ALSTOM EHS

SAFETY PROCEDURES AND SYSTEMS IN THE CONTRUCTION OF COMBINED CYCLE POWER PLANTS

Thesis Work

By

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Submitted to University of Petroleum and Energy Studies, Dehradun

In partial fulfillment of the requirements for the degree of

MASTER OF TECHNOLOGY

Approved as to style and content by:

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Major Subject: Health, Safety, & Environment

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There were many others in APIL who helped in various ways, so that I could visit their site to study and comprehend their systems. My thanks are due to them all. I may mention here that I will fondly remember their kindness and cooperation for a long time.

S.VENKATANARAYANAN

CERTIFICATE

This is to certify that **Mr. S. VENKATANARAYANAN**, a student of **M.Tech Health, Safety and Environment**, bearing **R. No R-070204004**, at **University of Petroleum and Energy Studies, Dehradun**, has carried out a project titled "**Safety Procedures and Systems in the Construction of Combined Cycle Power Plants**" at **Alstom Projects India Limited**, during the period **13th February 2006-30th April 2006** as part of his main project in the fourth semester for the partial fulfillment of the requirements for the curriculum. **The work is certified as bonafide.**

Nihal Anwar Siddiqui	**Dr. B.P.Pandey** 15/05/06
Course Coordinator HSE,	**Dean, College of Engineering**
COE, UPES	**UPES, Dehradun**

CERTIFICATE

This is to certify that Mr. S. VENKATANARAYANAN**, a student of** M.Tech Health, Safety and Environment**, bearing** R. No R-070204004**, at** University of Petroleum and Energy Studies, Dehradun, **has carried out a final semester project titled** "Safety Procedures and Systems in the Construction of Combined Cycle Power Plants" **at** Alstom Projects India Limited**, during the period** 13th February 2006-30th April 2006**. The work is certified as bonafide.**

Nihal Anwar Siddiqui
Sr. Lecturer,
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(Internal Guide)

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APIL, India, Delhi
(External Guide)

INDEX

ALSTOM Power Turbo Systems/Power Environment
Plant Business

ALSTOM

Environmental, Health and Safety Policy

In plant Business we consider EHS issues as an essential component of our overall business strategy. Our 3 key goals for which it is the responsibility of all our employees to achieve are stated below.

Goal 1:
Seek and maintain a safe, healthy and environmentally sound work place for our employees, contractors, visitors and any others that may be affected by our actions

Goal 2:
Promote a positive EHS Culture at all of our business locations with pro-active involvement of all our employees and contractors.

Goal 3:
Achieve zero accidents.
We shall treat all accidents as preventable and pursue the same standards and results in all countries of operation.

We aim to excel in EHS and achieve our goals through the implementation of a continually improving EHS Management System in line with International Standards and best practice by ensuring:

EHS Policy Deployment

- the Senior Vice President of the Plant Business is committed to this policy and will review it on an annual basis
- this policy is available to the general public and interested parties upon request
- that any country specific EHS policies are respected and followed

Planning

- the provision of suitable and sufficient resources to allow us to deliver on our EHS objectives and remain committed to this Policy
- the assessment of EHS risk in all aspects of the business and where necessary the implementation of corrective measures
- that management systems are in place, that persons receive information instruction training and supervision and that adequate resources are allocated for the Plant Business to comply with local EHS regulations, International EHS Standards and the requirements of ALSTOM

Implementation & Operation

- education and training of our employees to allow them to safely perform their tasks
- metrics are established to measure our EHS performance
- communication with our employees, customers, suppliers, the community and other stakeholders

Checking and Corrective Actions

- regular assessments to check the effectiveness of the implementation of our management system
- a review of all accidents and incidents by implementing corrective actions and relating this to the applicable risk assessment

Management review

- annual full review by the business management team of all aspects of the EHS management system
- regular intermediate reviews at general business management meetings

Andreas Lusch
Senior Vice President - Plant Business

Date: 31 Aug 05

1. ACTIVITIES CARRIED OUT

1. ACTIVITIES CARRIED OUT BETWEEN 13TH FEBRUARY-30TH APRIL-2006

- Understanding Alstom's EHS Policy and EHS Management System.
- Understanding Alstom's procedures for Road Map Audit.
- Understanding various work instructions.
- Providing EHS induction for new employees.
- Participation in various Tool Box talks.
- Review of activities carried out under permit to work.
- Routine inspection of construction site at Gautami Power Limited involving
    - Checking Personal Protective Equipment.
    - Ensuring housekeeping at site.
    - Checking and installing barricading.
    - Pre-audit preparation of site.
    - Inspection of welding machines, gas cutters, grinding machines, scaffoldings, and drilling machines.
    - Daily EHS walk down at site.
    - Completing Scaffold checklists, Electrical checklists and Safety Harness checklists.
    - Inspection of guards on machineries.
    - Display of Safety Boards and generating awareness of safety amongst workers.

2. EXECUTIVE SUMMARY

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Alstom Projects India Limited is a leading EPC company. The EPC contract for Gautami Power Limited, was awarded to Alstom Switzerland Limited which is building the 469 MW Combined Cycle Power Plant (CCPP) in Peddapuram, AP. CCPP is basically one which uses gas to generate electricity, and the heat enthalpy in the exhaust of the gas turbine is used to generate steam which is then sent to the steam turbine to generate additional power.

