAC sheets to keeps properly at stacking area.
4. To provide the proper stand and canopy for electrical distribution board.

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Frequency of unsafe acts and unsafe conditions at different construction activity Location												Ranking Method	
		Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Maximum Out-come of row	Rank Order
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	43
2	PPE's	16	18	29	13	15	12	27	19	7	5	16	33	33	43
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13	38	38	43
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	43
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	43
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	43
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	43
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	43
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	43
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15	29	29	43
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13	43	43	43
13	Walkway / Grating / Handrails / Openings	11	8	29	14	43	12	19	17	21	32	14	38	43	43
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	43
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	43
16	Stacking of Materials / Housekeeping	9	17	18	18	31	9	43	15	17	16	5		43	43
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	43
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	43
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	43
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	43
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	43
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	43
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	43
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	43
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	43
	Maximum Out-come of colomn	23	21	29	18	43	19	43	28	21	32	27	43	43	
	Rank Order	**43**	**43**	**43**	**43**	**43**	**43**	**43**	**43**	**43**	**43**	**43**	**43**		

Location Observation: 2

Construction Activity **:** Movement of materials

Safety Lapses / Shortfall **:** Stacking of Materials / Housekeeping

Onsite observations:

Nos of person = 36

Nos hazardous locations = 14

Table 4.3 Stacking of Materials / Housekeeping during Movement of materials

S No	**Safety Shortfalls/ lapses**	**Before**
1	Stacking materials	**14**
2	No clear access	**11**
3	Improper illumination level	**05**
4	No sign at stacking area	**11**
5	Others	**02**
	Total	**43**

Objectives :

1. All personnel must wear high visibility garments – safety jacket.
2. To provide the prescribed sign must be illuminated and affix the reflectorised tape as required.
3. To provide the barricading for clear visibility of earth-moving equipment.

Location Observation: 3

Construction Activity : Brick Work & Plastering

Safety Lapses / Shortfall : Walkway / Grating / Handrails / Openings

Onsite observations:

Nos of brick working location =07

Nos Plastering workplace = 05

No of opening =03

Brick and plastering work height = 08 Mts

Table 4.4 Walkway / Grating / Handrails / Openings

S No	Safety Shortfalls/ lapses	Before
1	Stacking materials	**13**
2	Walkway	**10**
3	Grating	**06**
4	Handrails	**08**
5	Openings	**03**
6	Others	**03**
	Total	**43**

Objectives :

1. Provide the proper stacking of bricks, sand , reinforcement, aggregate at work place.
2. To provide the grating and handrail at height work place of brick work and plastering area.
3. To clear the walkway of grating for personnel movement.
4. Temporary brick work to be done at opening location.
5. To provide the fall protection in the form of safety net at all location where fall distance exceeds five meter.

Location Observation: 4

Construction Activity : Electrical services Viz Fire, HVAC, BMS, Electrical wiring

Safety Lapses / Shortfall : Unsafe electrical Equipment/ Earthing / Guards

Onsite observations:

Nos of unguarded equipment =03

Nos short wire / cable = 13

No of wire / cable tapped with plastics =03

Table 4.5 Unsafe electrical Equipment/ Earthing / Guards during electrical services

S No	Safety Shortfalls/ lapses	Before
1	Unsafe electrical Equipment	**14**
2	Earthing	**12**
3	Guards	**11**
4	Others	**06**
	Total	**43**

Objectives :

1. To use single long cable / wire with electrical equipments to avoid taping of cable.
2. To Provide the earthing with proper connection to earth pit.

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Frequency of unsafe acts and unsafe conditions at different construction activity Location												Ranking Method	
		Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Maximum Out-come of row	Rank Order
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	38
2	PPE's	16	18	29	13	15	12	27	19	7	5	16	33	33	38
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13	38	38	38
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	38
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	38
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	38
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	38
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	38
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	38
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15	29	29	38
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13		25	38
13	Walkway / Grating / Handrails / Openings	11	8	29	14		12	19	17	21	32	14	38	38	38
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	38
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	38
16	Stacking of Materials / Housekeeping	9	17	18	18	31	9		15	17	16	5		31	38
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	38
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	38
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	38
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	38
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	38
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	38
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	38
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	38
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	38
	Maximum Out-come of colomn	23	21	29	18	31	19	27	28	21	32	27	38	38	
	Rank Order	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**		

Location Observation: 5

Construction Activity : Electrical services Viz Fire, HVAC, BMS, Electrical wiring

Safety Lapses / Shortfall : Ladder/Fall Arrester / life Line / Access

Onsite observations:

Nos of unguarded equipment =08

Nos short wire / cable = 18

No of wire / cable tapped with plastics = 05

Defective ladder = 01

Fall arrester = 02

Table 4.6 Ladder/Fall Arrester / life Line / Access during electrical services

S No	Safety Shortfalls/ lapses	Before
1	Ladder	**11**
2	Fall Arrester	**13**
3	life Line	**07**
4	Access	**05**
5	Others	**02**
	Total	**38**

Objectives :

1. Ladders not to be use for carrying the material .
2. Safe ladder to be use – rubber stopper, locks, equle steps and firm support while working on height.
3. For external services – to provide the life line and fall arrester to personnel with all necessary tools.
4. To provide the fall protection in the form of safety net at all location where fall distance exceeds five meter.

Location Observation: 6

Construction Activity **:** Electrical services Viz Fire, HVAC, BMS, Electrical wiring

Safety Lapses / Shortfall **:** Walkway / Grating / Handrails / Openings

Onsite observations:

Nos of unguarded equipment =08

Nos short wire / cable = 15

No of wire / cable tapped with plastics = 08

Movement = On scaffolding

Table 4.7 Walkway / Grating / Handrails / Openings during electrical services

S No	Safety Shortfalls/ lapses	Before
1	Walkway	**12**
2	Grating	**11**
3	Handrails	**06**
4	Openings	**06**
5	Others	**03**
	Total	**38**

Objectives :

1. To provide the firm support and handrail for any electrical services.
2. To clear the walkway of grating for personnel movement.
3. All opening are to be cover with hand rail/ grating/ GI Sheet
4. Avoid the water stagnation of near to all electrical equipment.
5. To provide the overhead protection to maintain safe distance from energized electrical lines on the access of earthmoving equipment.

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction- pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Ranking Method: Maximum Out-come of row	Ranking Method: Rank Order
		Frequency of unsafe acts and unsafe conditions at different construction activity Location													
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	33
2	PPE's	16	18	29	13	15	12	27	19	7	5	16	33	33	33
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13		17	33
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	33
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	33
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	33
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	33
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	33
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	33
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15	29	29	33
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13		25	33
13	Walkway / Grating / Handrails / Openings	11	8	29	14		12	19	17	21	32	14		32	33
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	33
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	33
16	Stacking of Materials / Housekeeping	9	17	18	18	31	9		15	17	16	5		31	33
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	33
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	33
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	33
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	33
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	33
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	33
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	33
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	33
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	33
	Maximum Out-come of colomn	23	21	29	18	31	19	27	28	21	32	27	33	33	
	Rank Order	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**		

Location Observation: 7

Construction Activity **:** Electrical services Viz Fire, HVAC, BMS, Electrical wiring

Safety Lapses / Shortfall **:** Personal protective equipments

Onsite observations:

No of person = 08

Safety gadget = Nil

Table 4.8 Personal protective equipments during electrical services

S No	Safety Shortfalls/ lapses	Before
1	Eye Protection	**07**
2	Face Protection	**03**
3	Head Protection	**06**
4	Hand Protection	**09**
5	Body Protection	**03**
6	Fall Protection	**05**
	Total	**33**

Objectives :

1. To provide the hand gloves and other necessary personnel protective equipment to personnel involves for electrical services work.

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Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Ranking Method: Maximum Out-come of row	Ranking Method: Rank Order
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	32
2	PPE's	16	18	29	13	15	12	27	19	7	5	16		29	32
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13		17	32
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	32
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	32
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	32
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	32
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	32
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	32
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15	29	29	32
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13		25	32
13	Walkway / Grating / Handrails / Openings	11	8	29	14		12	19	17	21	32	14		32	32
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	32
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	32
16	Stacking of Materials / Housekeeping	9	17	18	18	31	9		15	17	16	5		31	32
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	32
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	32
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	32
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	32
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	32
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	32
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	32
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	32
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	32
	Maximum Out-come of colomn	23	21	29	18	31	19	27	28	21	32	27	29	32	
	Rank Order	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**		

Location Observation: 8

Construction Activity **:** Storage of Materials

Safety Lapses / Shortfall **:** Walkway / Grating / Handrails / Openings

Onsite observations:

Materials = Cement, Reinforcement, chemical Compound

No of Person = 09

Equipment Evolve = JCB, loader, tractor

Table 4.9 Walkway / Grating / Handrails / Openings during storage of materials

S No	Safety Shortfalls/ lapses	Before
1	Walkway	**09**
2	Grating	**10**
3	Handrails	**07**
4	Openings	**04**
5	Others	**02**
	Total	**32**

Objectives :

1. To follows the FIFO system for storage of material.
2. Materials would be kept at designated locations.
3. Materials would be unloaded as possible near to work place to avoid re-handling.
4. For stacking of cement , reinforcements , and other chemical compounds to follows the standard.
5. Scrap materials would to keep at designated location.
6. Clear walkway and high illumination level to be proved for safe in/ out of materials.
7. MSDS instruction to be follows for storage of materials.

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Frequency of unsafe acts and unsafe conditions at different construction activity Location												Ranking Method	
		Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Maximum Out-come of row	Rank Order
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	31
2	PPE's	16	18	29	13	15	12	27	19	7	5	16		29	31
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13		17	31
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	31
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	31
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	31
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	31
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	31
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	31
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15	29	29	31
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13		25	31
13	Walkway / Grating / Handrails / Openings	11	8	29	14		12	19	17	21		14		29	31
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	31
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	31
16	Stacking of Materials / Housekeeping	9	17	18	18	31	9		15	17	16	5		31	31
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	31
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	31
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	31
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	31
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	31
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	31
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	31
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	31
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	31
	Maximum Out-come of colomn	23	21	29	18	31	19	27	28	21	21	27	29	31	
	Rank Order	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**		

Location Observation: 9

Construction Activity : Brick Work & Plastering

Safety Lapses / Shortfall : Stacking of Materials / Housekeeping

Onsite observations:

No of person = 25

Working height = More than 8 mt

Working Platform = on Scaffold

Table 4.10 Stacking of Materials / Housekeeping during Brick work & plastering

S No	Safety Shortfalls/ lapses	Before
1	Stacking materials	**10**
2	No clear access	**07**
3	Improper illumination level	**07**
4	No sign at stacking area	**05**
5	Others	**02**
	Total	**31**

Objectives :

1. To use only tabular steel scaffold for higher structure for carrying the raw material on grating with certified tag line system.
2. To provide the illumination level at workplace.
3. To provide the ramp system and avoid ladder for carrying the materials.
4. To prepare the mortar etc near to workplace.
5. To Avoid loose or laying cable / wire near to brick work and plastering location.

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Ranking Method: Maximum Out-come of row	Ranking Method: Rank Order
		Frequency of unsafe acts and unsafe conditions at different construction activity Location													
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	29
2	PPE's	16	18	29	13	15	12	27	19	7	5	16		29	29
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13		17	29
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	29
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	29
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	29
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	29
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	29
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	29
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15	29	29	29
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13		25	29
13	Walkway / Grating / Handrails / Openings	11	8	29	14		12	19	17	21		14		29	29
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	29
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	29
16	Stacking of Materials / Housekeeping	9	17	18	18		9		15	17	16	5		18	29
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	29
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	29
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	29
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	29
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	29
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	29
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	29
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	29
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	29
	Maximum Out-come of colomn	23	21	29	18	21	19	27	28	21	21	27	29	29	
	Rank Order	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**		

Location Observation: 10

Construction Activity : Electrical services Viz Fire, HVAC, BMS, Electrical wiring

Safety Lapses / Shortfall : Scaffolding related

Onsite observations:

Working Platform = Scaffold

No Of Person = 26

Ladder = 02

Table 4.11 Scaffolding related during electrical services

S No	Safety Shortfalls/ lapses	Before
1	Scaffolding related	08
2	Without wheel stopper	05
3	Defective ladder kept on scaffold	06
4	Distance more than wall	07
5	Others	03
	Total	29

Objectives :

1. To provide the safe and supporting for four times the maximum intended load.
2. Wheel stopper to be used for moving scaffolding.

Location Observation: 11

Construction Activity : Excavation

Safety Lapses / Shortfall : Personal protective equipments

Onsite observations:

No of Person = 35

No of excavator = 03

No of Loader/ tractor = 12

Table 4.12 Personal protective equipments

S No	Safety Shortfalls/ lapses	Before
1	Eye Protection	**12**
2	Face Protection	**01**
3	Head Protection	**14**
4	Hand Protection	**02**
5	Body Protection	**00**
6	Fall Protection	**00**
	Total	**29**

Objectives :

1. All personnel must wear high visibility garments – safety jacket , safety helmet , ear plug etc as per site requirement.

Location Observation: 12

Construction Activity **:** Excavation

Safety Lapses / Shortfall **:** Walkway / Grating / Handrails / Openings

Onsite observations:

No of Person = 35

No of excavator = 03

No of Loader/ tractor = 12

Table 4.13 Walkway / Grating / Handrails / Openings

S No	Safety Shortfalls/ lapses	Before
1	Walkway	9
2	Grating	7
3	Handrails	5
4	Openings	5
5	Others	3
	Total	**29**

Objectives :

2. All personnel must wear high visibility garments – safety jacket , safety helmet , ear plug etc as per site requirement.

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Ranking Method: Maximum Out-come of row	Ranking Method: Rank Order
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	28
2	PPE's	16	18		13	15	12	27	19	7	5	16		27	28
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13		17	28
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	28
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	28
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	28
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	28
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	28
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3	28	9	2	8	23	28	28
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15		21	28
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13		25	28
13	Walkway / Grating / Handrails / Openings	11	8		14		12	19	17	21		14		21	28
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	28
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	28
16	Stacking of Materials / Housekeeping	9	17	18	18		9		15	17	16	5		18	28
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	28
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	28
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	28
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	28
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	28
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	28
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	28
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	28
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	28
	Maximum Out-come of colomn	23	21	27	18	21	19	27	28	21	21	27	23	28	
	Rank Order	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**		

Location Observation: 13

Construction Activity **:** Lifting of materials Eraction- pipe,steel etc

Safety Lapses / Shortfall **:** Erection Methodology / Work permit / SOP

Onsite observations:

No of person = 13

No of cage for person working = 02

No of slings = 05

Table 4.14 Erection Methodology / Work permit / SOP during lifting of materials

S No	Safety Shortfalls/ lapses	Before
1	Erection Methodology	**07**
2	Work permit	**10**
3	SOP	**04**
4	Testing of wire , rope, slings etc by competent person.	**05**
5	Others	**02**
	Total	**28**

Objectives :

1. All lifting equipments or materials to be tested and thoroughly examined by competent and experience person.
2. To follows the instruction and sequence as provided in work methodology and standard operation procedures.
3. To comply all the requirement of work permit system.

Leading Indicator in the form of lapses/ shortfalls

SNo	Particulars of Lapses / shortfall	Frequency of unsafe acts and unsafe conditions at different construction activity Location												Ranking Method	
		Demolition	Transportation - loading & unloading	Excavation	RCC/Concreting	Brick Work & Plastering	Scaffolding	Movement of materials	Lifting of materials Eraction-pipe,steel etc	Piling	Storage of Materials	Confined Space	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Maximum Out-come of row	Rank Order
1	Gate Pass / Safety Induction	4	3	4	7	2	4	6	1	3	4	4	3	7	27
2	PPE's	16	18		13	15	12	27	19	7	5	16		27	27
3	Ladder/Fall Arrester / life Line / Access	14	17	9	11	17	7	16	6	3	6	13		17	27
4	Safety Net	7	0	0	8	7	14	3	6	0	0	9	11	14	27
5	Cordoning / barricading	5	7	11	7	9	7	8	9	3	10	3	19	19	27
6	Vehicle / Hydra unsafe operation	2	6	7	8	6	0	0	3	3	4	0	0	8	27
7	Certification of machinery / man cage	0	0	0	0	0	0	0	16	8	0	0	0	16	27
8	Cables / wires / welding leads	0	0	13	6	0	8	6	8	4	18	8	6	18	27
9	Erection Methodology / Work permit / SOP	2	7	6	9	7	19	3		9	2	8	23	23	27
10	Scaffolding related	11	11	17	12	21	7	17	8	0	3	15		21	27
11	Unsafe electrical Equipment/ Earthing / Guards	23	0	25	17	17	4	25	14	17	19	13		25	27
13	Walkway / Grating / Handrails / Openings	11	8		14		12	19	17	21		14		21	27
14	Fire Hazards	5	6	11	6	7	6	6	3	2	13	3	14	14	27
15	Canteen / Toilets/ Urinals/ Labour Camp	6	11	10	1	4	3	5	5	2	10	0	15	15	27
16	Stacking of Materials / Housekeeping	9	17	18	18		9		15	17	16	5		18	27
17	Compressed Gas Cylinders	0	7	3	13	0	8	18	9	16	6	7	21	21	27
18	Illumination	8	9	14	17	6	7	21	6	8	13	9	7	21	27
19	Poor rigging / lifting / Lifting Tools / Tackle	0	18	0	0	0	0	16	26	15	2	3	8	26	27
20	Fume /dust	18	21	19	6	0	0	23	0	2	21	6	0	23	27
21	Noise	23	19	27	3	0	0	9	6	3	2	0	6	27	27
22	Mechanical Vibration	18	5	8	3	0	0	0	0	3	0	0	3	18	27
23	Eletromagnetic Radition	0	0	0	3	0	0	0	0	0	0	9	7	9	27
24	Weather	6	2	9	13	0	9	19	21	9	16	4	17	21	27
25	Work in cramped and unnatural position	17	0	5	3	3	6	10	13	4	19	27	17	27	27
	Maximum Out-come of colomn	23	21	27	18	21	19	27	26	21	21	27	23	27	
	Rank Order	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**		

Location Observation: 14

Construction Activity **:** Confined Space

Safety Lapses / Shortfall **:** Work in cramped and unnatural position

Onsite observations:

No of person = 09

Table 4.15 Work in cramped and unnatural position during confined space

S No	Safety Shortfalls/ lapses	Before
1	Work in cramped and unnatural position	**03**
2	Work Permit	**05**
3	Electrical Supply less than 24V	**06**
4	Exhaust system	**03**
5	Worker Health check-up	**02**
6	Signalling system	**02**
7	Safety Gadgets	**04**
8	Others	**02**
	total	**27**

Objectives :

1. To follows the instructions from a supervisor and not to enter or permit to work without a written permit.
2. To proved the clear and safe access to work inside the confined space.
3. To provide the training to personnel and examine the health condition of person.

Location Observation: 15

Construction Activity : Movement of materials

Safety Lapses / Shortfall : Personal protective equipments

Onsite observations:

No of person = 36

Table 4.16 Personal protective equipments during movement of materials

S No	Safety Shortfalls/ lapses	Before
1	Eye Protection	**09**
2	Face Protection	**08**
3	Head Protection	**07**
4	Hand Protection	**02**
5	Body Protection	**01**
6	Fall Protection	**00**
	Total	**27**

Objectives :

1. To provide the signs most commonly used on most construction sites are those designation danger, caution, traffic, direction, exit , and safety precaution.
2. To provide the flag man at all crossing with necessary PPE's.

Location Observation: 16

Construction Activity : Excavation

Safety Lapses / Shortfall : Noise

Onsite observations:

No of Person = 35

No of excavator = 03

No of Loader/ tractor = 12

Table 4.17 Noise during excavation

S No	Safety Shortfalls/ lapses	Before
1	Use of muffler	**09**
2	Capacity lading	**08**
3	Ramp Condition	**07**
4	Others	**03**
	Total	**27**

Objectives :

1. To provide the muffler to all earthmoving equipment.
2. To provide the necessary PPE’s to driver, helper and those working at such location.

CHAPTER – 5

DATA EVALUATION & RESULT DISCUSSION

The construction industry has come a long way. Over the years the construction workplace has transformed from a un- organized to organized sector. This change in the industry characteristics has brought in challenges to construction workplace. It is time, the construction industries to evolve appropriate safety arrangement for unsafe acts and conditions strategies to be in the run. The construction industries have to first devise strategy to develop brand awareness for workplace safety. The brand awareness for workplace safety is possible by only and only by implementation of effective and efficient workplace safety.

The workplace safety needs to formulate unique implementation of workplace safety i.e. ranking analysis. This may move on the lives of different component of safety such as severity and probability of unsafe acts and conditions. Effective use of corporate image should be made in safety workplace of workers.

There is ample scope for construction industries to use "psychological appeals" too to move away from completion workplace safety grounds. The inevitable conclusion from the study is that safety massages to workers and take the image of organization to the worker to the possible extent. The aggressive and appropriate implementation of safety techniques at construction workplace level are a sine qua non in construction industry.

Ranking analysis provides a valuable framework for project monitoring by identifying the unsafe acts and conditions over at any stage of the construction implementation. It uses as frequency measure system based on the project activities rather than on the functional organization of the firm.

Notion of work activities in control of safety at workplace:

- Objective would neither too big nor too small for implementation
- Well defined responsibility by frequency monitoring.

- Possibility of time bound safety implementation to be checked for safety workplace.
- Project performance, time & cost favourable are the major watch words in monitoring and control of unsafe acts and conditions. These can be evaluated and used to compute the unsafe acts and conditions frequency in a project at any stage.
- Ranking analysis to provide an aggregate measures of how the project doing in terms of safety parameters.