Construction and Erection work at Site is a hazardous. Most of the tasks involve Work at Heights, Hot Works, Radiography, etc, which have major hazard potential. It is necessary that appropriate measures be taken to ensure that safety of personnel, equipment is taken into account and safe work practices are there in the site. It is also necessary that any environmental impacts be minimized. This project basically looks into the hazards in a construction site, as there was erection going on, their potential impacts, and strategies for minimization of the hazards. An effort was made to check and improve safety of equipments such as gas cutters, welding machines etc, and also to improve the safety awareness of people carrying out the various tasks.

3. INTRODUCTION

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3.1 ALSTOM PROJECTS INDIA LIMITED: ALSTOM, the global leader in power and rail transport, is in the business of designing, building and servicing technologically advanced products and systems for the world's energy and transport infrastructure.

In India, ALSTOM is active in two major areas of businesses i.e. Power and Transport

Commencing its operations in Kolkata in the 1910s and later in Chennai in the 1950s, ALSTOM in India traces its lineage to English Electric, CEGELEC, AEI, GEC ALSTHOM, ASEA, HBB, FLAKT and ABB, drawing its strengths from technologies developed over the years by these companies. ALSTOM has been a long-term player in India in the energy and transport infrastructure business, supplying critical electrical and industrial equipment including boilers and turbines and pollution control equipment for power plants, and transmission & distribution equipment. With its significant presence in the transport sector in India, ALSTOM provides railway equipment and technology solutions.

The Industrial equipment division with annual sales of 15 Million Euro manufactures rotating machinery, motors, industrial and domestic fans.

ALSTOM in India helps generate nearly 40% of the total power produced in the country.

In India, ALSTOM companies have together a turnover of about 150 Million Euro with about 2,700 employees. ALSTOM is the majority shareholder in ALSTOM Projects India Ltd.

In India, ALSTOM is active in two major areas of businesses:

- Power
- Transport

3.2 ALSTOM OPERATIONS:

Power:

The Power Sector forms a major part of ALSTOM's business operations in India, accounting for 59 per cent of its total revenue through its activities as an Equipment Supplier, Engineering Procurement and Construction Contractor and Products/Services supplier for central and state public sector utilities or Independent Power Producers.

ALSTOM's power sector in India specializes in designing & supplying integrated and cost efficient Steam, Combined Cycle and Hydro Power Plants.

This includes their Engineering, Procurement & Construction development and supply of Air Pollution Control Systems and Equipment. In addition, it also offers a full range of services in spare parts, repairs & maintenance to improve the reliability and availability of the plants.

ALSTOM's power sector also offers a complete range of Utility & Industrial Boilers in India. It has manufacturing locations at Durgapur in West Bengal and Shahabad in Karnataka.

With manufacturing location at Kolkata for Environment Control Systems, ALSTOM's power sector in India employs more than 1800 people, with annual sales in excess of 125 Million Euro.

A joint venture between ALSTOM and NTPC has a mandate for the total renovation and modernisation (R&M) business in India and the SAARC countries for thermal power plants and thermal based utilities.

ALSTOM's power sector in India has contributed towards more than 15,000 MW to India's power generation capacity with a successful track record in the execution of supplies & services for many prestigious power projects in the country.

Transport:

ALSTOM's Transport sector is among the leaders in rail transport in the world. Its TGV needs no introduction.

ALSTOM's transport sector in India is equipped with RDSO approved 'state-of-the-art' factory at Coimbatore equipped for manufacture, supply, assembly and testing of Power Electronics & Traction Equipment, Signaling products such as Point Machines, Audio Frequency Track Circuits etc. The company manufactures world class traction drives, auxiliary converters, control electronics, electro-mechanical products and safety systems. The factory is ISO 9001- 2000 and ISO - 14001 certified and is located in the industrial belt with access to component suppliers. The company also has a world class software centre at Bangalore handling design of Train Control System and Application Software.

Being members of the ALSTOM Transport Group, there is access to global technologies. ALSTOM's global transport product range includes TGVs and High Speed Tilting Train for industry operations, tramways and metro's for urban transit and locomotives, and freight wagons. It also provides train control systems, train life management services, the railroad maintenance and turnkey or full concession transportation system solutions.

The Transport sector in India has tremendous potential in view of similar upcoming metro projects in Bangalore, Hyderabad, Ahmedabad and other major cities in the near future.

The Transport sector sales in India averages over 10 Million Euro annually.

3.3 GAUTAMI POWER: GVK Industries has taken lead in the development of the 469 MW Gautami CCPP located in Peddapuram near Kakinada in Andhra Pradesh being developed at a cost of Rs. 14,500 million. The construction of this natural gas-based power plant commenced in early 2004 and is scheduled to synchronize with the AP grid by September 2006. Alstom is the principal EPC contractor. With its wide experience in the construction of power plants, Alstom is constructing this plant after having constructed GVK's Jegurupadu CCPP Phase 1 and 2. The Gautami power plant consists of the following constituents.

1) 2 Gas Turbine's of ISO rating 160 MW capacities each.
2) Steam turbine of 150 MW capacity.
3) 2 Heat Recovery Steam Generators which work on forced flow.
4) Switchyard Area consisting of Switchyard and switchyard building.
5) Transformer Area.
6) Chlorination Plant.
7) Cooling tower and cooling water pump house.
8) DG house.
9) Water tank.
10) Chemical Building.
11) Common Control Room
12) Clarifier Tank.
13) Demineralization Tank and DM plant.
14) Compressor Building.
15) Raw Water pump house.
16) High Speed Diesel Tanks.

4. COMBINED CYCLE POWER PLANT

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In a **combined cycle** power plant, or combined cycle gas turbine (CCGT) plant, a gas turbine generator is combined with a steam turbine generator with the objective to increase the efficiency of electricity generation.

In a thermal power plant, high-temperature heat as input to the power plant, usually from burning of fuel, is converted to electricity as one of the outputs and low-temperature heat as another output. As a rule, in order to achieve high efficiency, the temperature of the input heat should be as high as possible and the temperature of the output heat as low as possible. This is achieved by combining the Rankine (steam) and Brayton (gas) thermodynamic cycles.

4.1 RANKINE CYCLE

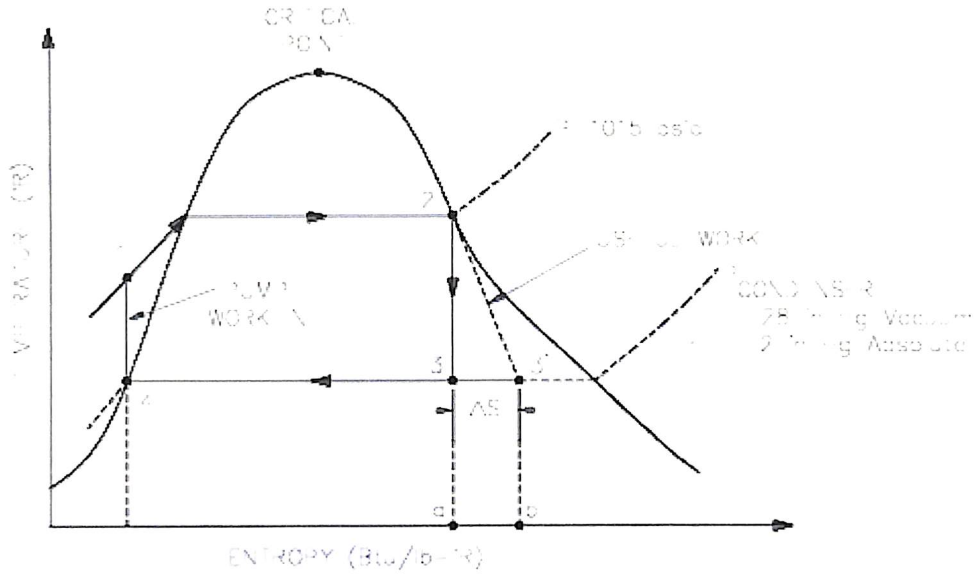
Rankine cycles describe the operation of steam heat engines commonly found in power generation plants. In such vapor power plants, power is generated by alternately vaporizing and condensing a working fluid (in many cases water, although refrigerants such as ammonia may also be used).

The working fluid in a Rankine cycle follows a closed loop and is re-used constantly. Steam seen billowing from power plants is evaporating cooling water, not working fluid.

Processes of the Rankine cycle:

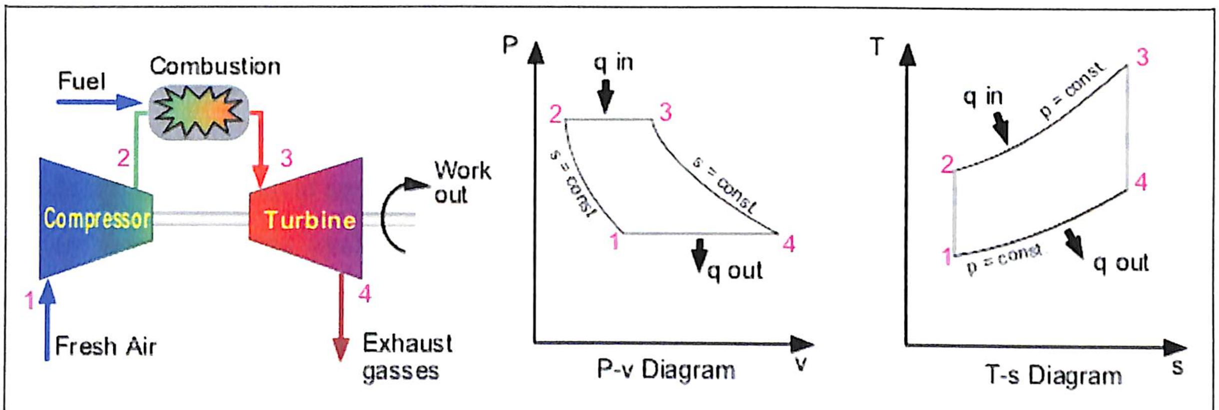
There are four processes in the Rankine cycle, each changing the state of the working fluid. These states are identified by number in the diagram above.

- **Process 4-1**: First, the working fluid is pumped (ideally isentropically) from low to high pressure by a pump. Pumping requires a power input (for example mechanical or electrical).
- **Process 1-2**: The high pressure liquid enters a boiler where it is heated at constant pressure by an external heat source to become a superheated vapor. Common heat sources for power plant systems are coal, natural gas, or nuclear power.
- **Process 2-3**: The superheated vapor expands through a turbine to generate power output. Ideally, this expansion is isentropic. This decreases the temperature and pressure of the vapor.
- **Process 3-4**: The vapor then enters a condenser where it is cooled to become a saturated liquid. This liquid then re-enters the pump and the cycle repeats.