The data, after collection, has to be processed and analyzed in accordance with the outline laid down for the purpose at the time of developing the research plan. This is essential for a scientific study and for ensuring that we have all relevant data for making contemplated comparisons and analysis. Technically speaking, processing implies editing, coding, classification and tabulation of collected data so that they are amenable to analysis. The term analysis refers to the computation of certain measure along with searching for patterns of relationship that exist among data groups. In the processes of analysis, relationships or differences supporting or conflicting with original or new hypotheses should be subjected to statistical tests of significance to determine with what validity data can be said to indicate any conclusions.

The role of t- test and A- test statistics in research is to function as a tool in designing study, analyses its data and drawing the conclusion there from. For research studies result in a large volume of raw data which must be suitably reduced so that the same can be read easily and can be used for further analysis.

In last, a graphic diagram depicting the relationship between two or more variables used, for instance, in visualizing scientific data for conclusion purpose.

We give below a brief outline of unsafe acts and unsafe conditions observations in the context of research studies.

5.1 ANALYSIS OF DATA - Observations of Unsafe Act and Unsafe Condition

Table 5.1 - Location Observation: 1

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$		Difference squared D_i^2	
1	Electrical cable/wire on ground	14	7		7		49
2	No of cable drums	16	6		10		100
3	Moulded HVAC sheets	7	2		5		25
4	Electrical stand	5	1		4		16
5	Others	4	1		3		9
n = 5	**Total**	**46**	**17**	**ΣD_i =**	**29**	**ΣD_i^2=**	**199**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{29}{5}$

$= 5.8$

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

$= \sqrt{(199 - 5.8 * 5.8 * 5 / 5 - 1)}$

$= \sqrt{\frac{192-135.2}{4}} = \sqrt{\frac{30.8}{4}} = \sqrt{77}$

$= 2.775$

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{58}{1.24}$

$= 4.677$

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 4.677 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{199}{29*29}$$

$$A = 0.237$$

b) Degree of freedom = (n-1) = (5-1) = 4

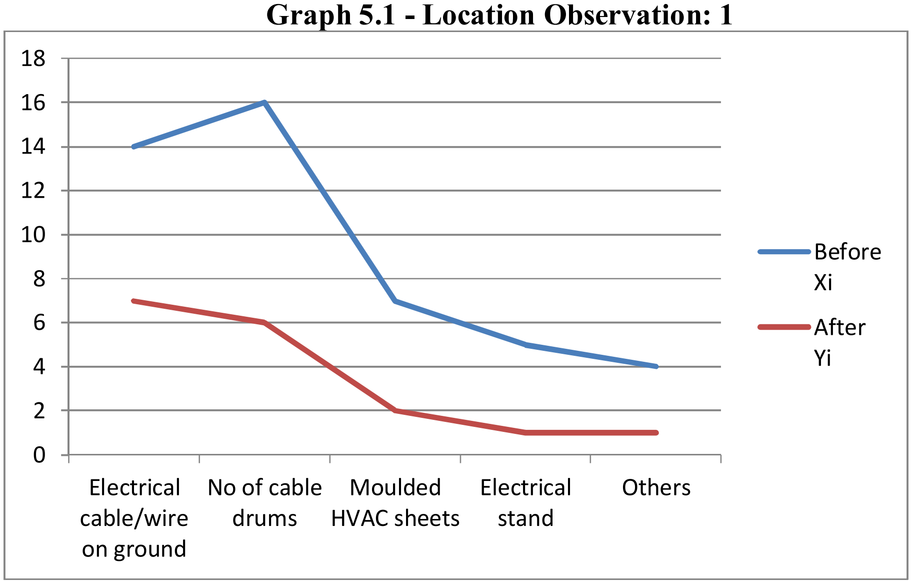
c) Critical Value of A- Statistic as per table (5 %) = 0.376

d) **Result:** The computed value of A , being 0.237, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) .

Graph 5.1 - Location Observation: 1



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.2 - Location Observation: 2

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Stacking materials	14	3	11	121
2	No clear access	11	6	5	25
3	Improper illumination level	5	2	3	9
4	No sign at stacking area	11	5	6	36
5	Others	2	1	1	1
n = 5	**Total**	**43**	**17**	**ΣD_i = 26**	**ΣD_i^2 = 192**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{26}{5}$

= 5.2

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(192 - 5.2 *5.2*5 / 5-1)

$= \sqrt{\frac{192 - 135.2}{4}}$

= 3.768

c) t value $t = \frac{\bar{D} - 0}{\sigma_{diff} / \sqrt{n}} = \frac{5.2 - 0}{3.768 / \sqrt{5}} = \frac{5.2}{1.685}$

= 3.086

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 3.086 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{192}{26*26} = \frac{192}{676}$$

A = 0.284

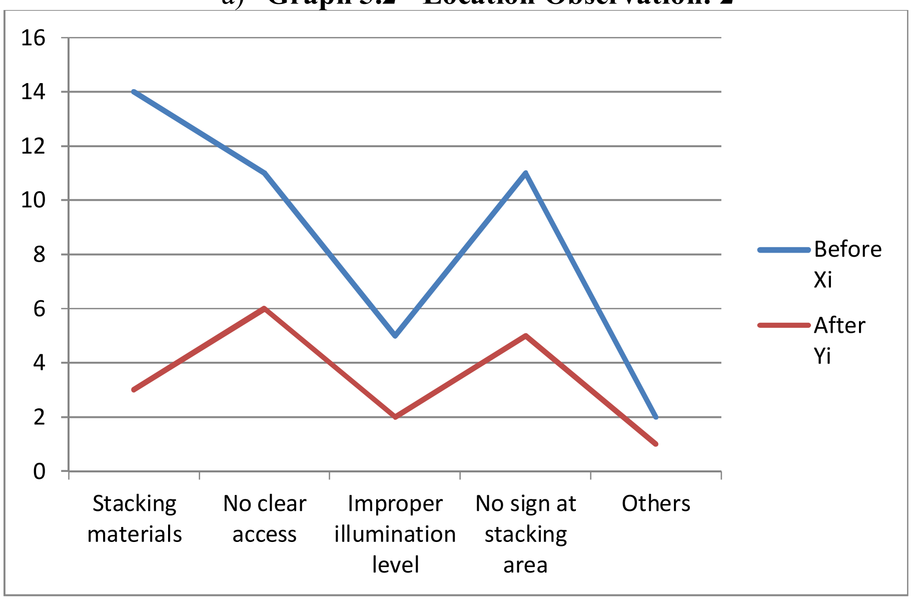
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.376

d) **Result:** The computed value of A , being 0.284, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.2 - Location Observation: 2**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.3 - Location Observation: 3

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Stacking materials	13	6	7	49
2	Walkway	10	5	5	25
3	Grating	6	3	3	9
4	Handrails	8	4	4	16
5	Openings	3	2	1	1
6	Others	3	1	2	4
n = 6	**Total**	**43**	**21**	**$\Sigma D_i =$ 22**	**$\Sigma D_i^2 =$ 104**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{22}{6}$

D = 3.67

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(104 - 3.66 *3.66*6 / 6-1)

$= \sqrt{\frac{104-80-373}{5}} = \sqrt{\frac{23.626}{5}} = \sqrt{4.725}$

= 2.173

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{3.667}{0.887}$

= 4.134

d) Critical Value of t- Statistic as per table (5 %) = 2.571

e) **Result:** The observed value of t is 4.134 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{104}{22*22} = \frac{104}{484}$$

A = 0.2148

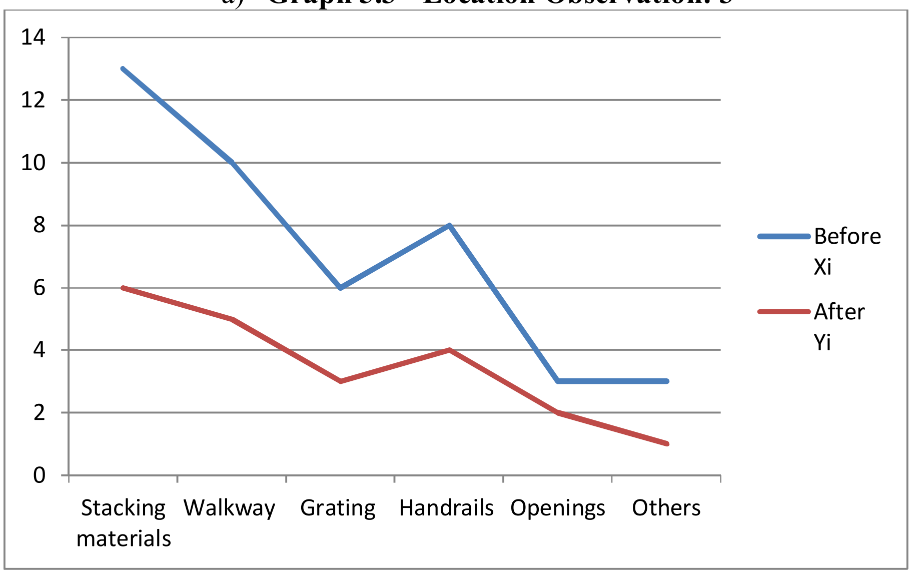
b) Degree of freedom = (n-1) = (6-1) = 5

c) Critical Value of A- Statistic as per table (5 %) = 0.372

d) **Result:** The computed value of A , being 0.214, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.3 - Location Observation: 3**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.4 - Location Observation: 4

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Unsafe electrical Equipment	14	7	7	49
2	Earthing	12	8	4	16
3	Guards	11	3	8	64
4	Others	6	4	2	4
n = 4	**Total**	**43**	**22**	**ΣD_i = 21**	**ΣD_i^2 = 133**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{21}{4}$

D = 5.25

b) Degree of freedom = (n-1) = (4-1) = 3

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

$\sigma diff = \sqrt{(133 - 5.25 * 5.25 * 4 / 4-1)}$

$= \sqrt{\frac{133 - 110.25}{3}}$

= 2.753

c) t value $t = \frac{\bar{D} - 0}{\sigma_{diff} / \sqrt{n}} = \frac{5.25}{1.3765}$

= 3.814

d) Critical Value of t- Statistic as per table (5 %) = 3.182

e) **Result:** The observed value of t is 3.814 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{133}{441}$$

A = 0.301

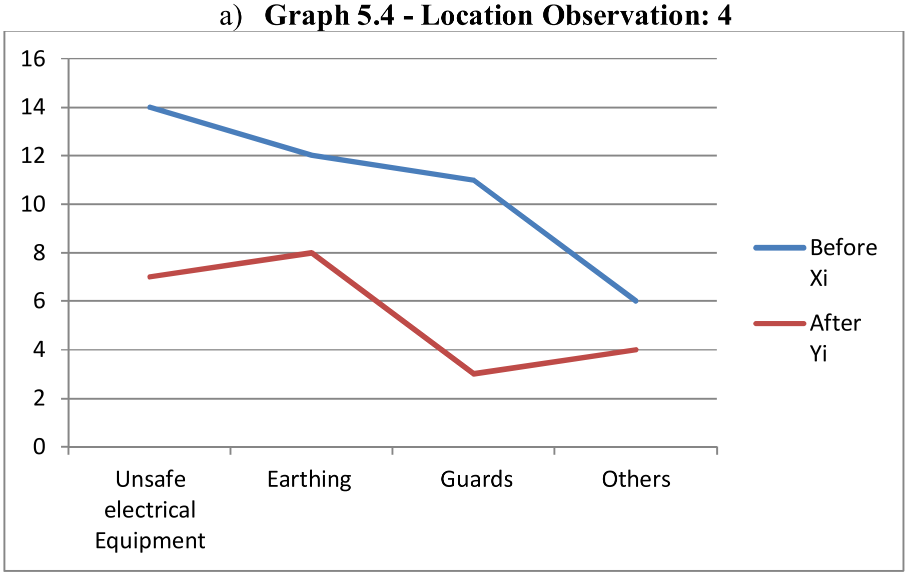
b) Degree of freedom = (n-1) = (4-1) = 3

c) Critical Value of A- Statistic as per table (5 %) = 0.324

d) **Result:** The computed value of A , being 0.301, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.4 - Location Observation: 4**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.5 - Location Observation: 5

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Ladder	11	6	5	25
2	Fall Arrester	13	3	10	100
3	life Line	7	4	3	9
4	Access	5	2	3	9
5	Others	2	1	1	1
n = 5	**Total**	**38**	**16**	**$\Sigma D_i =$ 22**	**$\Sigma D_i^2 =$ 144**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{22}{5}$

D = 4.4

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(144 - 4.4 *4.4*5 / 5-1

$= \sqrt{\frac{144-96.8}{4}} = \sqrt{\frac{47.2}{4}}$

= 3.435

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{4.4}{1.536}$

= 2.864

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 2.864 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{144}{484}$$

$$A = 0.297$$

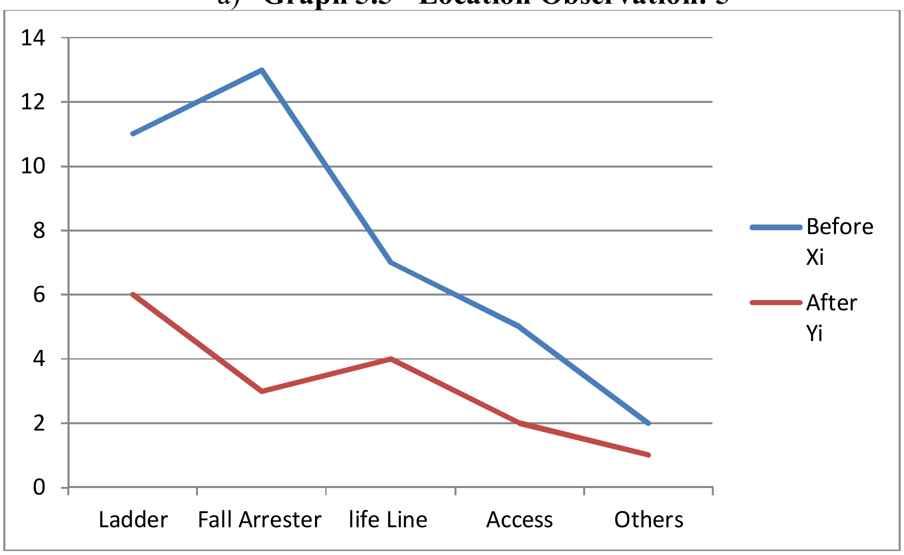
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.304

d) **Result:** The computed value of A , being 0.297, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.5 - Location Observation: 5**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.6 - Location Observation: 6

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Walkway	12	5	7	49
2	Grating	11	4	7	49
3	Handrails	6	3	3	9
4	Openings	6	4	2	4
5	Others	3	1	2	4
n = 5	**Total**	**38**	**17**	**ΣD_i = 21**	**ΣD_i^2= 115**

PART A: Solution using t – test

a) Mean $\overline{D} = \frac{\sum D_i}{n} = \frac{21}{5}$

D = 4.2

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\overline{D})^2 * n}{n-1}}$

σdiff = √(115 - 4.2 *4.2*5 / 5-1)

$= \sqrt{\frac{115-88.2}{4}} = \sqrt{6.7}$

= 2.588

c) t value $t = \frac{\overline{D}-0}{\sigma_{diff}/\sqrt{n}}$

= 3.630

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 3.630 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{115}{441}$$

A = 0.260

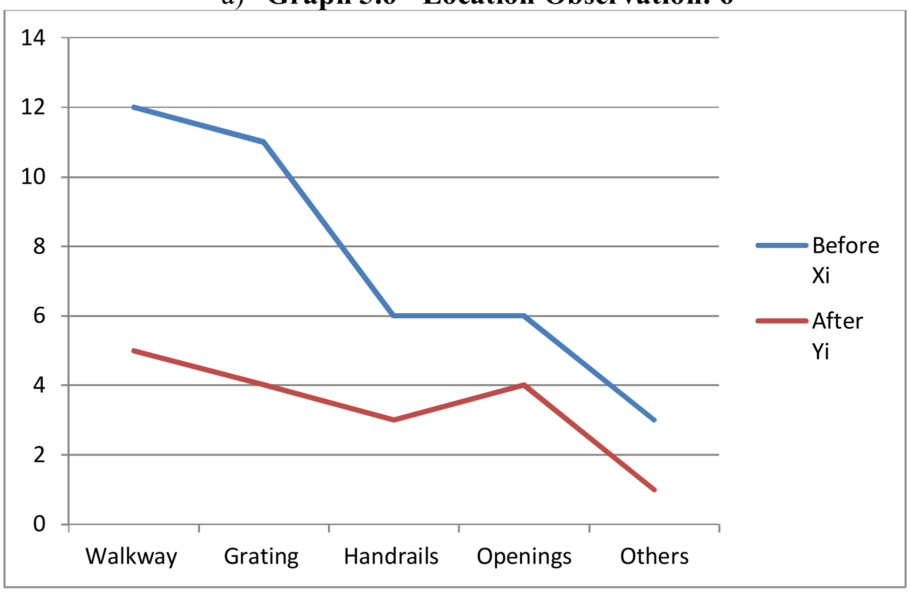
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.304

d) **Result:** The computed value of A , being 0.260, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.6 - Location Observation: 6**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.7 - Location Observation: 7

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Eye Protection	7	5	2	4
2	Face Protection	3	3	0	0
3	Head Protection	6	2	4	16
4	Hand Protection	9	3	6	36
5	Body Protection	3	0	3	9
6	Fall Protection	5	4	1	1
n = 6	**Total**	**33**	**17**	**$\Sigma D_i =$ 16**	**$\Sigma D_i^2 =$ 66**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{16}{6}$

D = 2.666

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(65 - 2.5*2.5 *6 / 6-1)

$= \sqrt{\frac{65-37.5}{45}} = \sqrt{5.5}$

= 2.345

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{2.666}{0.957}$

= 2.785

d) Critical Value of t- Statistic as per table (5 %) = 2.571

e) **Result:** The observed value of t is 2.785 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{65}{225}$$

$$A = 0.288$$

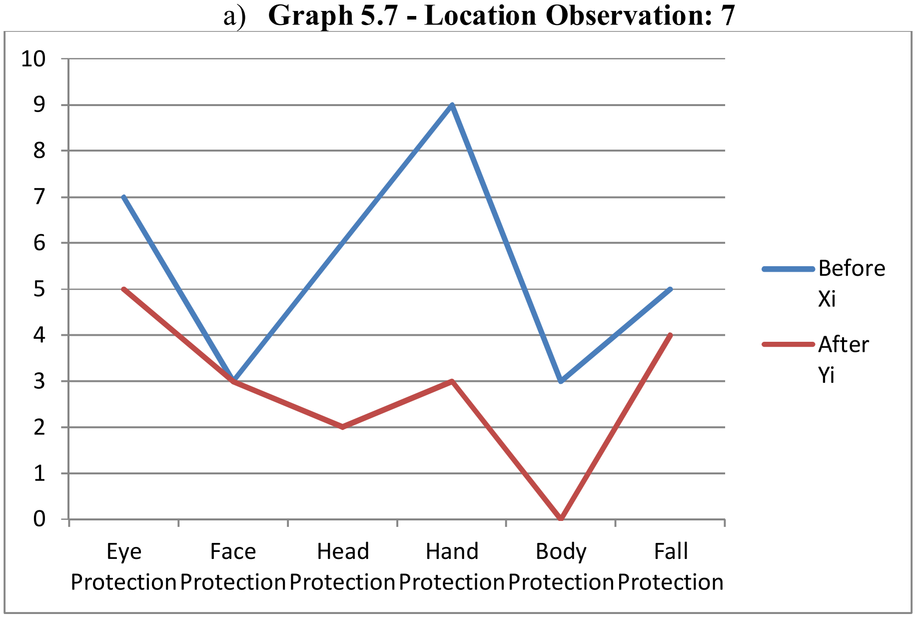
b) Degree of freedom = (n-1) = (6-1) = 5

c) Critical Value of A- Statistic as per table (5 %) = 0.293

d) **Result:** The computed value of A , being 0.288, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.7 - Location Observation: 7**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.8 - Location Observation: 8

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i-Y_i)$	Difference squared D_i^2
1	Walkway	9	4	5	25
2	Grating	10	5	5	25
3	Handrails	7	3	4	16
4	Openings	4	3	1	1
5	Others	2	1	1	1
n = 5	**Total**	**32**	**16**	**ΣD_i = 16**	**ΣD_i^2 = 68**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{16}{5}$

D = 3.2

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(68 - 3.2*3.2 *5 / 5-1)

$= \sqrt{\frac{68-51.2}{4}} = \sqrt{\frac{16.8}{4}} = \sqrt{4.2}$

= 2.049

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{3.2}{0.916}$

= 3.493

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 3.493 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} \frac{68}{256}$$

$$A = 0.265$$

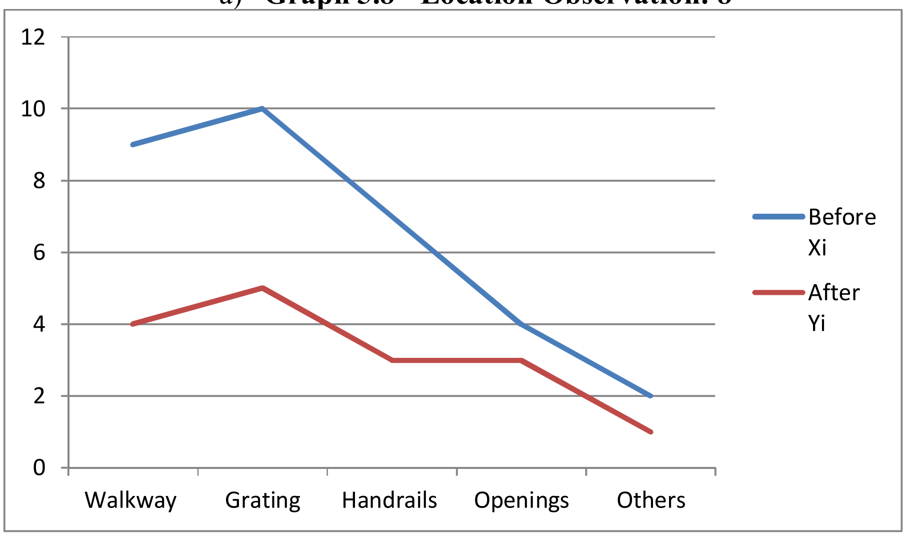
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.304

d) **Result:** The computed value of A , being 0.265, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.8 - Location Observation: 8**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.9 - Location Observation: 9