4.2 BRAYTON CYCLE

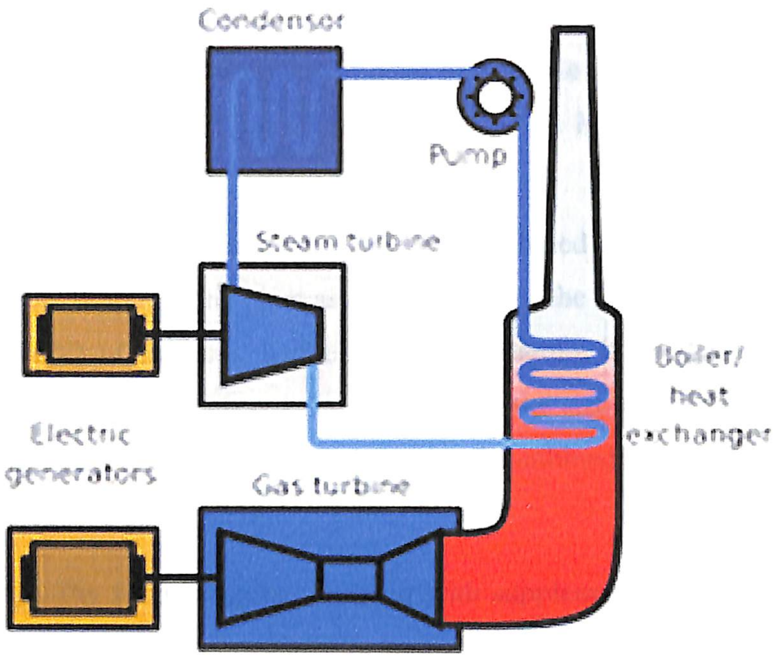
The **Brayton cycle** is a cyclic process generally associated with the gas turbine. Like other internal combustion power cycles it is an open system, though for thermodynamic analysis it is a convenient fiction to assume that the exhaust gases are reused in the intake, enabling analysis as a closed system.



Idealized Brayton Cycle

Ambient air is drawn into the compressor, where it is pressurized—a theoretically isentropic process. The compressed air then runs through a combustion chamber, where fuel is burned, heating that air—a constant-pressure process, since the chamber is open to flow in and out. The heated, pressurized air then gives up its energy, expanding through a turbine (or series of turbines)—another theoretically isentropic process. Some of the work extracted by the turbine is used to drive the compressor. Since neither the compression nor the expansion can be truly isentropic, losses through the compressor and the expander represent sources of inescapable working inefficiencies. In general, increasing the **compression ratio** is the most direct way to increase the overall power output of a Brayton system.

4.3 DESIGN PRINCIPLE OF A COMBINED CYCLE POWER PLANT



In a steam power plant water is the working medium. In this case high pressure has to be employed which leads to bulky components. High cost of special alloys that endures high temperature limit practical steam temperature to 655°C. For compact gas turbines this limitation does not apply and gas cycle firing temperature in excess of 1,200°C is practicable. In the combined cycle plant the thermodynamic working cycle is operated between the high firing temperature and the ambient temperature at which the low temperatures (usually governed by the sulphur dew point which is around 150° C depending upon the sulphur content in the fuel)at which waste heat can be disposed.

In a gas turbine set, composed primarily of a compressor, burner and the gas turbine proper, the input temperature to the gas turbine is relatively high (some 900°C to 1,350°C) but the output temperature of the flue gas is also relatively high (some 450°C to 500°C). Flue gas temperature is sufficient for production of steam in the second, steam cycle (Rankine cycle), with live steam temperature in the range of 420°C. The lowest temperature of the steam cycle depends (like in normal steam turbine power plants) on the cooling water temperatures which in turn depends upon ambient temperature, and dry bulb temperature, and the method of waste heat disposal, either by direct cooling by lake, river or sea water, or using towers. Therefore, by combining both processes, high input temperatures and low output temperatures can be achieved and the power plant efficiency can be increased.

The output heat of the gas turbine flue gas is utilized to generate steam by passing it through a heat recovery steam generator (HRSG) and therefore is used as input heat to the steam turbine power plant.

Efficiency of CCGT plants: The thermal efficiency of a combined cycle power plant is normally in terms of the net power output of the plant as a percentage of the lower heating value (LHV) or net calorific value (NCV) of the fuel. In the case of generating only electricity, power plant efficiencies of up to 58% can be achieved depending upon the size of the GT unit, cost benefit ratios of having a three pressure boiler etc. In the case of combined heat and power generation, the efficiency can increase to about 85%.

Supplementary firing: The HRSG can be designed with supplementary firing of fuel after the gas turbine in order to increase the quantity or temperature of the steam generated. Without supplementary firing, the efficiency of the combined cycle power plant is higher, however supplementary firing allows the plant to respond to fluctuations of electrical load. Supplementary burners are also called *duct burners*.

Supplementary firing is possible because turbine exhaust gas (flue gas) contains considerable fraction of unused oxygen. Due to temperature limitation at the gas turbine inlet, excess air, above the optimal stochiometric ratio is used. Often in gas turbine designs part of the compressed air flow bypasses the burner and is used for cooling of the turbine blades.

Supplementary firing is however generally resorted to in industrial power plants to correct the imbalance between power and steam demands. e.g. petrochemical plants, refineries etc.

Fuel for combined cycle power plants: Typical combined cycle plants are powered by natural gas, although other sources of fuel can be used such as fuel oil or synthesis gas. Supplementary fuel may be natural gas, fuel oil.

5. HAZARDS IN POWER STATIONS

5. HAZARDS IN POWER STATIONS

Power plants under construction and operations can be a source of various hazards. It is important that these hazards and their associated risks are identified and mitigation measures adopted wherever applicable.