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Stacking materials	10	4	6	36
2	No clear access	7	4	3	9
3	Improper illumination level	7	4	3	9
4	No sign at stacking area	5	3	2	4
5	Others	2	2	0	0
n = 5	**Total**	**31**	**17**	**$\Sigma D_i =$ 14**	**$\Sigma D_i^2 =$ 58**

PART A: Solution using t – test

a) Mean $\overline{D} = \frac{\sum D_i}{n} = \frac{14}{5}$

D = 2.8

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\overline{D})^2 * n}{n-1}}$

σdiff = √(58- 2.8 *2.8*5 / 5-1)

$= \sqrt{\frac{58-39.2}{4}} = \sqrt{4.7}$

= 2.167

c) t value $t = \frac{\overline{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{2.8}{0.969}$

= 2.889

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 2.889 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum(Di)^2} = \frac{58}{196}$$

$$A = 0.295$$

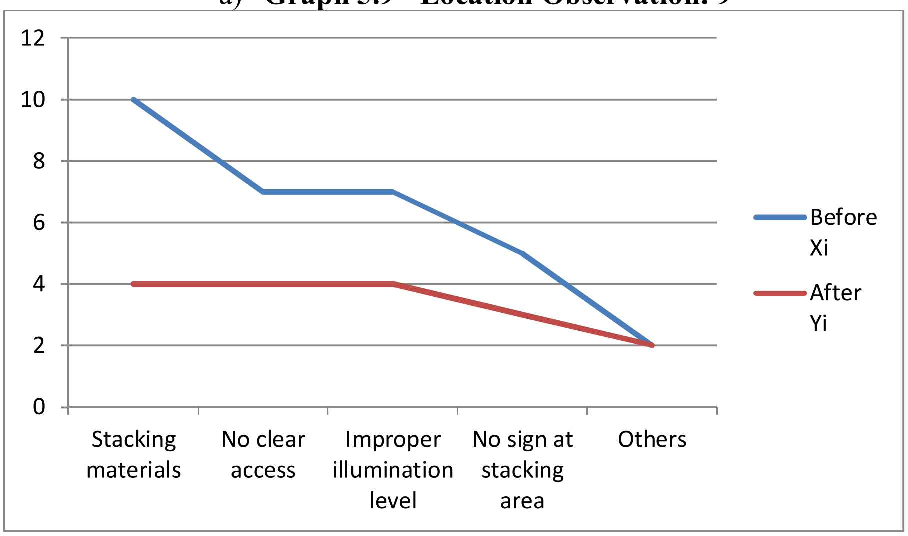
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.304

d) **Result:** The computed value of A , being 0.295, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.9 - Location Observation: 9**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.10 - Location Observation: 10

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Scaffolding related	**8**	**4**	4	16
2	Without wheel stopper	**5**	**5**	0	0
3	Defective ladder kept on scaffold	**6**	**3**	3	9
4	Distance more than wall	**7**	**2**	5	25
5	Others	**3**	**1**	2	4
n = 5	**Total**	**29**	**15**	$\Sigma D_i =$ **14**	$\Sigma D_i^2 =$ **54**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{14}{5}$

D = 2.8

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

$\sigma\text{diff} = \sqrt{}(54 - 2.8 * 2.8 * 5 / 5-1)$

$= \sqrt{\frac{54-39.2}{4}} = \sqrt{\frac{14.8}{4}} = \sqrt{3.7}$

= 1.923

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{2.8}{0.860}$

= 3.255

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 3.255 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{54}{196}$$

$$A = 0.275$$

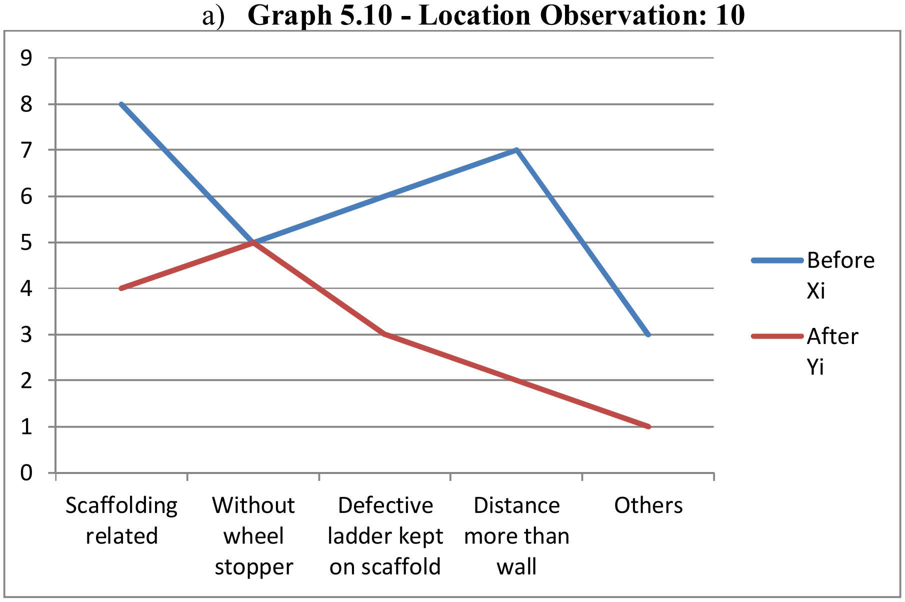
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.304

d) **Result:** The computed value of A , being 0.275, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.10 - Location Observation: 10**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.11 - Location Observation: 11

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Eye Protection	12	5	7	49
2	Face Protection	1	2	-1	1
3	Head Protection	14	3	11	121
4	Hand Protection	2	1	1	1
5	Body Protection	0	0	0	0
6	Fall Protection	0	0	0	0
n = 6	**Total**	**29**	**11**	**$\Sigma D_i =$ 18**	**$\Sigma D_i^2 =$ 172**

PART A: Solution using t – test

a) Mean $\overline{D} = \frac{\sum D_i}{n} = \frac{18}{6}$

D = 3.000

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\overline{D})^2 * n}{n-1}}$

σdiff = √(172 - 3.0* 3.0 *6 / 6-1)

$= \sqrt{\frac{172-54}{5}} = \sqrt{\frac{118}{45}} = \sqrt{23.6}$

= 4.857

c) t value $t = \frac{\overline{D} - 0}{\sigma_{diff} / \sqrt{n}} = \frac{3.000}{1.983}$

= 1.512

d) Critical Value of t- Statistic as per table (5 %) = 2.571

e) **Result:** The observed value of t is 1.512 which falls in the acceptance region and thus, we accept H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been not implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{172}{324}$$

$$A = 0.530$$

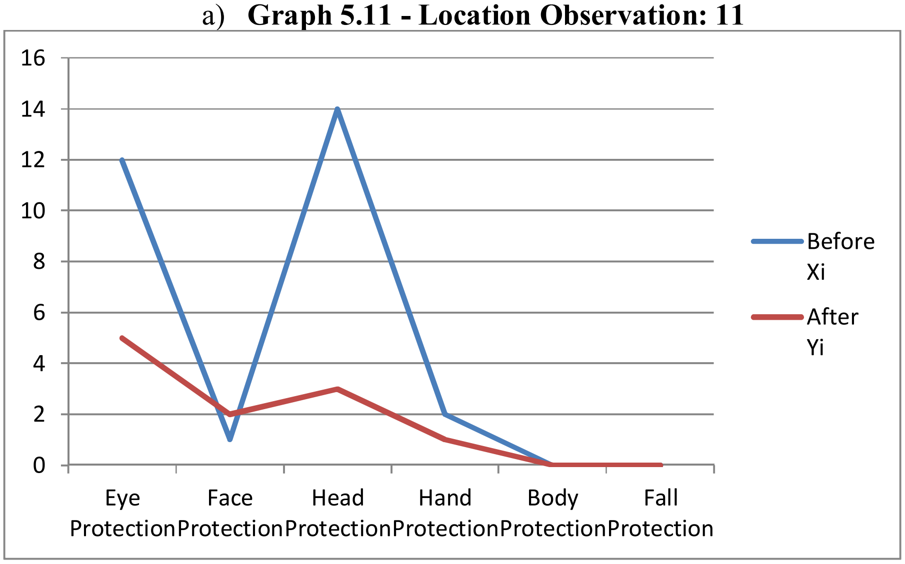
b) Degree of freedom = (n-1) = (6-1) = 5

c) Critical Value of A- Statistic as per table (5 %) = 0.293

d) **Result:** The computed value of A , being 0.530, is more than the table value and such A- statistic is non-significant

PART C: Two Dimensional Graphs

a) **Graph 5.11 - Location Observation: 11**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends but not effective.

Table 5.12 - Location Observation: 12

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Walkway	9	6	3	9
2	Grating	7	6	1	1
3	Handrails	5	4	1	1
4	Openings	5	5	0	0
5	Others	3	2	1	1
n = 5	**Total**	**29**	**23**	**Σ D_i = 6**	**Σ D_i^2= 12**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{6}{5}$

D = 1.2

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(12 - 1.2 *1.2*5 / 5-1)

$= \sqrt{\frac{12-7.2}{4}} = \sqrt{\frac{4.8}{4}} = \sqrt{1.2}$

= 1.095

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{1.2}{0.489}$

= 4.677

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 4.677 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{115}{21*21} = \frac{115}{441}$$

A = 0.260

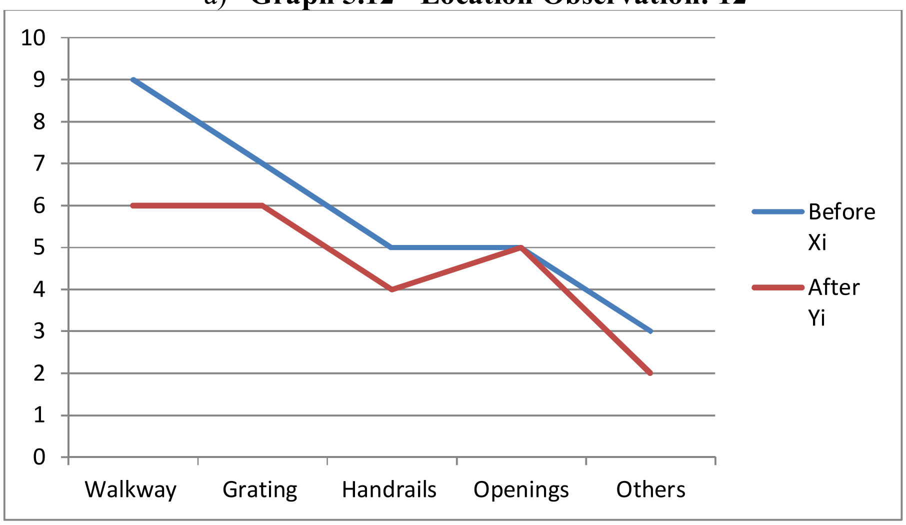
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.304

d) **Result:** The computed value of A , being 0.260, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.12 - Location Observation: 12**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.13 - Location Observation: 13

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i\text{-}Y_i)$	Difference squared D_i^2
1	Erection Methodology	**7**	**3**	4	16
2	Work permit	**10**	**4**	6	36
3	SOP	**4**	**2**	2	4
4	Testing	**5**	**2**	3	9
5	Others	**2**	**1**	1	1
n = 5	**Total**	**28**	**12**	**ΣD_i = 16**	**ΣD_i^2= 66**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{16}{5}$

D = 3.2

b) Degree of freedom = (n-1) = (5-1) = 4

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(66 - 3.2 * 3.2 *5 / 5-1)

$= \sqrt{\frac{66-51.2}{4}} = \sqrt{\frac{14.8}{4}} = \sqrt{3.7}$

= 1.923

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{3.2}{0.860}$

= 3.720

d) Critical Value of t- Statistic as per table (5 %) = 2.776

e) **Result:** The observed value of t is 3.720 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{66}{16*16} = \frac{66}{256}$$

A = 0.257

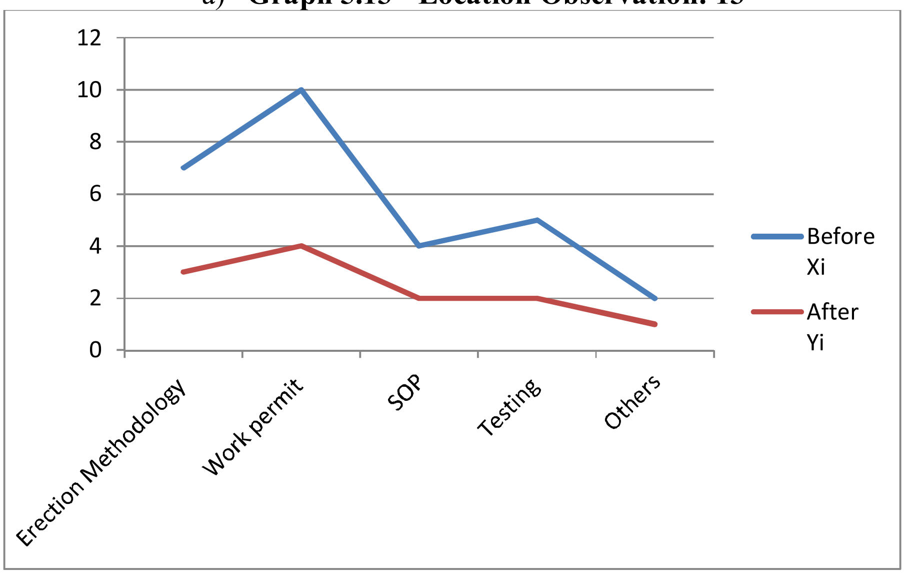
b) Degree of freedom = (n-1) = (5-1) = 4

c) Critical Value of A- Statistic as per table (5 %) = 0.304

d) **Result:** The computed value of A , being 0.257, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.13 - Location Observation: 13**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.14 - Location Observation: 14

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Work in cramped and unnatural position	3	2	1	1
2	Work Permit	5	3	2	4
3	Electrical Supply less than 24V	6	2	4	16
4	Exhaust system	3	1	2	4
5	Worker Health check-up	2	1	1	1
6	Signaling system	2	1	1	1
7	Safety Gadgets	4	1	3	9
8	Others	2	1	1	1
n = 8	**Total**	**27**	**12**	**ΣD_i = 15**	**ΣD_i^2 = 37**

PART A: Solution using t – test

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{15}{8}$

D = 1.875

b) Degree of freedom = (n-1) = (8-1) = 7

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(37 - 1.88 *1.88 *8 / 8-1)

$= \sqrt{\frac{37-28.27}{7}} = \sqrt{1.247}$

= 1.116

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{1.394}{0.394}$

= 3.538

d) Critical Value of t- Statistic as per table (5 %) = 2.365

e) **Result:** The observed value of t is 3.538 which falls in the rejection region and thus, we reject H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{37}{15*15} = \frac{37}{225}$$

A = 0.164

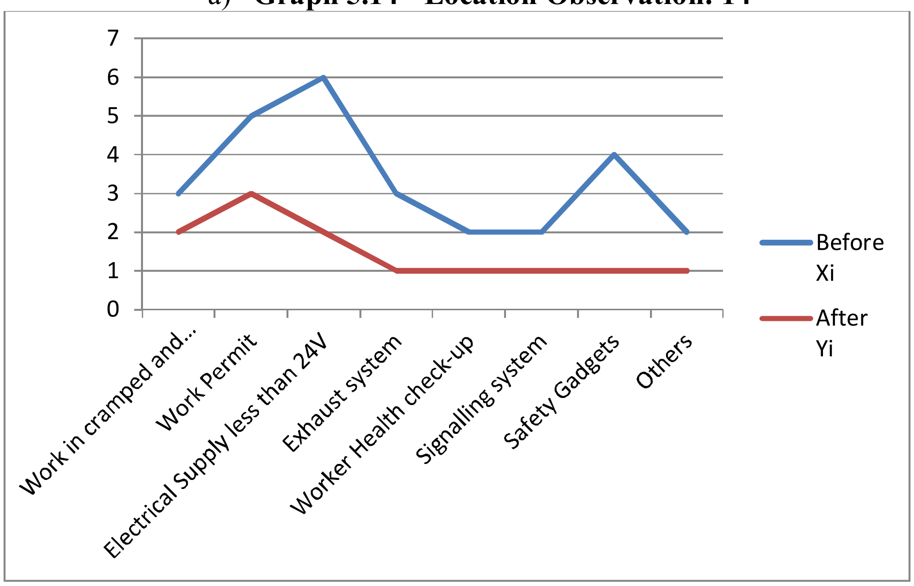
b) Degree of freedom = (n-1) = (8-1) = 7

c) Critical Value of A- Statistic as per table (5 %) = 0.281

d) **Result:** The computed value of A , being 0.164, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.14 - Location Observation: 14**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends.

Table 5.15 - Location Observation: 15

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Eye Protection	9	4	5	25
2	Face Protection	8	5	3	9
3	Head Protection	7	2	5	25
4	Hand Protection	2	1	1	1
5	Body Protection	1	1	0	0
6	Fall Protection	0	0	0	0
n = 6	**Total**	**27**	**13**	**ΣD_i = 14**	**ΣD_i^2 = 60**

PART A: Solution using t – test

a) Mean $\overline{D} = \frac{\sum D_i}{n} = \frac{14}{6}$

D = 2.3333

b) Degree of freedom = (n-1) = (6-1) = 5

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\overline{D})^2 * n}{n-1}}$

σdiff = √(60 - 2.33 *2.33*6 / 6-1)

$= \sqrt{\frac{60-32.573}{5}} = \sqrt{\frac{27.42}{5}} = \sqrt{5.485}$

= 2.342

c) t value $t = \frac{\overline{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{2.333}{0.956}$

= 2.440

d) Critical Value of t- Statistic as per table (5 %) = 2.571

e) **Result:** The observed value of t is 2.440 which falls in the acceptance region and thus, we accept H_O at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been not implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{60}{14*14} = \frac{60}{196}$$

A = 0.306

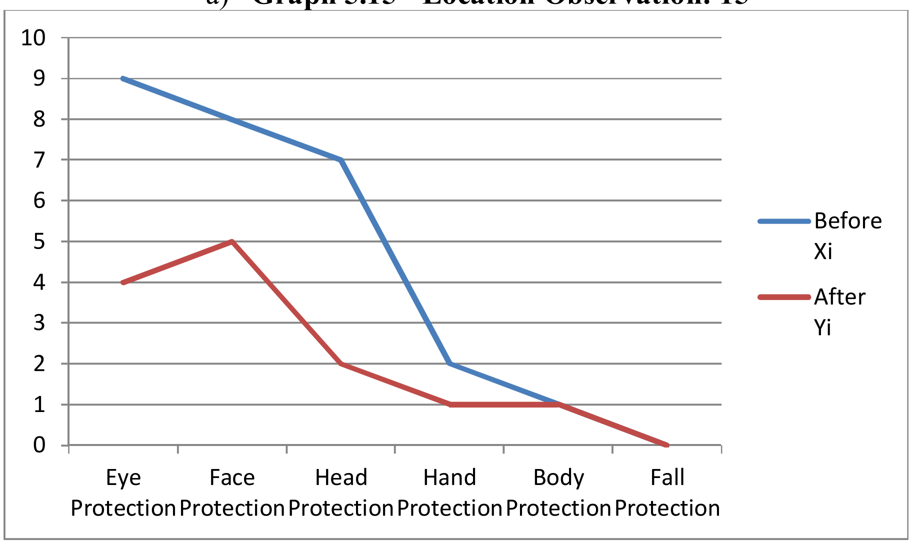
b) Degree of freedom = (n-1) = (6-1) = 5

c) Critical Value of A- Statistic as per table (5 %) = 0.293

d) **Result:** The computed value of A , being 0.306, is more than the table value and such A- statistic is non-significant

PART C: Two Dimensional Graphs

a) **Graph 5.15 - Location Observation: 15**



b) **Result:** Unsafe acts and unsafe condition are in reducing trends but not effective.

Table 5.16 - Location Observation: 16

S No	Safety Shortfalls/ lapses	Before X_i	After Y_i	Difference $D_i = (X_i - Y_i)$	Difference squared D_i^2
1	Use of muffler	9	3	6	36
2	Capacity lading	8	4	4	16
3	Ramp Condition	7	3	4	16
4	Others	3	2	1	1
n = 4	**Total**	**27**	**12**	**ΣD_i = 15**	**ΣD_i^2 = 69**

PART A: **Solution using t – test**

a) Mean $\bar{D} = \frac{\sum D_i}{n} = \frac{15}{4}$

D = 3.75

b) Degree of freedom = (n-1) = (4-1) = 3

Standard Deviation $\sigma_{\text{diff}} = \sqrt{\frac{\sum Di^2 - (\bar{D})^2 * n}{n-1}}$

σdiff = √(69 - 3.75 *3.75 *4 / 4-1)

$= \sqrt{\frac{69-56.25}{3}} = \sqrt{\frac{12.75}{3}} = \sqrt{4.25}$

= 2.061

c) t value $t = \frac{\bar{D}-0}{\sigma_{diff}/\sqrt{n}} = \frac{3.75}{1.030}$

= 3.640

d) Critical Value of t- Statistic as per table (5 %) = 3.182

e) **Result:** The observed value of t is 3.640 which falls in the rejection region and thus, we reject Ho at 5 percent level and concluded that safety objectives for unsafe acts and unsafe conditions have been implemented effectively

PART B: Solution using A – test

a) Solution using A – test

$$A = \frac{\sum Di^2}{\sum (Di)^2} = \frac{69}{15*15} = \frac{69}{225}$$

A = 0.307

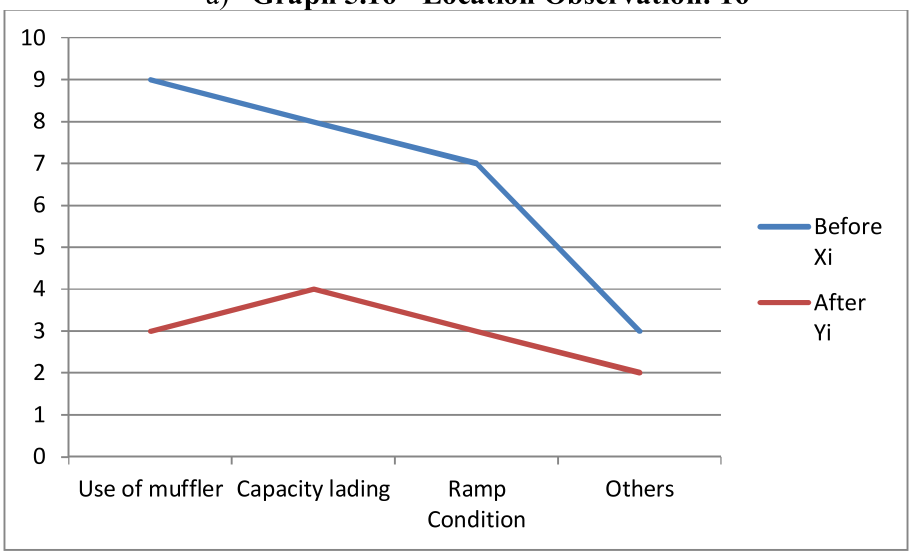
b) Degree of freedom = (n-1) = (4-1) = 3

c) Critical Value of A- Statistic as per table (5 %) = 0.324

d) **Result:** The computed value of A , being 0.307, is less than the table value and such A- statistic is significant

PART C: Two Dimensional Graphs

a) **Graph 5.16 - Location Observation: 16**



Result: Unsafe acts and unsafe condition are in reducing trends.

CHAPTER – 6

CONCLUSION & SUGGESTION

6.1 CONCLUSION BASED ON STUDY: The study carried out and interaction at construction site the workplace safety issues summarized as under:

- The unsafe acts and unsafe conditions is one of the main safety concerns in the construction industry in context workplace construction activities.

- The unsafe acts and unsafe conditions in construction industry is comparatively high as most of the organized factory. In factories they are follows the safety norms as per instructions of factory inspector of labor department.

- Ranking Observation analysis is based on workplace condition and chiefly of value in determining safe work methods and setting job standards that promoting safety, but though this analysis will also bring to light many hazardous conditions not foreseen when the work was not laid down.

- Ranking Observation analysis is very simple method and can be executed at any level of supervision with similar objective and targets. It is effective for implementation of construction safety at work place. It is simple and very effective method to develop understanding at all levels and objective and target would be revised periodically as needed.

- In matrix analysis, the unsafe acts and unsafe conditions the strategy / approach to reduce unsafe acts and unsafe conditions will involve three way approaches:

    - Pre assumed Control Measures.
    - Based on probability and consequences of occurrence of hazards and risk.
    - Integrated Approach (combination of site observation and standards)

- In matrix analysis, the unsafe acts and unsafe conditions workplace reduction include:
    - Optimization of hazards and risk
    - Setting of objectives on personnel capability, sometimes it may be easily achievable.
    - Difficult to measure the site personnel Key Result Area (KRA) and Key Performance Indicator (KPI)
    - No post performance indicator for Matrix Analysis.

- For setting the objectives, the matrix analysis is available for setting the objectives is on based on personnel capability. In this analysis, the objectives are pre-assumed or based on legal requirements. Sometimes objective is to become hypothetical.

- Ranking observation analysis may also implement to in existing safety system organization and without system of safety like mostly construction industry.

- Unsafe acts and unsafe conditions reduction can be achieved very efficiently through ranking observation analysis after setting of objectives and targets.

- The results of implementation of Ranking Observations Analysis have been found to be effective in reduction of unsafe acts and unsafe conditions of workplace construction activities about 63.04 %, which ultimately reduce the unsafe acts and unsafe conditions.

- The first problem is to find the hazards. One these are recognized and apprised, suitable corrective action can be taken by setting the objectives of workplace unsafe acts and/or unsafe conditions.

6.2 OTHER OBSERVATIONS DURING STUDY OF WORKPLACE SAFETY:

- In many construction organizations, safety terms are absent or negligible. The traditional method of safety measures are safety results i.e. the number of accidents, the severity, the frequency rate, and the incident cost.

- The unsafe act and conditions are one of the major workplace safety concerns in construction industries.

- The unsafe acts and conditions at construction site comparatively high as most of the other industry, where more improvement is required.

- The main issues before the Indian construction industry in context of unsafe acts and unsafe condition are –
    - Client and social requirements of safe workplace

- Reduce the unrest of construction site due to any incident cost.
    - Workplace safety protection to reduce the unsafe acts and conditions.

- Safety activities such as training, on-boarding new employees, leadership, supervision, safety meetings, and others, all these can impact the results, but how and how to measure them? The question for such questions is ongoing.

- Participation of workers participate in training or meetings, or serve on safety teams or committees can impact results and can be measured rather easily in terms of committee membership or meeting attendance percentages.

- Worker perceptions or think of safety and how do they perceive the effectiveness of other strategies in helping them avoid accidents. Perceptions impact behaviors and behaviors impact accidents.

- Worker behaviors performance is observable and therefore measurable in workplace toward the safety objectives involving specific precautions. Certain behaviors can be targeted based on unsafe act and unsafe condition of workplace can be measured and trended as a percentage of safe behavior vs. at-risk behavior.

6.3 SUGGESTION OF IMPROVEMENT FOR FUTURE:

- A construction workplace safety specification in contract needs to be revised with regard to pinpointing requirements.
- Construction workplace safety induction trainings by contractors are not very effective. Project Management Consultant /OWNER / Client should have a centralized system of workplace Safety Training/induction on

unsafe acts and unsafe conditions of construction activities for all contractors' employees & workmen.

- Quality of Personnel Protective Equipments and Safety equipments are found inconsistent with quality. There is a tendency of Contractors to save money in this respect. This aspect can be taken care of. If owner can provide all Personnel Protective Equipments & Safety Equipments, which can be specified in the contract.
- Contract Specification should clearly give requirements for deployment of specialized agencies for scaffolding, confined space work, welding & cutting, electrical work with trained & experienced manpower.
- Project Management Consultant /OWNER / Client should deploy sufficient number of qualified / experienced Safety Engineer compatible to legal requirements or specific industry requirement (e.g. one for every thousand of contractors' manpower deployed).
- Minimum requirement of mobilization at site (with respect to Safety personnel) to be clearly defined in contract & should be practiced.

CHAPTER – 7

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Appendix A

Government of India

Ministry of Labour and Employment

NATIONAL POLICY ON SAFETY, HEALTH AND ENVIRONMENT AT WORK PLACE

1. PREAMBLE

1.1 The Constitution of India provide detailed provisions for the rights of the citizens and also lays down the Directive Principles of State Policy which set an aim to which the activities of the state are to be guided.

1.2 These Directive Principles provide

(a) for securing the health and strength of employees, men and women;

b) that the tender age of children are not abused;

c) that citizens are not forced by economic necessity to enter avocations unsuited to their age or strength;

d) just and humane conditions of work and maternity relief are provided; and

e) that the Government shall take steps, by suitable legislation or in any other way, to secure the participation of employee in the management of undertakings, establishments or other organisations engaged in any industry.

1.3 On the basis of these Directive Principles as well as international instruments, Government is committed to regulate all economic activities for management of safety and health risks at workplaces and to provide measures so as to ensure safe and healthy working conditions for every working man and woman in the nation. Government recognizes that safety and health of workers has a positive impact on productivity and economic and social development. Prevention is an integral part of economic activities

as high safety and health standard at work is as important as good business performance for new as well as existing industries.

1.4 The formulation of policy, priorities and strategies in occupational safety, health and environment at work places, is undertaken by national authorities in consultation with social partners for fulfilling such objectives. A critical role is played by the Government and the social partners, professional safety and health organizations in ensuring prevention and in also providing treatment, support and rehabilitation services.

1.5 Government of India firmly believes that without safe, clean environment as well as healthy working conditions, social justice and economic growth cannot be achieved and that safe and healthy working environment is recognized as a fundamental human right. Education, training, consultation and exchange of information and good practices are essential for prevention and promotion of such measures.

1.6 The changing job patterns and working relationships, the rise in self employment, greater sub-contracting, outsourcing of work, homework and the increasing number of employees working away from their establishment, pose problems to management of occupational safety and health risks at workplaces. New safety hazards and health risks will be appearing along with the transfer and adoption of new technologies. In addition, many of the well known conventional hazards will continue to be present at the workplace till the risks arising from exposure to these hazards are brought under adequate control. While advancements in technology have minimized or eliminated some hazards at workplace, new risks can emerge in their place which needs to be addressed.

1.7 Particular attention needs to be paid to the hazardous operations and of employees in risk prone conditions such as migrant employees and various vulnerable groups of employees arising out of greater mobility in the workforce with more people working for a number of employers, either consecutively or simultaneously.

1.8 The increasing use of chemicals, exposure to physical, chemical and biological agents with hazard potential unknown to people; the indiscriminate use of agro-chemicals including pesticides, agricultural machineries and equipment; industries with major accident risks; effects of computer controlled technologies and alarming influence of stress at work in many modern jobs pose serious safety, health and environmental risks.

1.9 The fundamental purpose of this National Policy on Safety, Health and Environment at workplace, is not only to eliminate the incidence of work related injuries, diseases, fatalities, disaster and loss of national assets and ensuring achievement of a high level of occupational safety, health and environment performance through proactive approaches but also to enhance the well-being of the employee and society, at large. The necessary changes in this area will be based on a co-ordinated national effort focused on clear national goals and objectives.

1.10 Every Ministry or Department may work out their detailed policy relevant to their working environment as per the guidelines on the National Policy.

2. GOALS:

The Government firmly believes that building and maintaining national preventive safety and health culture is the need of the hour. With a view to develop such a culture and to improve the safety, health and environment at work place, it is essential to meet the following requirements:-

2.1 providing a statutory framework on Occupational Safety and Health in respect of all sectors of industrial activities including the construction sector, designing suitable control systems of compliance, enforcement and incentives for better compliance.

2.2 providing administrative and technical support services.

2.3. providing a system of incentives to employers and employees to achieve higher health and safety standards .

2.4 providing for a system of non-financial incentives for improvement in safety and health.

2.5. establishing and developing the research and development capability in emerging areas of risk and providing for effective control measures.

2.6. Focusing on prevention strategies and monitoring performance through improved data collection system on work related injuries and diseases.

2.7 Developing and providing required technical manpower and knowledge in the areas of safety, health and environment at workplaces in different sectors.

2.8 Promoting inclusion of safety, health and environment, improvement at workplaces as an important component in other relevant national policy documents.

2.9 Including safety and occupational health as an integral part of every operation.

3. OBJECTIVES:

3.1 The policy seeks to bring the national objectives into focus as a step towards improvement in safety, health and environment at workplace. The objectives are to achieve:-

a) Continuous reduction in the incidence of work related injuries, fatalities, diseases, disasters and loss of national assets.

b) Improved coverage of work related injuries, fatalities and diseases and provide for a more comprehensive data base for facilitating better performance and monitoring.

c) Continuous enhancement of community awareness regarding safety, health and environment at workplace related areas.

d) Continually increasing community expectation of workplace health and safety standards.

e) Improving safety, health and environment at workplace by creation of "green jobs" contributing to sustainable enterprise development.

4. ACTION PROGRAMME

For the purpose of achieving the goals and objectives mentioned in paragraphs 2 and 3 above, the following action programme is drawn up and where necessary time bound action programme would be initiated, namely:-

4.1. Enforcement

4.1.1 by providing an effective enforcement machinery as well as suitable provisions for compensation and rehabilitation of affected persons;

4.1.2 by effectively enforcing all applicable laws and regulations concerning safety, health and environment at workplaces in all economic activities through an adequate and effective labour inspection system;

4.1.3 By establishing suitable schemes for subsidy and provision of loans to enable effective implementation of the policy;

4.1.4 by ensuring that employers, employees and others have separate but complementary responsibilities and rights with respect to achieving safe and healthy working conditions;

4.1.5 by amending expeditiously existing laws relating to safety, health and environment and bring them in line with the relevant international instruments;

4.1.6 by monitoring the adoption of national standards through regulatory authorities;

4.1.7 by facilitating the sharing of best practices and experiences between national and international regulatory authorities;

4.1.8 by developing new and innovative enforcement methods including financial incentives that encourage and ensure improved workplace performance;

4.1.9 by making an enabling legislation on Safety, Health and Environment at Workplaces;

4.1.10 by setting up safety and health committees wherever deemed appropriate;

4.2 National Standards

4.2.1 by developing appropriate standards, codes of practices and manuals on safety, health and environment for uniformity at the national level in all economic activities consistent with international standards and implementation by the stake holders in true spirit;

4.2.2 by ensuring stakeholders awareness of and accessibility to applicable policy, documents, codes, regulations and standards;

4.3 Compliance

4.3.1 by encouraging the appropriate Government to assume the fullest responsibility for the administration and enforcement of occupational safety, health and environment at workplace, provide assistance in identifying their needs and responsibilities in the area of safety, health and environment at workplace, to develop plans and programmes in accordance with the provisions of the applicable Acts and to conduct experimental and demonstration projects in connection therewith;

4.3.2 by calling upon the co-operation of social partners in the supervision of application of legislations and regulations relating to safety, health and environment at work place;

4.3.3 by continuous improvement of Occupational Safety and Health by systems approach to the management of Occupational Safety and Health including developing guidance on Occupational Safety and Health management systems, strengthening voluntary actions, including mechanisms for self-regulatory concept and establishing auditing mechanisms which can test and authenticate occupational safety and health management systems;

4.3.4 by providing specific measures to prevent catastrophes, and to co-ordinate and specify the actions to be taken at different levels, particularly in the industrial zones with high potential risks;

4.3.5 by recognising the best safety and health practices and providing facilitation for their adoption.

4.3.6 by providing adequate penal provisions as deterrent for violation of laws for the time being in force;

4.3.7 by encouraging all concerned to adopt and commit to "Responsible Care" and / or "Corporate Social Responsibility" to improve safety, health and environment at workplace performance;

4.3.8 by ensuring a suitable accreditation machinery to recognise institutions, professionals and services relating to safety, health and environment at workplace for uniformity and greater coverage as also authenticating safe management system;

4.3.9 by encouraging employers to ensure occupational safety and health management systems, establish them in efficient manner to improve workplace safety and health;

4.3.10 by specifically focusing on such occupational diseases like pneumoconiosis and silicosis; developing a framework for its prevention and control as well as develop technical standards and guidelines for the same;

4.3.11 by promoting safe and clean technology and progressively replacing materials hazardous to human health and environment;

4.4 Awareness

4.4.1 by increasing awareness on safety, health and environment at workplace through appropriate means;

4.4.2 by providing forums for consultations with employers' representatives, employees representatives and community on matters of national concern relating to safety, health and environment at work place with the overall objective of creating awareness and enhancing national productivity;

4.4.3 by encouraging joint labour-management efforts to preserve, protect and promote national assets and to eliminate injuries and diseases arising out of employment;

4.4.4 by raising community awareness through structured, audience specific approach;

4.4.5 by continuously evaluating the impact of such awareness and information initiatives;

4.4.6 by maximizing gains from the substantial investment in awareness campaigns by sharing experience and learning;

4.4.7 by suitably incorporating teaching inputs on safety, health and environment at work place in schools, technical, medical, professional and vocational courses and distance education programme;

4.4.8 by securing good liaison arrangements with the International organisations;

4.4.9 by providing medical criteria wherever necessary which will assure insofar as practicable that no employee will suffer diminished health, functional capacity, or life expectancy as a result of his work place activities and that in the event of such occupational diseases having been contracted, is suitably compensated;

4.4.10 by providing practical guidance and encouraging employers and employees in their efforts to reduce the incidence of occupational safety and health risks at their places of employment and to impress upon employers and employees to institute new programmes and to improve existing programmes for providing safe and healthful working conditions, requiring employers to ensure that workers and their representatives are consulted, trained, informed and involved in all measures related to their safety and health at work;

4.5 Research and Development

4.5.1 by providing for research in the field of safety, health and environment at workplace, including the social and psychological factors involved, and by developing innovative methods, techniques including computer aided Risk Assessment Tools, and approaches for dealing with safety, health and environment at workplace problems which will help in establishing standards;

4.5.2 by exploring ways to discover latent diseases, establishing causal connections between diseases and work environmental conditions, updating list of occupational diseases and conducting other research relating to safety, health and environmental problems at workplace;

4.5.3 by establishing research priorities as per national requirements; exploring partnerships and improving communications with various national and international research bodies;

4.5.4 by ensuring a coordinated research approach and an optimal allocation of resources in Occupational Safety and Health sector for such purposes;

4.6 Occupational safety and health skills development

4.6.1 by building upon advances already made through employer and employee initiative for providing safe and healthy working conditions;

4.6.2 by providing for training programmes to increase the number and competence of personnel engaged in the field of occupational safety, health and environment at workplace;

4.6.3 by providing information and advice, in an appropriate manner, to employers and employees organisations, with a view to eliminating hazards or reducing them as far as practicable;.

4.6.4 by establishing occupational health services aimed at protection and promotion of health of employee and improvement of working conditions and by providing employee access to these services in different sectors of economic activities;

4.6.5 by integrating health and safety into vocational, professional and labour related training programmes as also management training including small business practices;

4.6.6 by adopting Occupational Safety and Health training curricula in workplace and industry programmes;

4.7 Data collection

4.7.1 by compiling statistics relating to safety, health and environment at work places, prioritising key issues for action, conducting national studies or surveys or projects through governmental and non-governmental organisations;

4.7.2 by reinforcing and sharing of information and data on national occupational safety, health and environment at work place information amongst different stake holders through a national network system on Occupational Safety and Health;

4.7.3 by extending data coverage relevant to work-related injury and disease, including measures of exposure, and occupational groups that are currently excluded, such as self-employed people;

4.7.4 by extending data systems to allow timely reporting and provision of information;

4.7.5 by developing the means for improved access to information;

4.8 Review

4.8.1 An initial review and analysis shall be carried out to ascertain the current status of safety, health and environment at workplace and building a national Occupational Safety and Health profile.

4.8.2 National Policy and the action programme shall be reviewed at least once in five years or earlier if felt necessary to assess relevance of the national goals and objectives.

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5. Conclusion

5.1 There is a need to develop close involvement of social partners to meet the challenges ahead in the assessment and control of workplace risks by mobilising local resources and extending protection to such working population and vulnerable groups where social protection is not adequate.

5.2 Government stands committed to review the National Policy on Safety, Health and Environment at Workplace and legislations through tripartite consultation, improve enforcement, compilation and analysis of statistics; develop special programmes for hazardous operations and other focus sectors, set up training mechanisms, create nation-wide awareness, arrange for the mobilisation of available resources and expertise.

5.3 The National Policy and programme envisages total commitment and demonstration by all concerned stake holders such as Government and social partners. Our goals and objectives will be that through dedicated and concerted efforts consistent with the requirements of safety, health and environment at work place and thereby improving the quality of work and working life.

Appendix B

ILO CONVENTIONS AND RECOMMENDATIONS

Convention No. & Title	Recommendation No and Title
13. White Lead (Painting)	53. Safety Provision (Building)
27. Marking of weight (Packages transported by Vessels)	79. Medical Examination of young persons
62. Safety Provision (Building)	81. Labour Inspection
73. Medical Examination of Young Persons (Industry)	82. Labour Inspection (Mining and Transport)
78. Medical Examination of Young persons (Non-industrial Occupations)	97. Protection of Workers Health
81. Labour Inspection (Industry)	
113. Medical Examination (Fishermen)	112. Occupational Health Services
115. Radiation Protection	114. Radiation Protection.
119. Guarding of Machinery	118. Guarding of Machinery
120. Hygiene (Commerce and Offices)	120. Hygiene (Commerce and Offices)
121. Employment Injury	121. Employment injury Benefits
124. Medical Examination of Young Persons (Underground Work)	
127. Maximum Weight	128. Maximum Weight
129. Labour Inspection (Agriculture)	133. Labour Inspection (Agriculture)
134. Prevention of Accidents (Seafarers)	142. Prevention of Accidents(Seafarers)
136. Benzene	144. Benzene
139. Occupational Cancer	147. Occupational Cancer
148. Working Environment (Air Pollution, Noise and Vibration)	156. Working Environment (Air Pollution. Noise and Vibration)
152. Occupational Safety and Health (Dock Work)	160. Occupational Safety and Health (Dock Work).

156. Occupational Safety, Health and Working Environment	164. Occupational Safety. Health and Working Environment.

Conventions: A Convention is a legal document regulating some aspects of labour administration, social welfare or human rights. A Convention creates binding obligations by virtue of its ratification by the Member State concerned.

Recommendations: A Recommendation is complementary to a Convention except that it is not subject to ratification.