Broadly the hazards in power plants can be brought under the following headings.

1) Hazards due to Construction
2) Mechanical Hazards
3) Electrical Hazards
4) Physical hazards
5) Chemical hazards

5.1 Hazards due to construction at the site can cause damage both to human life as well as to property. The main hazards during to the construction phase of the power plant are

1) Work at height
2) Erection and working of scaffolds
3) Lack of Personal Protective Equipment
4) Unsafe lifting equipment and lifting gear.

5.2 Mechanical Hazards at the site can be caused due to the large amount of machinery used at site. These can be due to revolving part of the machinery and can be controlled by providing machinery guards, which are statutory requirements of the Factories Act 1948. All lifting gear and equipments should be tested periodically and should display their lifting capacities

5.3Electrical hazards at the site can lead to shocks, burns, fire and explosion. Sufficient precaution must be taken to ensure that hazards are mitigated.

5.4 Physical Hazards can be due to Heat, Fire, Light and Noise.

5.5 Chemical hazards can be in the form of liquids and even gases. They are in the form of dust, smoke, fumes, poisonous gases, acids, alkalies. They enter the body through Inhalation, Skin and through Ingestion.

5.6 Fire hazards in power stations: In big power stations, huge boilers are installed to drive turbines with the help of superheated steam. In a separate turbine room (turbine hall) where the turbo-generator is installed, a lubricating oil tank of about 15000lts is installed as part of l of lubricating oil system, which circulates through the lube oil to the machine bearings. The flash point of turbine oil is about 205°C and the ignition temperature is 371°C. There is also a switch gear room from where the different transformers and electrical circuits can be switched on/off etc.. The main control room equipment is used to monitor and control the different system. The control room receives visual and audible signals that indicate the status of different systems and the important parameters. The operator on duty, according to the situation, can either reset certain parameters e.g. load, temp, pressure etc , or can switch on standby equipment, or shut down the plant , activate maintenance steps etc. The plant start up, operation, control and shut down is performed from the control room by a fully automatic ALSPA control system of ALSTOM.

Fire Risk: A modern power station is designed keeping in mind fire safety. There are several international design codes that are applicable. There are also local statuary regulations without which a power plant today cannot obtain a FIRE INSURANCE COVER. The main buildings like the turbine hall, control rooms etc steel framed building with brick or concrete and with reinforced concrete fire walls with separate the different hazard areas that house cubicles for its transformers and switch gears etc so that fire does not spread from one area to the other. Fire resistant doors are installed between these areas and are always kept closed by door closers. In the generating stations, the main fire risk is due to oil and the electrical cables which may either electrocute a man or cause a fire due to the formation of an arc and igniting flammable materials like bitumen, rubber, textile covering on the conductors or the lubricating oil or other materials used A large quantity of lubricating oil circulating through oil pipes for lubrication of turbines and alternators is afire hazard and for this purpose, oil pies are fully welded and flange joints are kept to a minimum. Further, oil pies are double walled around the turbine area. Double walled piping also prevents oil spilling on to the foundations in the event of pipe rupture, In a generating station, the turbo-alternator, rotating with high speed and producing a high voltage current, introduces in some respects, serious fire hazards. If there is any leakage of oil through fractured oil pipe sand if the oil comes in contact with hot turbine or superheated steam pipe, it will immediately ignite and with the aid of forced draught for cooling the generator and with forced oil circulation a veritable inferno may develop in a few seconds, resulting in serious fire damage and fatalities.

Fire fighting: Fires in generators are usually dealt with by the use of CO_2 equipment and the burning oil by water spray projectors; but the main difficulty is the inaccessibility to the burning materials within the generator and the fact that the machine takes about 20 minutes to run down and become stationary. A fire officer is usually acquainted with these hazards and the fire risks relating to the defective transformers oil filed cables and switchgear and the fuel stores.

Broadly fire-fighting equipment can be classified as 1) Manual and 2) Automatic.

Manual Fire fighting equipment:

Equipment for manual fire fighting can be classified as:

a) Hand appliances such as buckets for water or sand; shovels for san; implements for beating out fires; and asbestos or other fire-resisting blankets for smothering fires.
b) Portable fire-extinguishers with various agents for a range of risks; portable pumps for water.
c) Hose reels with jet or spray nozzles.
d) Foam making equipment such as branch pipes, mechanical foam generators, and proportioners.
e) Major hose and jet or spray nozzles.
f) Foam or dry-powder mobile appliances.
g) Special appliances or hand operated installations for special fire risks.

The best form of fire protection is to avoid fires altogether. The next best solution is to prepare for emergencies by selecting the correct type of equipment for the risk, and placing them in readiness.

Automatic fire fighting equipment: Automatic fire protection has played, and continues to play a great part in saving life and property from fire hazards in industry and commercial buildings. The provision of fixed pipe work systems employing water as extinguishing medium is acknowledged to be an efficient means of protecting buildings and many other classes of risk against extensive damage resulting from outbreak of fire. Such systems can be divided into three main classes.

a) Automatic Sprinklers: Automatic sprinkler and fire alarm systems use water to extinguish or control fire in its incipient stage. Pipe work is fitted with sprinklers spaced at regular intervals is installed through out the protected building, and is connected to a reliable water supply. When a fire occurs only the sprinklers in the vicinity operate and discharge water to control it. The operation of any one sprinkler causes an audible alarm to warn people around. Further the sprinkler systems are divided into Wet, Dry and alternate Wet and Dry system.

b) Drenchers: Drencher systems are designed to provide a discharge of water over windows, doors, or other openings in a building in order to prevent the transmission of fire from adjacent premises. Drencher systems have proved their value on numerous occasions by preventing the spread of fire across narrow streets.

c) Water spray systems: Water spray systems have been developed to deal with fires involving flammable liquids and are installed in a wide range of plant through out the world. It's widely used in power stations for protection of indoor and outdoor transformers, turbo-alternators, switchgear and other oil filled equipment. Water is applied in the form of conical spray consisting of droplets of water traveling at high velocity. Three principles of extinguishments are employed in the system-emulsification, cooling and smothering. The result of application of these three principles is to extinguish the fire with in seconds.

Transmission lines: The current generated is transmitted through special type of heavy-duty cables in view of the output from power station alternators ranging from 10,000 KW to 70,000 KW. There may be more than one generating station depending upon the consumption of electricity. The generating stations are linked together and to the main centers of consumption by a network of high voltage conductors called grid, which may be upto 132,000volt or even 4, 00,000volt. The transmissions may be through underground cables or overhead wiring of reinforced aluminium conductor fixed to galvanized steel lattice structures, being well secured and insulated from the structures by porcelain insulators and at adequate distance from the next phase conductor. . Underground cables are laid either on sand and buried directly of in concrete cable trenches.

Insulation of high voltage wiring: Cables are usually made in the form of a number of strands of copper wire twisted together in the form of a conducting core and then covered with the requisite number of layers of insulation and lead sheathing to prevent the access of moisture and armoring to provide the mechanical strength. For a conductor carrying 33,000 volt, the general arrangement for insulation of a three core cable is jute wrapping then wire-armoring, paper covering, lead covering and finally the cores of inner wire are insulated from each other by means of paper covering. Hence, in a fire involving these cables, dense black smoke with the burning of waxy substances and bitumen would be evolved. In view of the nature of the insulated coverings, such a fire is difficult to extinguish once it gets a good hold over the substance.

Distribution System-Grid: From the generating stations, current is fed by means of the grid to the substations, where by means of transformers, the voltage is increased to cope with the requirements of the area concerned. Such substations might be situated far away from the main generating station and hence a voltage drop results. Generally, the transmission liens are supplied with 1,32,000 volt and some times even with 2,75,000 or 4,00,000 volt. The need for the employment of high voltage is that it allows greater power to be transmitted over long distances, the minimum size of conductor and the transmission loss are proportional to the current, and for a given power, the higher voltage allows smaller-size conductors to be used and also reduce the losses.

Cooling of transformers: There are radiating fins on the body of the high voltage transformers upto 33KV. They also improve the dissipation of heat in addition to the general cooling effect produced by the circulation of oil. The working temperature of a transformer should not exceed 40-50°C. in oil-filled switch gears or transformers, volatilization of the oil by arcing and the consequent rupture of the tank with flaming oil and oil vapours flooding the compartment are the most serious features of the fire and a good structural protection by sectionalizing the transformer chamber or chambers from the rest of the premises is essential. The fire will otherwise inevitably spread and will be difficult to extinguish. For this reason, all transformer chambers, switchgears etc. are mounted in separate buildings or in chambers opening to the outdoor air, and scaled up from the inner side.

Transformer Mounting: Dwarf walls should surround oil-cooled transformer and a trench under the transformer should be provided through which oil contained in the transformer finds its way out to a concrete pit. Under the transformer there must be granite chippings, which are about 45cms deep. The granite chippings are to be placed on iron gratings under the pit. In case of a fire the blazing oil, while passing through the granite chippings, gets cooled and the clear oil may be filtered and allowed to drain away to a safe place outside, where it is automatically extinguished due to the cooling effect of granite, and in case any fire is found still blazing, this may be attacked with a foam branch if suitable size.

Fire protection of transformers: Transformers are protected by the water spray projector system, which not only extinguishes the fire but also cools the transformer. In addition the H.T transformers, have oil filled switchgears or circuit breakers that may also rupture and explode by formation of an arc inside and the blazing oil may thus be thrown all around. All major transformers are to be protected by automatic MV spray systems which are triggered by Quartz bulb heat detectors. The spray envelopes the transformer and starves the fire of air so that the fire is put out.

General fire precautions in generating station: There may also be fires in the outside yard where oil is stored. In an oil-fired furnace there is a danger of oil fire. In the turbine room the oil in the governor mechanism or in the gears may get cracked into the lighter fractions on coming in contact with heated surface of the turbojets or steam pipes and catch fire. Apart from these risks, in a generating station, there may be considerable amount of other flammable materials such as paint on steel work and insulation of cables. Burning insulation and in particular the bitumen used for sealing joints gives off dense clouds of smoke. It is therefore, necessary for fire fighters to use BA sets when entry has to be made inside. It should also be borne in mind that HT cables do not generally run near the ground level. There are placed about 2.5 metres high from the floor level inside the room or in underground cable ducts. Under no circumstances, during fire fighting, should any such parts be touched by a fireman standing on earth without clear instruction from the shift engineer-in-charge that it is safe to do so.

Safety measures for fire risk at generating stations: The general measures are given below.