Appendix C

LIST OF LAWS & REGULATIONS RELATING TO WORKPLACE SAFETY

1. **The Factories Act, 1948 (amended 1987 & 2001) -** An Act to consolidate and amend the law regulating labour in factories
   - State Factory Rules of respective States

2. **The Mines Act, 1952 (amended 1984)** - An Act to amend and consolidate the law relating to the regulation of labour and safety in mines.
   - The Mines Rules, 1955 (amended 1989)
   - The Coal Mines Regulations, 1957
   - The Metallic-ferrous Mines Regulations, 1961
   - The Mines Vocational Rules, 1966
   - The Oil Mines Regulations, 1984 (amended 1996)
   - The Mines Rescue Rules, 1985

3. **The Dock Workers (Safety, Health & Welfare) Act, 1986** - An Act to give effect to the Convention concerning the protection against accidents of workers employed in loading and unloading ships.
   - The Dock Workers (Safety, Health & Welfare) Regulations, 1989

4. **The Indian Boilers Act, 1923 (amended 1986)** – An Act to consolidate and amend the law relating to steam boilers.
   - The Indian Boilers Regulations 1950 (amended 2007)
   - Boilers Rules of respective States

5. **The Building and Other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996** - An Act to regulate the employment and conditions of service of building and other construction

workers and to provide for their safety, health and welfare measures and for other matters connected therewith or incidental thereto.

- The Building and Other Construction Workers (Regulation of Employment & Conditions of Service) Central Rules, 1998

6. The Dangerous Machines (Regulation) Act, 1983 An Act to provide for the regulation of trade and commerce in, and production, supply distribution and use of, the product of any industry producing dangerous machines with a view to securing the welfare of labour, operating any such machine and for payment of compensation for death or bodily injury suffered by any labourer while operating any such a machine, and for matters connected there with or incidental thereto.

- The Dangerous Machines (Regulation) Rules, 1984

7. The Motor Transport Workers Act, 1961 (amended 1986) - An Act to provide for the welfare of motor transport workers and to regulate the conditions of their work

- The Motor Transport Workers Rules, 1964

8. The Plantation Labour Act, 1951 (amended 1982) and Rules there under - An Act to provide for the welfare of labours and to regulate the conditions of work, in plantations.

9. The Beedi & Cigar Workers (Conditions of Employment) Act, 1966 (amended 1993) - An Act to provide for the welfare of the workers in beedi and cigar establishments and to regulate the conditions of their work and for matters connected therewith.

- State Rules of respective states

10. The Shops and Commercial Establishments Acts enacted by respective State Governments.

11. The Explosives Act, 1884 (amended 1983) - An Act to regulate the manufacture, possession, use, sale, transport, import and export of Explosives.

- The Explosives Rules, 1983 (amended 2002)
- The Static and Mobile Pressure Vessels (unfired) Rules, 1981 (amended 2002)
- The Gas Cylinders Rules, 2004 (replaces the Gas Cylinders Rules, 1981)

12. The Petroleum Act, 1934 – An Act to consolidated and amend the law relating to the import, transport, storage, production, refining and blending of petroleum.

- The Petroleum Rules, 2002 (replaces the Petroleum Rules, 1976)
- The Calcium Carbide Rules, 1987
- The Cinematograph Film Rules, 1948

13. The Inflammable Substances Act, 1952 - An Act to declare certain substances to be dangerously inflammable and to provide of the regulation of their import transport, storage and production by applying thereto the Petroleum Act, and the rules there under and for certain matters connected with such regulation.

14. The Oilfields (Regulation and Development) Act, 1948 - An Act to provide for the regulation of oilfields and for the development of mineral oil resources.

- The Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008

15. The Environment Protection Act, 1986 (amended 1991) - An Act to provide for the protection and improvement of environment and matters connected therewith.

- The Environment Protection Rules, 1986 (amended 2006)

- The Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 (amended 2000)
- The Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro Organisms, Genetically Engineered Organisms or Cells, 1989 (amended 2007)
- The Hazardous Wastes (Management, Handling and Tranboundry Movement) Rules, 2008 [in supersession of the Hazardous Wastes (Management & Handling) Rules, 1989]
- The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
- The Bio-medical Waste (Management & Handling) Rules, 1998 (amended 2003)
- The Environment (siting for Industrial Projects) Rules, 1999
- The Recycled Plastics Manufactures and Usage Rules, 1999 (amended 2003)
- The Noise Pollution (Regulation & Control) Rules, 2000 (amended 2002)
- The Ozone Depleting Substances (Regulation & Control) Rules, 2000
- The Municipal Solid Wastes (Management & Handling) Rules, 2000.
- The Batteries (Management & Handling) Rules, 2001.
- The Environmental Impact Assessment Notification, 2006

16. The Water (Prevention & Control of Pollution) Act, 1974 (amended 1988) - An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water; for the establishment with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for cont erring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

- The Water (Prevention & Control of Pollution) Rules, 1975

17. The Water (Prevention & Control of Pollution) Cess Act, 1977 (amended 2003) - An Act to provide for the levy and collection of a cess on water consumed by persons carrying on certain industries and by local authorities, with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974.

- The Water (Prevention & Control of Pollution) Cess Rules, 1978

18. The Air (Prevention & Control of Pollution) Act, 1981 (amended 1987) - An Act to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to car, carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected there with

- The Air (Prevention & Control of Pollution) Rules, 1982

19. The Public Liability Insurance Act, 1991 (amended 1992) - An Act to provide for public liability insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto.

- The Public Liability Insurance Rules, 1991 (amended 1993)

20. The Motor Vehicles Act, 1988 (amended 2001) – An Act to consolidate and amend the law relating to motor vehicles

- The Central Motor Vehicles Rules, 1989 (amended 2006) and Motor Vehicles Rules of respective States

21. The Atomic Energy Act, 1962 (amended 1987) - An Act to provide for the development control and use of atomic energy for the welfare of the people of India and for other peaceful purposes and for matters connected therewith.

- The Atomic Energy (Radiation Protection) Rules, 2004 (replaces Radiation Protection Rules, 1971)

- The Atomic Energy (Working of Mines, Minerals and handling of Prescribed Substances) Rules, 1984
- The Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987
- The Atomic Energy (Control of Food Irradiation) Rules, 1996
- The Atomic Energy (Factories) Rules, 1996

22. The Insecticides Act, 1968 (amended 2000)— An Act to regulate the import, manufacture, sale, transport, distribution and use of insecticides with a view to prevent risk to human beings or animals, and for matters connected therewith.

- The Insecticides Rules, 1991 (amended 1999)

23. The Electricity Act, 2003 (replaces The Indian Electricity Act, 1910) - An Act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto.

- The Indian Electricity Rules, 1956 (amended 2002)

24. The Energy Conservation Act, 2001 - An Act to provide for efficient use of energy and its conservation and for matters connected there with or incidental thereto.

25. The Disaster Management Act, 2005- An Act provides for the effective management of disasters and for matters connected therewith or incident thereto.

Appendix D

List of Indian Standards on Safety & Health

General

IS 3646: 1992 Part 1	Code of practice for interior illumination- General Requirements and recommendations for welding interiors.
IS 3646: 1966 Part 2	Code of practice for interior illumination - Schedule for values of illumination and glare index
IS 3646: 1968 Part 3	Code of practice for interior illumination - Calculation of coefficients of utilization by the BZ method.
IS 3786: 1983	Methods for computation of frequency and severity rates for industrial injuries and classification industrial accidents.
IS 5182:	Methods for Measurement of Air Pollution
Part 1 to 21	
IS8095:1976	Specification for Accident Prevention Tags
IS8990: 1978	Code of practice for maintenance and care of industrial safety clothings
IS 9457: 1980	Safety colours and safety signs
IS 11972: 1987	Code of practice for safety precautions to be taken when entering a sewerage system
IS14489: 1998	Code of practice on occupational safety and health audit
IS14624:1998	Safety of laser products:
Part 2	Safety of optical fibre communication system
IS 15296: 2003	Industrial Automation Systems - Safety of Integrated Manufacturing Systems - Basic Requirements
IS 15551:2003	Quality Management System - Guidelines for Process Improvements in Health Service Organisations
IS 18001:2000	Occupational Health and Safety Management Systems - Specification with Guidance for Use
SP 53: 1992	Hand operated hand tools - Safety code for the use, care and protection
IS/ISO/IEC: GUIDE 51	Guidelines for the Inclusion of Safety Aspects in Standards 1990

Machinery/Operations	
IS 659: 1964	Safety code for air conditioning (revised)
IS 818:1968	Code of Practice for Safety and Health Requirements in Electric and Gas Welding and Cuffing Operations
IS 1991:1988 Part 4	Safety requirements for the use, care and protection of abrasive grinding wheels: Safety guards
IS 2825: 1969	Code of unfired pressure vessels
IS 3233: 1965	Glossary of terms for safety and relief valves and their parts
IS 3483:1965	Code of practice for noise reduction in industrial buildings
IS 5903:1970	Recommendations for safety devices for gas cylinders
IS 6044:2000 Part 1	Code of Practice for Liquefied Petroleum Gas Storage Installations - Part 1 : Commercial and Industrial Cylinder Installations
IS 7155: Part l to8	Code of recommended practice for conveyor safety
IS 71 94: 1994	Assessment of Noise Exposure During Work for Hearing Conservation Purpose
IS 8089: 1976	Code of Safe practice for layout of outside facilities in an industrial plant
IS 8091 : 1976	Code of safe practice for industrial plant layout
IS 8216: 1976	Guide for inspection of lift wire ropes
IS 8235 : 1976	Guide for safety Procedures in Hand Operated Hand Tools
IS 8324 : 1988	Code of Practice for Safe use and Maintenance on Non-calibrated Round Steel Link Lifting Chains and Chin Slings
IS 8433: 1984	Code of practice for visual inspection of dissolved acetylene gas cylinders
IS 9020 : 2002	Power Threshers - Safety Requirements
IS 9474 : 1980	Specification for Principles of Mechanical Guarding of Machinery
IS 10553: 1983	Requirements for chlorination equipment:
Part I	General guidelines for chlorination plants including handling, storage and safety of chlorine cylinders and drums
IS 10224: 1982	Ergonomic principles in the design of work systems
IS 11006 : 1984	Specification for Flash Back Arrestor (Flame Arrestor)

IS11016:1984	General safety requirements for machine tools and their Operation
IS11461 :1985	Code of practice for compressor safety
IS 12735 : 1994	Wire rope slings - Safety criteria and inspection procedures for use
IS 13367 : 1992 Part 1	Safe use of cranes - Code of practice - General
IS 13583 : 1993 Part 1	Cranes - Training of drivers: General.
IS 14817 : 2004	Mechanical Vibration - Evaluation of Machine
Part 2	Vibration by Measurements on Non-Rotating Parts - Large Land-Based Steam Turbine Generator Sets in Excess of 50 MW
IS 14817: 2004	Mechanical Vibration - Evaluation of Machine
Part 4	Vibration by Measurements on Non-Rotating Parts - Gas Turbines Driven sets Excluding Aircraft Derivatives
Electrical and Electronics	
IS 818:1968	Code of Practice for Safety and Health requirements in Electric and Gas Welding and Cutting Operations
IS 2148:2004	Electrical Apparatus for Explosive Gas Atmosphere - Flameproof Enclosures "d"
IS 2309: 1989	Code of practice for the protection of buildings and allied structures against lightning
IS 3043: 1987	Code of practice for earthing
IS 4691 : 1985	Degrees of protection provided by enclosure for rotating electrical machinery
IS 5216: 1982 Part I	Recommendations on Safety Procedures and Practices in Electrical Work - General
IS 5216: 1982 Part II	Recommendation on Safety Procedures and Practices in Electrical Work - Life Saving Techniques
IS 5424: 1969	Specification for rubber mats for electrical purpose
IS 5571 : 2000	Guide for Selection of Electrical Equipment for Hazardous Areas
IS 5572: 1994	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation

IS 5780:2002	Electrical Apparatus for Explosive Gas Atmospheres - Intrinsic Safety "i" - Specification
IS 6381:2004	Electrical Apparatus for Explosive Gas Atmospheres - Increased Safety "e"
IS 6539:1972	Specification for Intrinsically Safe Magneto Telephones for Use in Hazardous Atmospheres
IS 7577: 1986	Specification for Gas Testing Flame Safety Lamps
IS 7724: 1975	Specification for Sand-Filled Protection of Electrical Equipment for Use in Explosive Atmospheres
IS 7689:1989	Guide for the control of undesirable static electricity
IS 7820:2004	Electrical Apparatus for Explosive Gas Atmospheres Method of Test for Ignition Temperature
IS 8239: 1976	Classification of maximum surface temperatures of electrical equipment for use in explosive atmospheres
IS 8607: 1983 Part 5	General and Safety Requirements for Electrical Equipment Used in Medical Practice - Protection Against Explosion Hazards
IS 8923: 1978	Warning symbol for dangerous voltages
IS 8945: 1987	Electrical measuring instruments for explosive gas atmospheres
IS 9249: 1979 Part 1	Safety requirements for indicating and recording electrical measuring instruments and their accessories: Common safety requirements for instruments
IS 9249: 1982 Part 2	Safety requirements for indicating and recording electrical measuring Instruments and their accessories: Safety requirements for instruments using a mains supply
IS 9835:2001	Series Capacitors for Power Systems -General Performance, Testing and Rating - Safety Requirements - Guide for Installation
IS 11000:1988 Part 1	Fire hazard testing: - Guidance for the preparation of requirements and test specifications for assessing fire hazard of electronic and electrical items, Sec 1 - General guidance
IS 11005: 1984	Dust tight ignition proof enclosures of electrical equipment
IS 11713:1986 Part 1	Guide for physical planning of computer complexes: - Layouts
IS 11743: 1986	Guide on Human Safety in Design, Manufacture, Use and Maintenance of Electronic Equipment

IS 12459: 1988	Code of Practice for Fire Safety in Cable Runs
IS 13925: 1998 Part 1	Shunt capacitors for ac power systems having a rated voltage above 1000 V - General performance, testing and rating safety requirements - Guide for installation and operation
IS 13947: Parts : Sec 2	Low-Voltage Switchgear and Control gear - Specification - Control Circuit 2004 Devices and Switching Elements - Section 2 : Proximity Switches
IS 14231:1995 Part 1	Cabled Distribution Systems for Television and Sound Signals - Specification - Safety Requirements
IS 14989 : 2001	Recommended Practices for Seismic Qualification of Electrical Equipment of the Safety System for Nuclear Generating Stations
IS 15111 :2002	Self Ballasted Lamps for General Lighting Services—Safety Requirements
IS 15451 :2004	Electrical Apparatus for Explosive Gas Atmospheres - Encapsulation “m”
Transportation	
IS 4357: 1974	Methods for stability testing of forklift trucks
IS 6305: 1980Part 1&2	Safety code for powered industrial trucks,
IS 7155 Part 1 to 8	Code of recommended practice for conveyor safety
IS 7631 :1993	Pallets stackers and high lift platform trucks - Method of stability tests
IS 7862:1975	Glossary of terms relating to safety aspects concerning operating areas of industrial Trucks
IS 9618: 1980	Specification for Road Tankers for Liquefied Petroleum Gas
IS 10311: 1982	General requirements of powered platform trucks and their acceptance criteria
IS 10312:1982	Safety code for powered tow trucks
IS 12009:1995	Automotive Vehicle - Safety Requirements for Side Door of Passenger Cars - Recommendations
IS 12056: 1987	Recommendations for safety requirements for fuel tank assembly of automotive vehicles
IS 13944:1994	Automotive vehicles - Window retention and release systems for buses - Safety requirements

IS 13971: 1994 Part 1	Rough terrain fork lift trucks - Code of practice for safety - Application, operation and maintenance
IS 13971: 1994 Part 2	Rough terrain fork lift trucks - Code of practice for safety - General requirements
IS 14283:1995	Automotive Vehicles - Accelerator Control Systems-Safety Requirements
IS 14665:2000 Part 1	Electric Traction Lifts - Guidelines for Outline Dimensions of Passenger, Goods, Service and Hospital Lifts
IS 15139 : 2002	Automotive Vehicles - Safety Belt Anchorages -Specification
IS 15140:2003	Automotive Vehicles - Safety Belt Assembly - Specification
Civil Engineering Construction	
IS 875:1987 Part 1	Code of practice for design loads (other than earthquake)for buildings and structures Dead Loads-Unit weights of building material and stored materials (Incorporating IS 1911 : 1967)
IS 1905: 1987	Code of Practice for Structural use of Unreinforced Masonry
IS 2750:1964	Specification for Steel Scaffoldings
IS 3696:1991 Part 2	Scaffolds and Ladders - Code of Safety - Ladders
IS 3764:1992	Code of safety, for excavation work
IS 4014: 1967 Part 2	Code of Practice for Steel Tubular Scaffolding - Safety Regulations for Scaffolding
IS 4081 :1986	Safety code for blasting and related drilling operations
IS 4082 :1996	Recommendations on stacking and storage of construction materials and components at site
IS 4130:1991	Safety code for demolition of buildings
IS 4138: 1977	Safety code for tunneling work
IS 4912:1978	Safety Requirements for Floor and Wall Openings, Railings and Toe Boards
IS 5121:1969	Safety code for piling and other deep foundations
IS 5916: 1970	Safety code for construction involving use of hot bituminous materials
IS 6609:1972 Part 5	Methods of test for commercial blasting explosives and accessories; Part V Safety fuses
IS 6922:1973	Criteria for safety and design of structures subject to

	underground blasts
IS 7205: 1974	Safety Code for Erection of Structural Steelwork
IS 7293:1974	Safety code for working with construction machinery
IS 7323:1994	Operation of reservoirs— Guidelines
IS 7969:1975	Safety code for handling and storage of building materials
IS 8989: 1978	Safety code for erection of concrete framed structures
IS 9706: 1997	Aerial Ropeways for Transport of Material - Code of Practice for Design and Construction
IS 9759: 1981	Guidelines for de-watering during construction
IS 9944:1992	Natural and man-made fibre rope-slings - Recommendations on safe working loads
IS 10291 : 1982	Safety code for dress divers in civil engineering works
IS 10386:1992 Part 4	Construction, Operation and Maintenance of River Valley Projects - Safety Code - Part 4: Handling, Storage and Transportation of Explosives
IS 10386:1993 Part 7	Safety code for construction, operation and maintenance of river valley projects - Fire safety aspects
IS 10386 :1983 Part 10	Safety code for construction, operation and maintenance of river valley projects - Storage, handling, detection and safety measures for gases, chemicals and flammable liquids
IS 11972: 1987	Code of practice for safety precautions to be taken when entering a sewerage system
IS 13063: 1991	Code of practice for structural safety of buildings on shallow foundations on rocks
IS 13415: 1992	Protective Barriers in and Around Buildings - Code of Safety
IS 13416:1992 Part 1	Recommendations for preventive measures against hazards at workplaces - Falling material hazards prevention
IS 13430: 1992	Code of practice for safety during additional construction and alteration to existing buildings
IS 14734:1999	Balancing Machines - Enclosures and Other Safety Measures
SP 70 : 2001	Handbook on Construction Safety Practices
Chemicals and other Hazardous Materials	
IS 1260 : 1973 Part 1	Pictorial marking for handling and labelling of goods - dangerous goods

IS 1446 : 2002	Classification of Dangerous Goods
IS 2379:1990	Colour code for identification of pipe lines
IS 4015 : 1998	Guide for Handling Cases of Pesticide Poisoning
IS 4155 : 1966	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals
IS 4209 : 1987	Code of Safety in Chemical Laboratories
IS 11451: 1986	Recommendations for Safety and Health Requirements Relating to Occupational Exposure to Asbestos
IS 11457 : 1985 Part 1	Code of practice for fire safety of chemical industries: Rubber and plastic
Fire Protection	
IS 1641 :1988	Code of practice for fire safety of buildings (general): General principles of fire grading and classification
IS 1642 : 1989	Code of practice for fire safety of buildings (general): Details of construction
IS 1643 : 1988	Code of practice for fire safety of buildings (general): Exposure hazard
IS 1644 : 1988	Code of practice for fire safety of buildings (general): Exit requirements and personal hazard
IS 1645:1960	Code of practice for fire safety of buildings
IS 1646 : 1997	Code of practice for tire safety of buildings (general): Electrical installations
IS 1647: 1960	Code of practice for fire safety of buildings
IS 1648 : 1961	Code of practice for fire safety of buildings (general): Fire fighting equipment and its maintenance
IS 2189 : 1999	Selection, Installation and Maintenance of Automatic Fire Detection and Alarm System Code of Practice
IS 2190 : 1992	Selection, Installation and Maintenance of First- aid Fire Extinguishers - Code of Practice
IS 2406 : 1963	Code of practice for fire safety of non-industrial buildings
IS 2726 : 1988	Code of practice for fire safety of industrial buildings: Cotton ginning and pressing (including cotton seed delintering) factories
IS 3016 : 1982	Code of practice for fire precautions in welding and cutting operations