Switchgear:

1) Switchgear should be divided into suitable sections interconnected by circuit breakers. Each section should be separated from adjacent sections by fire-resisting partitions. In major installations it may be desirable to house the sections in separate buildings.
2) Individual sections of switchgear should not be normally used for controlling, generating or transforming plant having an aggregate rating of more than 60,000 KVA together with a corresponding amount of feeder supply.
3) Feeder circuits should be connected to the various sections in such a manner as to ensure the maintenance of all essential supplies even with any one section out of commission.
4) The current loading per circuit breaker or busbar should not normally exceed a limit of 2000 amp. When loading individual circuits approach this limit, consideration should be given to the adoption of higher busbar voltage.
5) Separate vent pipes from each phase switch tank or tank group to the outside of the building should be provided wherever possible. These pipes should be reasonably straight, free from sharp bend and projecting in an upward direction so as to ensure the

free dispersion of any gases that may be given off from the oil in the switches under normal operating conditions.

6) The primary circuits of voltage transformers should be provided in addition to protection by suitable fuses with a sensitive from of automatic protective device such as that for the bus zone, feeder or power transformer circuits. Current-limiting resistances should be employed in series with primary fuses, the carrying capacity being proportional to the time/current rating of the fuses. Secondary circuits should always be protected by suitable fuses installed as near to the voltage transformer as is safe and practicable.
7) Control or operating busbars, when run near electrically operated switches, should be protected from the effects of fire or short circuit either by screening or by effective separation. Fuses for branch circuits to individual switches should be in the screened or protected area and not near the switches themselves since damage at the fuses may bring about a fault on the control busbars.

Cables:

1) Where cables pass through a switch room floor into a basement or cable tunnel, adequate precautions should be taken to prevent a) draining of oil from the switch room into the basement or tunnel, b) the slipping of the cables into the basement or tunnel.
2) In addition to the usual clamps above the floor level, cables should also be clamped immediately below floor level and in addition to the usual kerb round the cable at floor level each cable or group of cables should, where possible, be protected by a pipe or a form of heat resisting material rising to a height of at least 45cm above floor level or terminating just below the cable gland, sealed at the bottom and filled with sand or small pebbles.
3) Alternately, where it is impracticable to use this method of protection, a tight asbestos floor seal should be made and the cable between the floor level and dividing box should be wrapped with asbestos webbing. The webbing should not be less than 0.3 cm in thickness and two layers wound half lap and should be put on each cable. To render it non-absorbent to oils, this webbing should be painted with a fire-resisting paint and further protection may be given by providing one wrapping of thin steel tape and wound half lap from the bottom up.

4) Jute serving should be removed from all cables in switch room basements and tunnel; where this is impracticable, individual cables should be protected by a 10 to 1 mixture of clean, sharp sand and cement applied direct on the jute to a thickness of 5-7.5cm.
5) Main cables connected to any one section of busbars should be separated from the main cables connected to any other sections by fire resisting partitions wherever possible.
6) Where existing cables rest on the floor of tunnels or basements, they should be separated into groups of vertical barriers of tiles, brick, concrete and the trenches should formed should be filled with small pebbles.
7) Control cables should be divided in the same way as main cables and should follow an entirely different route where control cables are necessarily run in the same basement or tunnel as main cables. Special precautions should be taken to prevent fire spreading from one set of cables to another.
8) Power supply cables to the fire pumps should not pass through or below any buildings.

Building:

1) Buildings should be of fire-resisting construction and any part of the steel framework, which is liable to distortion by fire, should be protected with brickwork, concrete.
2) Apparatus other than switchgear involving special risk of fire or explosion should be segregated into separate sections or in separate buildings. Where such apparatus has to be located in the main building, it should be segregated by fire resisting partitions into a separate chamber with entrance from outside of the building.
3) Roof lights should be of wired glass. Other windows should be preferably of plain glass.
4) The type of building construction should be such that relief of the pressure is afforded in the vent of an explosion resulting from a failure of switchgear or other apparatus. Such relief may be provided to varying extents by window glazing, light doors or other means, it is suggested that the combined areas. It is suggested that the combined area of the doors and windows in the outside walls should be of the order of one-third of the total area of the wall.
5) Every switch room, transformer room or fire resisting section unless such room or section is of small size- and should be provided with two doors preferably at opposite ends. Any emergency door in outer walls should preferably open outwards.

6) Doors between sections should be fire resisting and self closing sill or other means should be provided at any opening, including ventilation openings, to prevent the flow of oil from one section to the other. The sill should be capable of holding all the oil in each section and should be of a minimum height of 15cm where two or more transformers are located in one room and where it is not practicable to have barrier walls of full height. Each transformer should be surrounded by a sill to prevent any leakage of oil from one flowing under another.

7) The floors switch and transformer rooms containing oil-filled apparatus should be provided with suitable drainage so that oil may flow away freely. The drains should pass to soakaways situated outside the buildings, and away from exits or entrances-the soakaways consisting f pits, filled with pebbles graded from 2,5 cm to 5 cm.

8) The floor of each switchgear cubicle should be dished and have individual drain pipe to the soakaway. Where more than one transformer is located in a room, this practice should be adopted in respect of each separate transformer.

9) The floors of switchgear cubicles, switch room, transformer rooms should have a minimum slope of 1 in 100 to the drainage pipe, but a slope of 1 in 30 or 1 in 40 should be adopted where possible.

10) Adequate heating and ventilation of switch rooms to prevent condensation of moisture are essential.

11) Where fire-resisting partitions are of bricks they should not be less than 25 cm in thickness and preferably reinforced. In the case of existing unsectioned switch houses, such partitions or suitable barriers constructed of asbestos-covered steel, stone or reinforced concrete should be added.

Maintenance of equipments:

1) As most fires having an electrical origin are due primarily to failures of insulation, it is important that the insulation of all electrical equipment should get frequent attention and be systematically inspected at regular intervals.