IS 3034 : 1993	Fire Safety of Industrial Buildings: Electrical Generating and Distributing Stations - Code of Practice
IS 3594 : 1991	Code of practice for fire safety of industrial buildings: General storage and warehousing including cold storage
IS 5896 : 1970 Part 1	Code of Practice for Selection, Operation and Maintenance of Special Fire Fighting Appliance - Combined Foam and Co Crash Tender
IS 6382 : 1984	Code of Practice for Design and Installation of Fixed Carbon Dioxide Fire Extinguishing System
IS 8757 : 1999	Glossary of Terms Associated with Fire Safety
IS 9668 : 1990	Code of practice for provision and maintenance of water supplies and fire fighting
IS 11460 : 1985	Code of Practice for Fire Safety of Libraries and Archives
IS 12456 : 1988	Code of practice for fire protection of electronic data processing installation
IS 13716:1993	Code of practice for fire safety of hotels
IS 14435:1997	Code of practice for fire safety in educational institutions
IS 14850: 2000	Fire Safety of Museums - Code of Practice
IS 15394:2003	Fire Safety in Petroleum Refineries and Fertilizer Plants - Code of Practice
Personal Protection	
Body	
IS 3521:1999	Industrial safety belts and harnesses - Specification
IS 4501 :1981	Specification for Aprons, Rubberized, Acid and Alkali Resistant
IS 6153 : 1971	Specification for Protective Leather Clothing
IS 7352 : 1974	Specification for X-ray Lead-rubber Protective Aprons
IS 8519 : 1977	Guide for selection of industrial safety equipment for body protection
IS 8990 : 1978	Code of practice for maintenance and care of industrial safety clothing
Ears	
IS 6229 : 1980	Method for Measurement of Real-ear Protection of Hearing Protectors and Physical Attenuation of Earmuffs
IS 8520 : 1977	Guide for selection of industrial safety equipment for eye, face

	and ear protection
IS 9167 : 1979	Specification for ear protectors
Eye and Face	
IS 1179: 1967	Equipment for eye and face protection during welding
IS 5983: 1980	Eye-protectors
IS 7524: 1980 Part 1	Methods of test for eye protectors: Non-optical tests
158521 :1977 Part 1	Industrial safety face shields - With plastic visor
IS 8521: 1994 Part 2	Industrial safety face-shields : - With wire mesh visor
IS 8940: 1978	Code of practice for maintenance and care of industrial safety equipment for eyes and face protection
IS 9973 : 1981	Specification for visor for scooter helmets
IS 9995 : 1981	Specification for visor for non-metal police and firemen's helmets
IS 14352:1996	Miners safety goggles - Specification
Feet and Legs	
IS 1989:1986 Part 1	Specification for Leather Safety Boots and Shoes - For Miners
IS 1989 : 1986 Part 2	Specification for Leather Safety Boots and Shoes - For Heavy Metal Industries
IS 3737 : 1966	Leather safety boots for workers in heavy metal industries
IS 3738 : 1998	Rubber boots - Specification
IS 3976 : 2003	Protective Rubber Canvas Boots for Miners - Specification
IS 4128 : 1980	Specification for Fireman's Leather Boots
IS 5557 : 1999	Safety Rubber Boots - Specification
IS 5852 : 1996	Protective steel toe caps for footwear - Specification
IS 6519 : 1971	Code of practice for selection, care and repair of safety footwear
IS 7329 : 1974	Metal last for safety rubber canvas ankle boots
IS 10348 : 1982	Safety footwear for steel plan
IS 10665: 1982	Safety rubber ankle boots for miners
IS 10667: 1983	Guide for selection for industrial safety equipment for protection of foot and leg

IS 11225:1985	Leather safety shoes for women workers in mines and steel plants
IS 11226:1993	Leather safety footwear having direct moulded rubber sole - Specification
IS 11264:1985	Code of practice for manufacture of safety rubber footwear for miners
IS 13295:1992	Code of practice for manufacture of leather safety boots and shoes for workers in mines and heavy metal industry
IS 14544:1998	Leather safety footwear with direct moulded PVC soles - Specification
IS 15298:2002 Part 2	Safety, Protective and Occupational Footwear for Professional use - Specification for Safety Footwear
Hands	
IS 2573:1986	Specification for Leather Gauntlets and Mittens
IS 4770: 1991	Rubber Gloves - Electrical Purposes - Specification
IS 6994 : 1973 Part 1	Specification for safety gloves - Leather and Cotton Gloves
IS 8807 : 1978	Guide for selection of industrial safety equipment for protection of arms and hands
Head	
IS 2745 : 1983	Specification for Non-Metal Helmet for Firemen and Civil Defence Personnel
IS 2925 : 1984	Specification for Industrial Safety Helmets
IS 4151: 1993	Specification for protective helmets for scooter and motorcycle riders
Respiratory	
IS 8318: 1977	Colour identification markings for air purifying canisters and cartridges
IS 8347:1977	Glossary of Terms Relating to Respiratory Protective Devices
IS 8522 : 1977	Respirators, chemical cartridge
IS 8523 : 1977	Respirators, canister type (gas masks)
IS 9473 : 2002	Respiratory Protective Devices - Filtering Half Masks to Protect Against Particles — Specification
IS 9563 :1980	Carbon monoxide filter self-rescuers
IS 9623 : 1980	Recommendations for the selection, use and maintenance of

	respiratory protective devices
IS 10245:Part 1 to 46	Breathing apparatus
IS 15322 : 2003	Particle Filters Used in Respiratory Protective Equipment - Specification
IS 15323:2003	Gas Filters and Combined Filters Used in Respiratory Protective Equipment - Specification
Other	
IS 5424 : 1969	Specification for rubber mats for electrical purpose
IS 6685 : 1972	Specification for Life .Jackets
IS 10592 : 1982	Specification for industrial emergency showers, eye and face fountains and combination units
IS 11057 : 1984	Specification for Industrial Safety Nets
IS 12078:1987	Recommendations for personal protection of workers engaged in handling asbestos
IS 302 : 1979 Part 1	General and Safety Requirements for Household and Similar Electrical Appliances
IS 616:2003	Audio, Video and Similar Electronic Apparatus - Safety Requirements
IS 1301: 1958	Code of safety requirements for electronic mains- operated audio amplifiers (incorporated in IS 616)
IS 2347: 1995	Domestic Pressure Cookers - Specification
IS 4011: 1997	Methods of test for safety evaluation of cosmetics
IS 4246: 2002	Domestic Gas Stoves for use with Liquefied Petroleum Gases - Specification [Fifth Revision]
IS 4798: 1968	Specification for Safety Pins
IS 7370 :1974	Specification for Razors Safety
IS 7371 :1982	Stainless steel safety razor blades
IS 9849 :1981	Guide for selection of toys for different age groups of children
IS 9873: Part 1 to 3	Safety Requirements for Toys
IS 10198 : 1982	Specification for Carbon Steel, Safety Razor Blades
IS 10373: 1982	Plastic boxes for safety matches

IS 10374: 1982	Wooden splints for safety matches
IS 12011: 1987	Code of safety practice for domestic LPG installation
IS 12155 : 1987	General and safety requirements for fans and regulators for household and similar purposes
Other Areas	
IS 6074 : 1971	Code for Functional Requirements of Hotels, Restaurants and Other Food Service Establishments
IS 10422: 1982	Requirement and test methods for safety of data processing equipment
IS 11713: 1986 Part 2	Guide for physical planning of computer complexes: - Safety
IS 12619:1989	Printing industry - Safety code
IS 13252 : 2003	Information Technology Equipment - Safety - General Requirements
IS 14530 : 1998	Manipulating industrial robots - Safety
IS 14624:1998 Part 2	Safety of laser products: - Safety of optical fibre communication system
IS 15296 : 2003	Industrial Automation Systems - Safety of Integrated Manufacturing Systems - Basic Requirements
IS 15398 : 2003	Software for Computers in the Safety Systems of Nuclear and Radiation Facilities
IS 15399 : 2003	Hardware for Computers in the Safety System of Nuclear and Radiation Facilities
IS 15442 : 2004	Parameters for Environmental Impact Assessment of Water Resources Projects
IS 15492 : 2004	Code of Recommended Practice for Safety in Water Parks (Part 1 to 3)

APPENDIX E

CONSTRUCTION WORKPLACE STUDY – OBSERVATIONS

S No	Unsafe Acts & Unsafe Conditions Observations
1.	One section of scaffold was found supported on scaffolding pipe instead of channel over the excavated pit. Also two of the scaffolding leg was found lying in air. **(Example: Safety Lapses - Scaffolding)**
2.	One of the distribution board was found charged with 2 core cable.
3.	Two workers of your subcontractor (M/s [redacted]) were found engaged in insulation (outer) of tank very unsafely sitting on scaffolding pipe. No platform with double scaffolding had been provided.
4.	One worker was found working by standing on oil drum, he was anchoring existing brick wall of cable tray structure
5.	Most of the electrical connections were found given by two core cable. **(Example: Safety Lapses - Electrical)**
6.	Connection of welding cable was found done directly without lugs.
7.	Rugs made of re-bars welded at support (lifting) of SS flue cane was being used for access the same to be provided with another safe access with provision of fall arrestor. **(Example: Safety Lapses - Electrical)**
8.	One of the halogen lamp was found connected with 2 core cable & its protective glass was also broken.
9.	Approx 2-5 meters deep excavation was found done vertically out without any provision of slope step cutting. More over loose soil, bricks, scrap steel was observed kept just at the edges.
10.	No means at access was provided while no peripheral hard barricading had been done to restrict other workers.
11.	One of the DG set was found with following lapses: - • Heavy oil leakage • No standby fire fighting equipments available inside shed i.e. fire extinguisher, sand bucket.

	• Earthing not done properly. It was found provided with thin GI wire, whereas in electrical panel no earthing was given. • Rotating parts of DG set were left unguarded/unprotected • Shock treatment chart / electrician name / danger sign has not been displayed.
12.	No emergency escape route is available due to nos. of excavations, structural material too were found dumped at many places leaving no space for free movement of workers. Excavated earth kept at the edges probably for chance of slipping into the pit.
13.	03 workers were found working by standing on scaffolding pipe, no platform provided.
14.	One worker was found working at top of the stack, incomplete scaffolding & anchoring of safety harness was also not observed.
15.	One worker was found accessing very unsafely from above incomplete bridge.
16.	Welding job was under progress in boiler feed pump (piping) but none of them were found using safety harness. However temporary platform with scaffolding jali's had been provided but nos. of gaps were found between them.
17.	04 nos. of grinding machines were found being used. Nos. of temporary joints without plug top.
18.	02 core cable was being used in halogen lamp.
19.	Openings were found at 4^{th} floor which had not been barricaded with permanent/temporary guardrail.
20.	Openings were found also workers were found working near it & near open ended portions.
21.	02 workers were found working over the duct without any fall protection.
22.	One number of the man basket was being lifted with the help of winch machine. No TPI was available.
23.	Manual surface finishing job was being carried out by 02 workers with the help of man baskets/winch arrangement. Till date no arrangement

	of manual locking system has been done, this point was also highlighted in job procedure/plan for painting of chimney but it has not been incorporated yet.
24.	Some openings were found without covering /barricading workers are often seen working near the edges.
25.	06 workers were found working over temporary structure but no ladder were found also no anchor points were available due to which non of them were found anchoring their safety harness.
26.	Roof sheeting work was observed under progress following lapses were found: - a. Workers were not anchoring their safety harness. b. Safety nets were found tied but actual location from where worker may probably fall, was not guarded.
27.	Sub-standard access made by scaffolding pipe was provided to workers.
28.	Nos. of jacks were found provided at base (which must be provided at top) most of them were found worn out and may damage due to impact of load during concreting.
29.	No guardrail was provided while approx 08 workers were found working at top.
30.	All the workers were found working without full body harness.
31.	One handicapped worker Mr. Bablu was found working at approx -12 meters height for stone cladding work .He was found working without safety harness & no ladder was also observed due to which he was observed coming down through scaffolding pipes.
32.	One worker (Mr. Muniruddin) was found working at height without full body harness. While other workers harness was found without hooks.
33.	Substandard fire retardant cloth was found again being used.
34.	Approximate 18 workers were found working at first floor of staircase but no guardrail was provided around the peripheral floor.
35.	04 UB workers were found accessing very unsafely through pipes and

	beams without any fall protection. No adequate ladders/fall arrestor/lifeline provided.
36.	07 workers were found working without safety induction card.
37.	Unsafe ladder made by scaffolding pipe with invariant spacing was being used by worker.
38.	Substandard safety harness was being used.
39.	Nos. of openings were found which were neither covered not barricaded.
40.	Substandard junction box was being used and cables were found routed without glands.
41.	Two core cables were found being used.
42.	Poor housekeeping was observed. Welding bits , angle scrap, M.S. scrap etc. were found in abundant. No dustbin was provided for keeping these materials.
43.	One of the handrails was found badly damaged & was tied very loosely by a thin dia rope.
44.	One of the valve was found hanging very unsafely through web sling attached on wooden batten (sling/chain pulley arrangement)
45.	One of the above chain pulley's hook was found without safety latch.
46.	03 workers of M/s [redacted] erectors were found working near the edges of GTG @ 5 meters elevation. No temporary/permanent guardrails were provided.
47.	One of the grinding machines was found energized by 2 core cable.
48.	03 workers were engaged in pipe/elbow fitting but ladder provided to them was not properly laid, as it was found creating obstruction with some parts of transformer.
49.	Under cutting was noticed below concrete manhole.
50.	No fire extinguisher was found kept at any locations. Where the panels are covered by cloth .
51.	Poor housekeeping was observed all around including no proper access to workplace. Numbers of electrical cables too were found routed along with the access.

52.	One LPG cylinder was found being used for gas cutting also no flash back arrestor was provided at torch end.
53.	02 underage workers (Mr. Anil & Mr. Tapos) were found engaged in curing work.
54.	Gas cutting operator along with two other workers were found engaged in gas cutting work at edge of F. O. Shed without anchoring of safety harness.
55.	Repeated use of substandard fire retardant cloth.
56.	Unsafe storing of diesel, fire extinguisher kept was not having inspection tag.
57.	No proper access to enter inside the pit.
58.	Numbers of pipes are kept loose at elevated structure without anchoring.
59.	Hydra ([redacted]) was found engaged in unloading of structural materials from tractor trailer. Following shortfalls were noticed- a) Test certificate was not available with operator. b) Web sling being used was found completely damaged. c) Tagline was not being used to control adverent movement. d) Rigger & his supervisor were found working at site without minimum PPE's.
60.	Pipes have been loaded over the structure without completing the welding. Even top moment connection plate of moment connection beam at EL-105.175 at grid 26B is also missing.
61.	Staircase is resting on tack welding. Grating on landings are missing, still staircase is being used by labors for access.
62.	Minor fire was caught in insulation of welding cable as damaged welding holder was found used in place of clamps.
63.	Welding cables were laid very haphazardly all among the booth & surrounding area.
64.	Three temporary joints were found in a power cable, passing through ground between HRSG-1 & 2.
65.	No fire extinguisher/shock treatment chart was available inside the

	booth.
66.	RCCB was found being used in place of ELCB.
67.	Nos. of electrical equipments were found being used without three pin tape.
68.	Mr. Rajesh Yadav, supervisor M/s [redacted] gate pass no. 117960 was found at height without safety harness.
69.	Pipes have been loaded over the structure without completing the welding. Even top moment connection plate of moment connection beam at EL-105.175 at grid 26B is also missing.
70.	Staircase is resting on tack welding. Grating on landings are missing, still staircase is being used by labors for access.
71.	Find enclosed photographs of workers working just near/at the edge without any fall protection nos. of them were also working above the duct at UB-01 & the same has been intimated to M/s [redacted] personal time to time.
72.	One crane (HR-[redacted]) was found working at site without proper TPI.
73.	Workers engaged in pipe lifting were found not working their lanyard of safety harness to any appropriate means.
74.	Lifeline was not provided in adequate nos. as per the movement (horizontal) over the pipe rack.
75.	No proper access was provided as one of the worker was found accessing through pipe. Also they were using incomplete staircase (however, handrail fixing was found under progress)
76.	No approach was found provided to reach at tank-farm area as it was obstructed by excavation, debris and piping material.
77.	Number of excavations have have been done and excavated earth has been kept at the edge. Workers were found accessing through that debris kept.
78.	Gas cutting set was found without flash back arrestor, at cylinder end.
79.	Four workers were found working very unsafely by standing on scaffolding pipes of single legged scaffold.

80.	Four workers (welders) were found working on red tag displayed scaffolding.
81.	Three workers were found engaged in reinforcement work without safety induction, safety helmet and safety shoe.
82.	Above Two workers were working in first floor and were using incomplete staircase (No hand rail, gaps in landing platform & no guard rails at open ends).
83.	Gas cutting operator was found working without PPE's.
84.	Nos. of unsafe excavation has been done by M/s [redacted] for UG piping and excavated earth has not been cleared, rather just kept at the edges. Workers were found every now and then accessing/ jumping over these excavated trenches, excavated earth heap, as there is not even single approach to reach at work place.
85.	Unsafe grit blasting job was being carried out inside one of the tank (CHT tank) by M/s [redacted] Following lapses were found, due to which we were compelled to immediately stop the engaged job. These were, • The worker was found working by standing on one of the scaffolding pipe as no platform with double scaffold had been provided. • No register / safety precaution in Hindi/etc. were displayed at job location. • No PPE's were being used by workers he was simply covering his face by cloth and spectacles, Instead of hood. • Grit blasting hopper was found without TPI & was being used without filter assembly • Electricity was found fetched directly without any use of 24 V or ELCB.
86.	It is observed that during fixing of sand stones on the wall of CCR bldg, stones are falling down on the cable trench on south side of CCR bldg. HT cables are already laid in the above trench & this falling stone blocks may damage the already laid cables. Proper cover to be

	provided immediately on the trench to safe guard the cable before taking up further stone cladding works.
87.	Three cables tray fixing workers were found working without safety harness. Also their supervisor was found without safety harness.
88.	Majority of welders were found working without safety harness.
89.	Handrails, neither temporary nor permanent were found installed at 5th /6th floor.
90.	One of the hanging scaffolds guardrails was found given by re-bars & welder was working by standing on it, was found without safety harness.
91.	Two workers Mr. Rajesh Sahani & Mr. Binay Dubay of M/s [redacted] were engaged in gas cutting work. LPG cylinder was found being used in place of DA cylinder, while acetylene cylinder was being used without flashback arrestor. Also hose was found tied by G.I wire in place of clamps & pressure gauges too were found completely damaged.
92.	Four nos. half body safety belts were found being used by height workers.
93.	Rope ladder was found approx two meters short from around level. It was also found damaged at 02 locations.
94.	No fall arrestor was provided with rope ladder.
95.	One worker at M/s [redacted] was found accessing through the HRSG structure very unsafely.
96.	Earthing of DG & its panel was found given by electrical wire & was tightened by scaffolding clamps.
97.	Earthing of welding machines was found given very poorly to the exiting structure without clamp.
98.	Excessive leakage was observed from DG but no fix extinguisher was found for emergency purpose.
99.	No weather protection shed, shock treatment chart were provided. Rotating parts were found unguarded.

100.	Earthing was found provided very poorly by G.I wire.
101.	No access to DG shed was provided as the structural materials were found dumped in & around the shed.
102.	Inadequate shed was provided against weather protection, also exhaust pipe of DG was found not routed outside the shed.
103.	ELCB was found of 63-A rating and only one ELCB was provided for so many welding machine, grinding machine etc.
104.	Rotating parts were found unguarded, also fire extinguisher, shock treatment chart were not displayed.
105.	Incomplete ladder was found for access to the top of scaffold, at pipe rack. Workers were accessing through scaffolding pipes, also no scaffolding tag was found displayed.
106.	Poor housekeeping was observed as manila rope, slings, electrical & welding cables were laid or scattered haphazardly.
107.	Temporary scaffolding platform was found laid one over another at many places, fouling free movement over it.
108.	Approx -four openings were noticed around the periphery of flue can.
109.	Approx –eight workers were found working at 92 meters EL without full body harness.
110.	Nos. of temporary joints were observed in electrical cable.
111.	Maximum electrical cables being used were found of two core that too were being used without plug top.
112.	Earthing of welding cable was found given very poorly through re-bars.
113.	04 workers were found engaged in reinforcement work without proper means of access & egress. (Mr. Bhutta, Mr. Rajkumar, Mr. Kamlesh)
114.	One worker Mr. Suresh Kumar was found working with damaged safety helmet.
115.	No ladder has been provided to scaffolding however approx 25 workers were found working at height.
116.	Nos. of vertical excavations were observed done for fire water line and main holes, without any provision of slope, step cuttings. Excavated

	earth was found just kept at the edges which was observed creating hindrance for free movement of workers. No access was provided for entrance / egress as cable tray was found laid inside one of the excavated pit.
117.	Approx 8 workers were engaged in grating fixing work, following short falls were observed: - • In-complete staircase was being used by them. • No lifeline was provided at open ended faces as workers were found wearing safety harness but not anchoring it.
118.	One men basket was found being used at one of the tank without TPI.
119.	Welder named Mr. S.K Samu of M/s [redacted] was found without safety belt at a height of 6 mtrs. Engaged in welding activity. Also the illumination level was poor.
120.	Temporary arrangement of earthing by using re-bars was found in practice. This re-bar was producing tripping hazards because it passes across the main road.
121.	**At DG Set: -** • Coupling guard was not provided. • No shock treatment chart found. • No sand filled bucket found. • Oil leakage around the DG set. • No radiator fan guard was provided.
122.	Cylinders mounted on trolleys no chain was tied.
123.	50 ton capacity crawler crane {Model : 101 MB-HM was found at site without documents .
124.	One of the scaffolding leg was found hanging in air while the other was found just near the edge of excavated pit which was completely filled with rain water. No arrangement for dewatering was done even after 36 hours of stoppage of rain by M/s [redacted].
125.	Cable tray is being used for access from top platform of HRSG-I to corresponding pipe rack.
126.	Approx 14 numbers of cable tray are stack one over another at 4

	locations at top of the pipe rack structure creating hindrance for free movement of workers over the grating platform.
127.	Vertical excavation without any provision of slope cutting, step cutting & hard barricading was observed.
128.	Very low illumination was provided for cable pulling worker.
129.	Workers were seen accessing through cable tray instead of ladder.
130.	Hands made slings (2 nos.) with only one clamp were found used in support of chimney flue can.
131.	Gate at EL-92 mtr. is not provided at platform /entrance of passenger lift.
132.	Regn. No. : HR[redacted] Vehicle Pass No. : 11/36 Owner: Mr. Dharmapal The above mentioned tractor trailer was found transporting structural materials (pipes) from AG piping (147 Acre) to [redacted] complex in a very haphazard way in dark hours without taking any safety precautions, as the materials was observed overhanging approx 3.5 mtrs. & some of the small diameter pipes were just kept projecting towards sideways.
133.	At most of the places, persons are working at height for welding / grinding activity without using spatter arrestor. Below that activity, persons are working for other civil jobs.
134.	Open ended part of the scheduled concerting portion was found unguarded.
135.	An opening was observed at the central part which has neither been barricaded not covered.
136.	Poor housekeeping as re-bars, clamps, steel scrapes etc. were found just lying at the edge of these opening. Also some workers were found taking rest / working just below these opening.
137.	9 workers were found working at top engaged in bracing welding etc. very unsafely. Also safety net just below their working location was found disengaged.

138.	Workers were often seen working very unsafely over the beam at first floor.
139.	No proper approach was given for workers as it was found blocked with wooden planks, high rise of GTG foundation.
140.	Some of the GI sheets made for overhead temporary welding booth were found very loosely tightened. "Chance of fall from height during high wind".
141.	Mr. Sapan Mukherjee (M/s [redacted] visitor) was found at site without safety shoe & induction card. He was using white helmet.
142.	Mr. Imran, Engineer (M/S [redacted]) engaged in fire water pipeline work was found moving inside the site without wearing safety helmet (although he was having it).
143.	Approx 12 workers were engaged in scaffolding erection work without height permit. The height permit shown as not having any description of scaffolding activities.Moreover the following shortfalls were observed in the erected scaffolding with respect to strength of the scaffold. • Distance between the standards was observed more than 2.5 mtrs • Inadequate nos. of runners were provided due to which the landing platform was found swaying during the movement of workers over it. • No scaffolding tags were displayed. Some workers were found using for the same carrying pipes of concrete compressor pump.
144.	Approx 08 workers were found working near the edges at the height of approx 16 mtrs. without any fall arrest system (safety harness / Guard rail etc.)
145.	Cable tray is being used for access as ladder and as a working platform.
146.	Guide rope pulley was being used without latch & was found tied by PP rope instead of sling.
147.	DG set was found in working condition without earthing..

148.	One welder was found working on temporary platform fixed with re-bars. Also no ladder was provided for access to that platform.
149.	Earthing to DG was found very poorly given by GI wire.
150.	Welding lugs were not provided to two welding machine.
151.	Substandard switch gears were observed which were not routed through glands.
152.	Danger board / rubber mat etc. have not been provided.
153.	Substandard wire rope sling with only one clamp was being used for shifting of shell into the chimney.
154.	Hydra No. HR [redacted] was found about to leave ground from backside during shifting of chimney flue shell.
155.	Man basket was found damaged (bend at several places) & its identification number was not punched on it.
156.	Spatters due to overhead welding was found falling on the workers engaged in gas cutting work at first beam from the G.L.
157.	Gas cutting work was under progress over the beam by keeping gas cutting set on the passenger lift itself. Instead of keeping the same on ground.
158.	Poor housekeeping was observed all around. Gas cylinders were found kept haphazardly everywhere at the site.
159.	Cable tray is being used for approach to pipe rack from HRSG-01 & as a platform.
160.	Hand rail at top staircase & guard rail at open ends were not porvided over the top floor.
161.	Electrical cables were observed laid haphazardly & without plug top at 1^{st} floor by hand rail fixing workers.
162.	Structural materials are dumped just at the entrance of stair case making the approach very unsafe.
163.	Cable tray was being used for access from HRSG-I to corresponding pipe rack by M/s [redacted] workers.
164.	Rope guided pulley was found tied with PP rope instead of sling.
165.	One welder was found at about 14 mts. height working by standing on

	single scaffolding jali without guard rail. Fall arrestor was also not provided for vertical movement.
166.	Substandard & damaged man baskets were found being used at site without TPI.
167.	Painting workers were often seen not hooking their lanyard of safety harness during horizontal movements.
168.	Two structural erection workers found working at height but fall arrestor was not found attached with rope ladder.
169.	Guide pulley of winch m/c was found displaced sideways i.e. alignment of wire rope with respect to winch m/c.
170.	Hand rails were found missing at some locations of $5^{th}/6^{th}$ floor.
171.	Most of the gratings were found just laid over & not bolted.
172.	Gap of 30mm was observed between the landing & stair in 3^{rd} floor.
173.	Temporary handrails made of re-bars have not yet replaced by permanent handrails.
174.	Wire rope sling was found tied by only 2 clamps instead of 3 clamps. Moreover the distance between them has not been maintained.
175.	It was observed that illumination level at height where workers were working was very low as compared to illumination provided at ground level. Workers (especially welders) were found accessing through the stair case / rope ladder in dark.
176.	First Aid Box – Medicines whose expiry date is over is kept. List of medicines is pasted on the box but the columns "Inspection date" and "next due date of inspection" are left blank.
177.	Welders are using only face-shield instead of helmet with face-shield (welder's helmet)
178.	Only one aluminium ladder is available. Two rope ladders provided are worn out and are not used by the workers.
179.	Water-filled excavations and other excavated area are not barricaded.
180.	Power cables (3 nos.) passing through water in the excavated trench.
181.	Hoses of gas cutting set found badly worn out at the torch end.
182.	A few ELCBs check and found OK. However the electrician is not

	provided with rubber gloves.
183.	Vertical excavation was observed without any provision of slope, step cutting, excavates earth was kept just at the edges.
184.	DG is being used without earthing & damaged electric panel (pipe line work corresponding to tank-age area).
185.	Helper of welder was found doing welding without PPE's.
186.	Approx 2 mts. excavated pit was found completely filled with water without hard barricading & display board.
187.	Hydra No. NL-[redacted] was found at site without test certificate & relevant documents.
188.	One worker was found engaged in plate erection work by standing on cleat of column in very unsafe way.
189.	Electrical Cable was found routed haphazardly on ground.
190.	Two core cable without plug top was found being used.
191.	Cross over's provided over the cable trenches were found without handrails
192.	Gas Cylinder was found lying haphazard over the electrical cables.
193.	A live electrical cable with temporary joints was found submerged in water.
194.	Workers not using lifeline for horizontal movement over the beams.
195.	No arrangements were observed been made for spatter arrest during overload welding.
196.	Worker was found inside deviator damper without permit & means of access.
197.	**DG near** [redacted] • Guards were not provided to rotating parts. • Its panel was kept at much lower level (not effective against adverent whether) • Cables were directly routed without glands. • ELCB of proper rating has not been provided. • Inspection date of fire extinguisher was expired & its lock pin was found missing.

	• One distribution box was found connected with 2-core wire. • 440 volt danger board was found kept on ground. • Nos. of temporary joints were observed in electrical cables being used in vessels.
198.	Nos. of chequered plate was found just laid over the beams no welding / tacking has yet been done.
199.	Openings were observed in most of the locations at higher elevations workers were observed taking rest just in close vicinity of such openings & under the shed of deaerator shell.
200.	Guard rail was found missing in one location while on other locations PP rope was found, which should immediately be replaced by scaffolding pipe.
201.	Guard rail at platform of ladder was found made of re-bars & openings were also observed.
202.	No mid rail etc. has been provided at the top(protective barricade)
203.	Lifeline was observed tied at much lower level
204.	Full length ladder with fall protection (cage) is provided, which should be preferably made in two parts, with an intermediate landing.
205.	3 gas cutting sets were found being used without flash back arrestor.
206.	Gas cylinder trolley was found without wheels.
207.	No proper approach was observed as the access was found congested with water logging and structural members.
208.	Cables were found passing through the water & 03 of them were routed through the road. (movement of vehicles observed)
209.	DG Shed: - • Oil leakage was observed. • No exhaust pipe is provided at the exhaust end.
210.	Shoring shuttering are not provides to avoid collapse of soil.
211.	No ladders had been provided to the scaffolding.
212.	Guard rails have not been provided at the scaffolding platform.
213.	No proper access was observed for the cement plastering workers.
214.	Scaffolding platform was not provided as two workers were found

	working standing on the scaffolding pipes, also they were not using the lanyards for anchoring.
215.	No proper approach was observed more ever water logging has been noticed.
216.	Cylinders (O2 &DA) were found lying haphazardly on the ground.
217.	Workers found climbing through scaffolding pipes, as ladders were not provided.
218.	Reinforcement worker not using hand gloves.
219.	Protective glass of halogen lamp was found broken and was fixed near the rebar at very low height
220.	Approx 20 pipes at a time was being lifted & stacked at the pipe rack structure.
221.	No barricading was provided below the lifting area.
222.	Poor housekeeping & no proper approach was observed as the whole area was dumped with guard rail, grating and hand rail etc.
223.	Three workers were observed standing unsafely on scaffolding platforms without guard rail.
224.	Four workers were found working on same temporary platform which is designed for maximum three persons.
225.	Grating fixing worker was found working just near the edges of structure without any fall protection
226.	Single earthing was provided to the DG set.
227.	Cables were not routed safely as live cables were observed passing through structural material, stagnated water etc.
228.	Temporary joints are found in electrical cables. Joints are taped with plastics/ cloth.
229.	Welding booth was found constructed very shabbily & also observed displaced sideways, may fall any time during high wind.
230.	No access provided for entrance / egress for de-shuttering workers.
231.	Cable tray was found being used as ladder by workers.
232.	No hard barricading found around cable trench.
233.	Stairs didn’t have hand rail but was found being used by workers.

234.	No protective guard rail provided on first floor open ends.
235.	Five shuttering workers were found working at height without full body harness.
236.	Hand rail was not provided to access ladder being made of scaffolding pipe.
237.	Two workers were engaged in shuttering/ scaffolding work for making staircase without full body harness.
238.	Access scaffold didn't have handrail, mid rail, toe board etc.
239.	Two brick workers were found working at the edges without protection guard rail/ full body harness.
240.	Fall arrestor was not being used by worker while accessing to top through rope ladder.
241.	Workers were often seen accessing through the cross beams/ tie beams.
242.	Two workers found engaged in tie beams fixing were found not using fall arrestor.
243.	Following safety lapses are observed for roof sheeting work: - • No safety net provided across the work area. • No proper lifeline provided. • No supervisor and safety officer available at work place • No workers were wearing hand gloves. • Roof sheeting work is under progress, though work procedure for the same has not been detailed approved.
244.	Painting job was going on at height, though height permit was not renewed for the day.
245.	It is observed that cantilevered supports for work platform has been welded to the underside of the beam. It is advised to get the welds checked by your welding inspector to estimate the amount of load your projected work platform would sustain. Depending on that load you may permit your persons (2-3 max) to carry out their work on the cantilevered position as work platform.
246.	Openings on the wall between columns in S grid 8&9, 13&14, 18&19 are not barricaded.

247.	Improper housekeeping on the second floor debris found at AHU area, instrument shop (between Grid S & R6).
248.	Hand rail, mid rail etc. are not provided with walking platform.
249.	Scaffolding tag (like green, red) is not used with scaffolding.
250.	Five workers were working at height without full body harness.
251.	Tool box talk is not conducted by site engineer.
252.	No safe access (like aluminium ladder) found at temporary work place.
253.	Fall arrestors not provided on the ladders used by workers for descending to the lower beam from the top most beam & workers were found using the ladders.
254.	Two workers were found working in an unsafe manner.
255.	Barricading on the erected beams are made up of very thin debars.
256.	The ladder on the erected beams does not have any fall arrestors.
257.	Rollers used for reducing friction of hoist / lift wires are not functional.
258.	Electrical cables are in tension due to the placement of the beams, to be attended as it might damage the cables.
259.	Openings on the chimney platform even though barricaded, has not been covered with GI sheets.
260.	Scaffolding erected for civil works has the following short comings: Rope ladder issued for access does not have fall arrestors. Large spacing between two levels of platform (more than 1.2 m). No hard barricading provided workers are working at height.
261.	Cylinders kept in horizontal position at the top of chimney platform.
262.	New openings barricaded not covered from sides with GI sheets, as done before.
263.	Handrails on erected beams are made of very thin rebars, not with pipes. Mid rails are also not provided
264.	Manila rope lifelines are being used across the beams instead of metallic wires.
265.	The following lapses found at your grit blasting shed: - • Site HSE documents found signed by [redacted] sub-agencies personnel; especially [redacted] safety personnel are not verifying HSE

	status or relevant documents. • At top of front side and back side, found no covering of cloth. • Sand blasting operator was working without blasting hood. • No filter assembly connected with blasting air line hose pipe. • Oil leakage found in compressor & leakage oil was dripping on ground overflowing a small can. • No test date and no validity date found on hopper. • Blasting operator, helper (Total Six Workers) etc. involved in blasting job expressed that they have not undergone any health check-up • Helpers of grit blasting job were using towel & sub-standard dust musk, instead of blasting hood. • All grit blasting workers were working without Safety Induction Card, Gate Pass.
266.	Chain-pulley block found installed for site work without TPI certificate.
267.	Quite a good number of cylinders found kept in open place.
268.	Gas cutting set being used without flashback arrestor.
269.	Welding booth made by non-fire retardant cloth for hot job (like Welding, Gas Cutting etc.) demonstrated at site.
270.	Unauthorized person found freely moving inside fabrication yard, although watchman found sitting at gate.
271.	[redacted]'s Safety Officer found not signing on daily safety checklist, tool box talk but job was going on. (Photocopy of daily Safety Check sheet attached)
272.	Welder's helpers were found sitting in front of welding job without safety goggles.
273.	Fifteen to Twenty workers were found working at site without Gate Pass, Induction Card.
274.	Most of the workers wearing helmet without chin-strap.
275.	Electrical cables & Welding cables found not drawn separately from electrical booth to working area. All are entangled & haphazard.

276.	At most of the places welding cables found in damaged condition.
277.	Three nos. of Hydras found having no: - • Hook Catch / Safety Catch. • Gate Pass. • EPCC Logo. • Registration No.
278.	Halogen lamps has been provided at different locations for illumination purpose these lamps are very close to tarpaulin
279.	It is observe that in 1st floor of CCR building, switch gear panels are covered with plastic tarpaulin.
280.	HVAC material found not properly stacked.
281.	Unauthorized person was found moving at work area without PPE.
282.	Wires used for lifting hoist / lift were found to be scraping with edges of the erected structural beam.
283.	Chimney still not cleared from unwanted materials.
284.	Found two new openings with barricading, but not covered with GI sheets.
285.	Following lapses were observed at chimney construction location : - • Cylinders are not kept in vertical position, found in horizontal position. • No Shed provided for lifting winch machine. • No barricading is provided for hoist/ lift winch machine area. Also some workers of another agency were found working in the area, doing civil works, where the hoist/ lift winch machine wires are passing. • Wires without plugs are being used for electrical connections on the chimney top. • No provision for stand for halogen lamps on the chimney top. • Unwanted materials are stored on the chimney platform. • No sign board provided on the chimney top to alert the workers about the signals to be used to call the hoist machine operator.
286.	Kindly provide the fire retardant cloth to protect the switchgear any

	untoward accident and arrange adequate No. of fire extinguishers, fire bucket etc.
287.	Exhaust fan provided without any protective guard.
288.	8 workers were found working inside the tank, where as names of only 6 workers were found entered in the confined space permit.
289.	Look out person at the entry of tank opening, who was supposed to be stationed outside the tank, was not available. Also no register is being maintained to record entry & exit times and duration of workers working inside the tank.
290.	Double scaffolding with grating was not provided; one welder was found welding on the tank surface standing on single scaffold pipe.
291.	No tagging system was being followed for the scaffolds both inside and outside of the tank.
292.	One structural Column is standing on 4 bolts, no bracings/ tie beams were provided.
293.	Handrails are not provided on the stair case and other platforms.
294.	Scaffold arrangements as constructed by your insulation agency for HRSG stacks are unsafe- no arrangements for placing gratings / making work platforms are there. Nor any fall arrestor or ladder also found attached for safe involvement of people at height.
295.	It is observed that excavated material has been deposited within 1.5 meter from the excavated trench of MHC-66 to 68 of UG piping.
296.	Hydra No. HR-[redacted] was found operating at your site (In front of CCR building) with following observation. • Reverse horn barely audible even at 1 feet distance. • Boom limit switch wire found disconnected, even though the limit switch is in working condition.
297.	Hygienic canteen condition site not being maintained
298.	Drinking water facilities not adequate.
299.	Stacking of material not proper at HVAC stacking Area.
300.	Re-bar are being used for earthing for welding equipments.
301.	Manila ropes are being used as life line instead of wire rope.

302.	End edge of gritting & stair case not provided hand rail, mid rail.
303.	It has been observed during routine site inspection, that height work permit was not signed by [redacted] site engineer & work was going on at height.
304.	Six nos. welding machines were found running without "body earthing".
305.	Eight nos. earth pits found present at ground floor having no cover.
306.	Poor housekeeping all around work areas like, cable tray, scaffolding pipe etc. are scattered haphazardly.
307.	Cable trench on ground floor found no barricade all around.
308.	Fifteen nos. of manila ropes are being used instead of metal wire rope for lifeline. It should be immediately replaced by wire rope of 10 mm dia (minimum).
309.	Workers wearing safety helmets without using chin straps.
310.	Workers without safety induction cards.It seems that tool box talk is not effective.
311.	Insulation of welding cables damaged & improperly joined.
312.	An erection was going on at HRSG-3, without provision of rope ladder, fall arrestors and one worker was found working at height.
313.	Poor housekeeping at site, structural members, rebars, pipes are kept haphazardly on ground.
314.	Pipes are kept in a disorderly / haphazard manner on ground.
315.	Poor housekeeping by HVAC team at site & store.
316.	Workers are not using face mask while carrying out insulation job, though same has been provided.
317.	Workers are urinating in open space near bypass stack area & foul smell is coming.
318.	It is observed that wooden planks of MCC's cover are being kept inside the switchgear room. Since wooden planks are flammable materials it is requested to remove the same from the switchgear room and also from the vicinity of the plant to avoid any fire hazards.
319.	Panel erection was being carried out inside switchgear room without

	proper lighting arrangement. [redacted] to ensure that lighting arrangement has to be done before taking up any erection activity inside CCR Building .
320.	Despite repeated observations at site, to provide proper lighting arrangement in the cellar, till date no action has been taken to provide the same. [redacted] to make necessary arrangement for the same.
321.	Painting job of structure was going on without : • Valid height permit. • No lifeline installed across the structure. • They were not using full arrestors for climbing & descending. • One worker was found with half body harness.
322.	Two workers were found painting at height & were not issued safety induction card.
323.	Reinforcement bars across base frame channels has been cut, creating large openings & the openings has been covered with thin wooden packing material. Hard barricading has to be provided.
324.	Angle supports for scaffolding have been given on reinforcement bars across channels, to be rectified.
325.	Also proper access to scaffolding has not been provided. Tagging of scaffolding has not been done.
326.	Handrails / Guard rails has not been provided on working platform.
327.	Six welding machines, one lifting machine are found without body earthing.
328.	No inspection tag on fire extinguishers kept at substation.
329.	Oil leakage is observed in DG Set & physical condition is very poor.
330.	Sub-standard electrical distribution board is found.
331.	Electrical supply is given without ELCB.
332.	No shock treatment chart is displayed at panel area.
333.	Ten workers were involved at site work without safety induction card & EPCC logo on helmet.
334.	Around excavated manhole hard barricading is not installed.
335.	Heap of loose soil is kept near road side. It is creating dust clouds &

	spreading on the road. It should be immediately removed as this is affecting vehicle movement on the road
336.	Manila rope is being used instead of metal wire rope for life line. It should be immediately replaced with wire rope (min 8-mts).
337.	Height permit was not available at site but work was going on.
338.	Fabricated material is not properly stacked. It should be kept in safe manner.
339.	Tool box is being not conducted by Site Engineer / Supervisor on daily basis. Before starting of job TBM must be conducted on daily basis.
340.	Concrete debris must be cleaned continuously in and around the chimney.
341.	Wire ropes of hoist is passing in concrete debris make clear route for passing the wire.
342.	Concrete bucket should be empty at least 6" from top to avoid falling of concrete from height.
343.	Electric wire lying on ground in haphazardly.
344.	Large gaps are exists inside and outside shell of chimney at platform. There may be chance of fall from height to persons & materials.
345.	Barricading from winch machines to chimney wall along with wire of erected from re-bars. It should be erected from GI sheds or materials from similar type.
346.	Shed to be provided up to passenger hoist to protect against falling concrete particles.
347.	Emergency no's on signboard to be provided at site.
348.	Following lapses were found at site for insulation jobs at HRSG: • Daily safety checklist not filled up. • Height work permit not prepared & workers were working at height. • No tagging system for scaffolding followed. • Ladders / access not provided on the scaffolding.
349.	Excavation has been done with vertical cut (without step cutting) in approximate 3M depth. Hard barricading to be provided. Either step

	cutting or shoring to be done.
350.	Earthing connections of motors & panels for hoist system to be done properly.
351.	Fabricated ladder is installed in the tank T-52B.
352.	Poor housekeeping on chimney platform. • Concrete dumped on the platform (to be removed). • Heaps of concrete on chimney net. • Net damaged at places, to be replaced.
353.	Passenger hoist cage gate is not closing properly due to accumulation of debris.
354.	DA & O2 cylinders are not tied though kept in upright position.
355.	Sand bucket to be provided on chimney platform.
356.	Body earthed to be provided for two nos bar cutting machine & one bar-bending machine.
357.	Found oil leakage from one bar-cutting machine.
358.	Bar-cutting & bar-bending work area is very congested steel bar, scaffolding, wooden batten etc are scattered haphazardly. Scrap to be removed.
359.	Fall arrestor not provided along with rope ladder at the erected structural column.
360.	Rope ladder not tied at the bottom.
361.	One person was climbing the column without using fall arrestor.
362.	Valid height work permit was not available.
363.	Electrical cables lying on ground & not protected.
364.	Poor housekeeping (Scraps, packing woods, re-bars etc.)
365.	Wooden sheets / boards are in use for mounting electrical panels.
366.	Temp. work platform in unsafe & unstable condition
367.	No safe access or exit.
368.	Gap exists between chimney shell & work platform (outside).
369.	Material stacking (rebars, bricks etc) very unplanned & unsafe.
370.	Dumping of construction materials all around chimney site are found unsafely.

371.	Height of safety net mounted outside work platform, not sufficient to prevent fall of persons.
372.	Almost 4/5 locations, "earth wire found disconnected at both ends (incoming & outgoing), whereas 3-core cables are actually used. (Earth, phase & neutral wires are there in 3-core cable). • Safety publicity arrangements are unsatisfactory. • Construction electrical booths are not safe for use – no safe access, sheds and side covers loose, earthing of DBs are improper.
373.	Kit-kats found used in place of HRC fuses ELCB not connected with portable tools.
374.	Double earthing of DG sets panel boards required. Incoming / outgoing switches not labelled.
375.	One hydra with registration no. HR [redacted] was found without: • Boom limit switch. • Hoist limit switch. • Reverse horn
376.	Winch machine area though should be cordoned off but area is being used as a bicycle stand.
377.	Access scaffolding area has been blocked by staging materials needs to be cleared.
378.	Housekeeping was very poor i.e. fabricated pipes were scattered outside the yard.
379.	Two nos. hydra movement found under high tension cables.
380.	Five person including One Engineer were present without safety helmet.
381.	Fencing below beneath of HT Cable was being not done properly.
382.	TBM & Daily safety checklist were not signed by main EPCC Safety Engineer & Safety Officer except only one sign each.
383.	Argon cylinders tied on rope & all cylinders were not kept on trolleys.
384.	All electrical charged distribution kept on ground.
385.	DG set kept on wooden log & shed not built for DG.
386.	Grit blasting compressor TPI certificate (from safety competent

	person) was not available on site.
387.	No provision of illumination in grit blasting shed for dark hours.
388.	Grit blasting shed was not covered properly with fire retardant clothes.
389.	Grit blaster and helper are not wearing respiratory hood & dust mask.
390.	Operator & helpers name are not displayed on the outside of grit blasting shed.
391.	Fire extinguisher which was provided at UB-1 welding booth had following deficiencies: • Hose was damaged. • Inspection sticker bearing date was not filled up / not present.
392.	Sand buckets were empty & were filled with discarded welding electrodes.
393.	Lifting of structural materials was under progress but area was not cordoned off.
394.	Sub-standard man baskets (newly fabricated ones) were installed at height & workers were using them.
395.	In some welded platforms, very thin re-bars were used for barricading purposes.
396.	Some welding cables were temporarily joined.
397.	No intermediate rest platforms were provided on the structure.
398.	Found one person was climbing a rope ladder without fall arrestor
399.	Four Nos. of welding machines are kept in open place without shed.
400.	Found three fall arrestors are provided at boiler work area but among them one fall arrestor is not working & other two fall arrestors are of insufficient length according to height. So immediately fall arrestor of adequate length should be provided / replaced at work place.
401.	Two ladders are installed without fall arrestors & workers were found climbing them.
402.	Five workers found engaged in shuttering work, without wearing full body harness.
403.	Walking access has been blocked with scaffolding / shuttering materials.

404.	Safety net not provided underneath where workers were working.
405.	Wire rope lifeline to be provided, whereas nylon rope lifeline was being used. Life line was found to be loose.
406.	Unauthorized persons were engaged in electric works
407.	Damaged rope ladder installed on the structure & no fall arrestor provided.
408.	At northern side, fall arrestor installed on the hook of the crane though it should be installed along with rope ladder.
409.	Workers were found climbing the rope ladder without using fall arrestor.
410.	At southern side fall arrestor & rope ladder not provided & five workers found working at height.
411.	Two workers found working at height without anchoring their lanyards.
412.	One worker found climbing column using column re-bars.
413.	Five workers (without full body harness) were found engaged in shuttering work at height.
414.	Very poor housekeeping near CCR Building DG Shed area found cluttered with scaffolding materials.
415.	Ten nos of DA cylinder & twenty nos of Oxygen cylinder without any safety caps are kept in the shed.
416.	Poor housekeeping around the chimney area. Metal scrap kept haphazardly.
417.	Electrical booth not provided with • Fire extinguisher • Sand bucket • Electrician name • Shock treatment chart. • Danger sign, caution board.
418.	Fall arrestor not provided on erected structural columns while persons were ascending / descending the column.
419.	Shed for electrical booth not provided and also does not have

	• Fire extinguisher • Sand bucket • Electrician name • Shock treatment chart • Danger sign, caution board.
420.	Hard barricading has not been provided around excavated pit.
421.	Access scaffold is very unsafe as it been prepared by passing safety norms
422.	Guard rail not provided at some places.
423.	Access is not clear at top as insert plates are blocking the area
424.	Wooden ladder is being used at top.
425.	One worker was found on top of the column without fall arrestor.
426.	At Grit blasting shed • No exhaust fan. • No respiratory hood for grit blasting operator. • In front of the shed & also other side of shed are not properly covered by fire retardant cloth. • No display of instruction board.
427.	Cylinders are kept on ground without protective cap & also no identification marks for full & empty cylinders.
428.	Electrical lapses at electrical pannel: • Found two ELCB's are not operating & identification mark on ELCB is required. • ELCB record is not being maintained. • Six nos charged electrical distribution boards were kept on ground. • Two core cables are being used for grinding machines, halogen lamp. • Found nos of temporary loose joints on electrical cable & kept on ground haphazardly. • Hand gloves (electrical shock proof) is not provided for

	electrician.
429.	Tool box meeting is not being conducted by Site engineer.
430.	EPCC logo is missing from all safety helmet.
431.	Record of medical check-up could not be produced by UB Engr.
432.	Working area has to be cleared as unwanted steel scraps are kept haphazardly. Same to be removed.
433.	Found unauthorized persons were walking at working area. Security arrangement to be made.
434.	Hydra with registration no. PB [redacted] was not installed with : • Boom limit switch. • Hoist limit switch. • Reverse horn. • Hook was not having safety latch
435.	Grit Blasting Shed at admin block: • Not covered from the top, both in the front & back side. • Not having exhaust fans.
436.	Welding cables were not properly routed from the welding booth to site.
437.	Area under HT lines still not barricaded / Fenced.
438.	No green / red tag has been displayed with the scaffold. Scaffolding ladder not proper as its staging is made of re-bars.
439.	Poor housekeeping as wooden materials, re-bars shuttering materials are lying all around.
440.	Man basket is being used without TPI.
441.	Medical test has not been done for height workers.
442.	Two-crawler cranes was found without wind shield (front glass).
443.	Urinals / toilet is not provided in tankage area. Maintenance of toilet / urinals is not being done.
444.	Eighteen workers were found working without hand protection while bar-cutting, bar-bending, operation etc.
445.	Unsafe & over weight transporting of structural columns without proper balancing & tagline.

446.	Unauthorized entry was observed at tank area.
447.	No provision of urinal / toilets for male / female workers.
448.	HT lines are passing above the fabrication yard.
449.	Pipes are not stacked properly & stopper has not been provided.
450.	DG Set was found in running conditions without earthing & shed.
451.	Electrical panel – No shed, cables were routed without glands, shock treatment chart, licensed electrician etc are not available.
452.	Electrical cables, welding cables was found lying on ground haphazardly.
453.	Welding booth is being used as office. No provision of fire extinguisher, sand bucket etc.
454.	No storage shed for gas cylinders as they were found lying on the ground at many locations.
455.	One gas cutting set was found working without flash back arrestor (cylinder side).
456.	Plastic sheet was being used for temporary welding shed.
457.	Hydra HR [redacted] • Boom limit switch, hoist limit switch not working. • Reverse horn was not fitted with the reverse gear. • Poor physical conditions and damaged safety latches.
458.	Daily safety checklist & tool box talk report was not available at site.
459.	No shed was found for storing of gas cylinders; also gas cylinders were not equipped with valve protection cap.
460.	Fire extinguisher was not available at electrical panel shed & near temporary welding shed. Moreover sand buckets were found empty.
461.	Hydra HR [redacted] - No provision of hoist limit switch. - Load chart was not available.
462.	No adequate illumination facilities were observed.
463.	Five workers were found working without adequate hand-gloves & nose mask / respiratory protection while wrapping / coating operation.
464.	Fall arrestors were not provided with the rope ladder while 6-workers

	were found working at height.
465.	Unsafe lifting of tie beams through single web sling.
466.	Ladders not provided, workers were found accessing through reinforcement bars.
467.	One hydra (registration no. HR [redacted]) was found without hoist limit switch.
468.	No daily safety checklist & tool box talk report was found at site.
469.	6-workers were found working without safety helmet.
470.	Approx. 15-workers were found working with damaged shoes.
471.	No shed is provided for gas cylinders in two locations of near to batch plant.
472.	Four nos. damaged pressure gauges of gas cylinder was being used for gas cutting operation.
473.	No fire extinguisher was provided in diesel shed & electrical / welding booth.
474.	Water is being accumulated near welding booth & poor housekeeping.
475.	Improper stacking of material.
476.	Nine nos. cable drum was found kept in front of DG Shed.
477.	Two hydras were found at site without hoist limit switches attached to the boom Registration nos. HR-[redacted] & HR-[redacted].
478.	Two workers were found climbing rope ladders without using retractable fall arrestors.
479.	Workers were not using lanyards for horizontal movement at the pipe rack structure.
480.	Workers were not using life line & lanyards while working at height.
481.	Proper hard barricading to be provided. Vertical cuts are provided while slopes can be maintained.
482.	Hard barricading not maintained at proper minimum distance of 15-metre not maintained.
483.	Access to the work at CCR top not proper, access blocked by steel beams. Arrangement of steps or short ladders to be provided to safe movement of workers.

484.	Found heavy steel beams is erected without any safety precautions.
485.	Lifeline for horizontal movement from ladder to work area not provided, also retractable fall arrestors was not installed along-with the rope ladder. Safety net was not tightened properly.
486.	Safety record is not available on site i.e. safety checklist, height permit etc.
487.	Hard barricade is not being erected along-with opening on CCR Building.
488.	Access (Stair case) for CCR Building has not proper hand rail, no mid-rail etc.
489.	Found inadequate illumination at substation area.
490.	Hard barricade to be done along-with edge of cast slab of CCR Building.
491.	Ten-workers were found working at height in CCR Building without wearing safety shoes.
492.	Poor housekeeping at CCR Building is being observed.
493.	CCR Building DG Shed – Electrician name not there despite repeated notices.
494.	CCR Building Access Scaffolding – Green tag not provided at prominent place.
495.	Workers not anchoring lanyard of full body harness while working at height.
496.	Lifeline not provided for horizontal movement of worker.
497.	During joint inspection of client/ PMC, following observations were made: • Fall arrestor & lifeline not provided. • 4-workers were found working at height and not tying their lanyard while horizontal movement of full body harness to suitable means. • TPI of man basket not completed, despite repeated notice for the same. • No proper guard rail is provided for man basket.

	• Safety net was not provided for one of the span while 5-worker were found working at height of approx 15-mts. • Unsafe temporary platform made by using coir rope.
498.	Welding booth not provided, as welding machines are lying in open.
499.	Fire extinguisher not provided.
500.	Cable glands for electrical panel is not provided.
501.	Design of ladder platform /scaffold is not proper.
502.	DG Shed without proper rain protection.
503.	Cylinder lying on ground – no shed is provided
504.	Fall arrestor is not being used while 4-workers were found working at (approx) 22-mts. height
505.	Electrical cables / cutting hoses are lying haphazardly on ground.
506.	Safety nets are not tied properly also. Structural materials are lying just under it
507.	Man baskets without TPI is being used at site.
508.	DG Set was found working without proper earthing.
509.	All the electrical wires are loosely connected without proper insulation.
510.	Cables are connected directly without any glands
511.	Poor housekeeping as hydraulic oil, diesel, sacks, and electrical wires are kept under the shed & no fire extinguisher is provided.
512.	Unsafe shed made with plastic sheet.
513.	Deep vertical excavation has been done in STG area without any provision of slope, shoring etc. Moreover, hard barricades has not been provided and 40-workers (approx.) were found working where the pit is being excavated for STG Transformer foundation & no route for entry / exit has been provided.
514.	Structural Erection work was under progress of your subcontractor M/s [redacted], in piperack area. Several times it has been communicated about following shortfalls. Despite of this erection work is in progress neglecting all the safety parameters.
515.	Use of rope ladder which are short in length moreover they are not tied at adjacent location to avoid swaying.

516.	No retractable type fall arrestor is used with the rope ladder
517.	Man basket without TPI, being used by welders.
518.	DA (full) & O_2 (full) cylinders were found stored in one shed. To be kept in separate shed.
519.	DG no [redacted] • No guard is provided for V-belts. • No electrician board is displayed in the shed. • No fire extinguisher is provided in the shed. • Oil leakage wooden platform is required.
520.	Three persons were found performing their trade test (Grinding) without proper PPE's
521.	Three workers were found without full body harness, while working at height.
522.	Hand rail of scaffolding is not proper and needs to be tightened.
523.	Housekeeping to be improved on top of CCR Slab and at site.
524.	In 6 erected structures (column) rope ladders provided are short in length. Presently work is going on beyond 15-m elevation.
525.	No adequate numbers of toilets / urinals are provided at site to meet the present capacity of workforce.
526.	Most of the sheds made at site are unsafe. • Tarpaulin used instead of GI sheet – De-aerator Area. • Rebars used instead of scaffolding pipes – Tankage Area. • DG Shed not enough against weather protection – chimney area, pipe-rack area.
527.	Crane – HR [redacted] • No angle indicator is provided. • No load chart is provided. Note: Since the approaches are narrow due to congestion in area, lifting procedure should be followed by strictly adhering to above safety parameters.
528.	No safety latches are provided in chain pulley blocks.
529.	Lifeline provided for height jobs are not enough tightened.

530.	No proper hard barricading is provided around the excavated pit.
531.	No means of access is provided for working at height for column reinforcement work.
532.	Transit Miller no. GJ-[redacted] was found working without reverse horn.
533.	Approach to the entire area is not clear as materials are scattered everywhere, very poor housekeeping around the site.
534.	4-workers were found working at the top of chimney while no safe means of access was provided to them.
535.	Electrical cables, gas cutting hose are lying haphazardly on ground.
536.	DG was found working without radiator fan guard, belt guard.
537.	Hand rails, guard rails & supports etc of slip form which is made of re-bars is totally unsafe.
538.	DG Set was found working without earthing.
539.	Temporary joints are found in electrical cables.
540.	Substandard quality of cables is being used in DG for connection purpose.
541.	Bar benders were found working without hand gloves.
542.	No retractable type fall arrestor was found in erected structure while three workers were found working at height.
543.	No scaffolding supervisor deployed / recruited by M/s L&T till date.
544.	Most of the erected scaffolding are unsafe.
545.	No proper access has been arranged with scaffolding to reach on platform.
546.	Earthing pit do not have the cover.
547.	Caution and shock treatment chart was not provided in electrical booth.
548.	Name of electrician was not mentioned on board.
549.	No scaffolding supervisor deployed / recruited by M/s [redacted] till date
550.	Most of the erected scaffolding are unsafe.
551.	No proper access has been arranged with scaffolding to reach on platform, workers are climbing up and down through scaffolding pipes.
552.	Very poor / insufficient area lighting was provided while erection of

	structural I Beams was under progress near HRSG.
553.	Precautionary barricading not provided around the erection area.
554.	No hard barricading is provided around excavated pit.
555.	No exit and entry route provided in excavated pit. While approximately four workers were working including female workers.
556.	Approximately eight workers were found working at height without tying their lanyard of full body harness with suitable means.
557.	Scaffolding Supervisor is not deployed at site till date.
558.	Shortfall noticed in scaffolding work. • Proper lifeline is not provided. • No proper working platform. • No proper access to working platform. • No handrails at several places in scaffolding. • Most of the erected scaffolding are plumb out.
559.	Fall arrestor – Only one retractable type fall arrestor is provided in erected column while work at height is in progress.
560.	Cylinders are stored haphazardly at storage shed.
561.	No trolleys provided for transportation of cylinders.
562.	Two workers found sleeping inside welding machine shed.
563.	Welding machines earth connections were found loosely connected.
564.	Scrap yard is not barricaded and no such board is provided for distinction.
565.	All the shed found in haphazard conditions as some of them were tilted sideways.
566.	Fire extinguisher should be checked on quarterly basis, but three extinguishers found whose due date was 22.04.08.

Note :

1) The observations are based on construction work site.

2) Some observations of unsafe acts and conditions are repeated but for different places.

[redacted] **PROJECT** [redacted]

SUB STANDARD CONDITIONS AND PRACTICES REPORT

Issued to: [redacted]
Serial No.: [redacted]
Time & Date of Inspection/Observation: [redacted]

Sheet 01 of 01
Time & Date of issue of SSCP Report:
[redacted]

Sr. No	Description of Lapses/Shortfalls/Hazards identified	Exact Location	Action Category (as per reverse page)	Closed out on		Signature of Contractor's Head of Site (RCM/SITE/RE)	Remarks
				Date	Time		
1.	One of the distribution board was found charged with 2 core cable, same observation was earlier also brought to your notice through SSCP No.-211 date 12.01.2009.	RCC Chimney	Reminder-1				
2.	Two workers of your subcontractor (M/s [redacted]) were found engaged in painting (outer) of tank very unsafely sitting on scaffolding pipe. No platform with double scaffolding had been provided. (**Supervisor: Mr. Sunil Kumar Dwevedi**).	Tankage area	B				
	PHOTOGRAPHS ATTACHED						

CC: Safety/[redacted]
RCM/AREA CO-ORDINATOR
[redacted]

ISSUED BY:
SIGNATURE:
NAME & DESIGNATION: [redacted]

RECEIVED BY:
SIGNATURE:
NAME & DESIGNATION:

GUIDANCE FOR COMPLETION OF SUBSTANDARD CONDITION & PRACTICE REPORT

[redacted] PERSON INITIATING THE SSCP REPORT SHALL ENSURE THAT –

- The form is issued to the MAIN CONTRACTOR concerned site engineer.
- The time and date of the initiation is recorded on the report form.
- A unique Serial No. is inserted at the head of the format. The number shall be provided by [redacted] Safety.
- Should more than one sheet be required for the report, indicate the same (top right of the format) e.g. sheet 1 of 1 etc.
- The "action category" selected is appropriate for the hazard / risk identified and realistic regarding the time scale required to implement suitable remedial action.
- The location of substandard condition or practice is clearly defined with the appropriate column.
- Initiator's name and signature is inserted (bottom middle of the format).

THE MAIN CONTRACTOR(S) IN RECEIPT OF THE FILLED-UP FORM SHALL ENSURE THAT –

- Appropriate remedial action is taken at the work area and the action items identified on the SSCP format are "closed out" within the "action category" time scale(s).
- Failure to "close out" items within the time scale/time frame, would be considered as a management failure of Main Contractor & will invite penalization (As per contract).
- A "Close Out" date and signature of the Site-In-Charge / Resident Engineer / Project Manager is inserted for the each item on the form.
- When the items have been suitably "closed out" on the format, a copy is to be returned to [redacted] Safety for record and verification purpose(s).
- In the case of B Category items, the work operation or activity in question shall be halted immediately and shall not recommence without a validation inspection by [redacted] safety representative / [redacted] Site Engineer and in agreement with satisfactory action.
- Acceptance of the "close out" status by [redacted] need to be recorded under "REMARKS" column.

ACTION CATEGORIES AND TIME SCALES:

A. Cease the operation. In the presence of [redacted] take immediate action to rectify the unsafe situation. When it is agreed that the work or activity is safe to continue then it may re-start.
B. Cease the operation immediately. Do not re-start without permission from [redacted].
C. Remedial action to be completed within 24 Hrs.
D. Remedial action to be completed wit in 72 Hrs.
E. Remedial action to be completed within 07 days.
F. Finer/Penalty for non-compliance or failure in implementation of any of the HSE provision as described in contract.

Ranking of objective setting for workplace activities vs safety lapses/shortfall

S No	Locaion	Safety Lapses / Shortfall	Before	After	Differance	Percentage
1	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Stacking of Materials / Housekeeping	46	17	29	63.04
2	Movement of materials	Stacking of Materials / Housekeeping	43	19	24	55.81
3	Brick Work & Plastering	Walkway / Grating / Handrails / Openings	43	25	18	41.86
4	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Unsafe electrical Equipment/ Earthing / Guards	43	22	21	48.84
5	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Ladder/Fall Arrester / life Line / Access	38	16	22	57.89
6	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Walkway / Grating / Handrails / Openings	38	17	21	55.26
7	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	PPE's	33	18	15	45.45
8	Storage of Materials	Walkway / Grating / Handrails / Openings	32	17	15	46.88
9	Brick Work & Plastering	Stacking of Materials / Housekeeping	31	17	14	45.16
10	Electrical services Viz Fire, HVAC,BMS,Elecrical wireing	Scaffolding related	29	15	14	48.28
11	Excavation	PPE's	29	18	11	37.93
12	Excavation	Walkway / Grating / Handrails / Openings	29	23	6	20.69
13	Lifting of materials Eraction- pipe,steel etc	Erection Methodology / Work permit / SOP	28	14	14	50.00
14	Confined Space	Work in cramped and unnatural position	27	12	15	55.56
15	Movement of materials	PPE's	27	13	14	51.85
16	Excavation	Noise	27	12	15	55.56