2) All parts of switchgear and transformers to be examined frequently and carefully for signs of overheating, cracking or for any other indication of incipient failure of insulation.

3) Main and auxiliary contacts and protective gear should be inspected and subjected to operation test and test of the oil used in switches and transformers should also be made at regular intervals.

Routine testing of switchgear:

1) Periodical testing of the insulation of such parts under skilled supervision is desirable and the test should be carried out at intervals of about six months. Normally, the tests are only against insulation and over-voltage and the latter should be carried with an AC voltage having a value of not less than 1.6 times the normal RMS voltage across the insulations under test.
2) Over voltage tests should be preceded by a careful inspection of the switchgear and it is advisable to make measurement of the power loss and current during the test. All records of tests are to be maintained.

Special steps to be taken in an emergency:

1) If a fault develops and fails to clear itself automatically owing to faulty equipment being outside the protected zone, or due to protective gear failing to operate, the faulty section should be isolated by hand as quickly as possible even though this may involve an interruption of supply. Where a fire results from such a fault and persists after the power supply is cut off, any adjacent sections of the installation, which is likely to be affected by the fire, should also be made dead as soon as possible. This applies particularly where an oil fire has started.
2) It is important that in the event of a fire the local fire brigade should be called immediately, either from a street fire alarm or from a telephone line or exchange telephone and the staff concerned should be familiar with them. The telephone number of the local fire brigade should be prominently displayed with requisite instructions on a fire notice board.

Fire prevention and Fire fighting equipments:

1) Cooperation with local fire brigade is essential and from time to time opportunities should be given to the officers of the brigade to make themselves familiar with the layout of the generating station, switchgear, transformer and with the location of local fire fighting appliances provided especially where any alteration or extension have been made. A framed plan showing the position of water supplies, hydrants, means of access

and special danger zone and other useful information should be displayed at suitable points.

2) Neither the self contained breathing apparatus nor the respiratory devices should be used except by men trained in their use and in this connection the local fire brigade should be consulted.
3) Hand fire fighting appliances should be provided in adequate numbers and so placed that they are readily available to attack any fire in its initial stage on any part of the installation. There should be an ample supply of dry sand in bins with suitable scoops or shovels.
4) With regard to places such as unattended switch rooms, where the occurrence of fire may prevent access, it is essential that a sufficient number of portable fire fighting appliances be provided outside the place, adjacent to the entrance.
5) For fighting oil fires, following equipments are recommended.
    a) Switch room, indoor transformer and underground substation may be protected by: 1) Emulsion forming water spray injector.2) CO_2 apparatus, provided risks of reignition are effectively covered. These are of fixed installation type. In addition, portable appliances such as 3) Hand Appliances and sand, and 4) hose and foam equipment to enable foam and water sprays to be produced and applied manually after rendering the circuit dead are also used.
    b) Outdoor transformers may be protected by 1) Fixed apparatus such as emulsion forming nozzles and 2) portable apparatus using DCP or foam under certain conditions.
6) Cable basements and cable tunnels of limited cubic capacity may be protected by carbon dioxide apparatus where effective sealing from the outside atmosphere can be ensured and in other cases by ordinary water sprinklers. Heat sensing cables are used to detect cable fires and to actuate the fire protection system.

Special Notes:

1) Local fire brigade should be consulted for installing fire hydrants.
2) It is important that all members of the staff of the electricity undertaking should be familiar with the handling of the fire fighting appliances installed so that when the occasion for use arises, no time is lost.

3) All fire appliances and equipments should be properly maintained by trained personnel and kept in a state of readiness, fit for emergency use.
4) Automatic fire alarms are to be installed at vulnerable places to be maintained properly.
5) Fire notices indicating telephone number of the nearest fire station and actions to be taken in case of emergency to be displayed at all places, especially hazardous locations.
6) Mock fire practices and fire drills to be conducted at regular intervals in which all members of the staff should participate.

The layout of the building with the location of the transformers, switchgears, underground cable ducts, water supply and fire fighting equipments installed should be displayed near the main entrance to facilitate the fire fighting operation.

6. HAZARDS IN CONSTRUCTION

6. HAZARDS IN CONSTRUCTION

Construction industry is the second largest economic activity in India and the capital investment is much larger than other industries. Inspite of mechanization the construction industry remains a labour intensive activity area. Being an unorganized sector the work is carried out on a daily or labour contract basis. Projections estimate the accident rates in construction industry as 3 times the manufacturing sector.

6.1 Hazards in construction work:

The causes of accidents in construction work can be divided in two categories

1) Unsafe working condition
2) Unsafe acts.

Unsafe working conditions: The unsafe working conditions results from failure to lay down safe systems of work and also failure to maintain the accessories used for construction in a safe condition. The unsafe working conditions can be divided into following subdivisions:

1) Ground access
2) Suspended access
3) Excavations
4) Ladders
5) Scaffolds
6) Access to high levels
7) Other material handling equipment.

6.2 Ground access: In many construction sites a clear walkway is not provided resulting into serious hazards. The workmen has to find his way through waste, protruding nails, improperly illuminated areas, uncovered trenches and piles of scaffolding material etc. It is desirable to eliminate such hazards to minimize accidents due to improper access.

Checklist for Ground Access

S.No	Item	Yes	No
1	Pedestrian walkways free from obstruction, giving access to entrances and exits, jobs site huts, and workshops.		
2	Access and exit walkways properly lighted without shadows		
3	Steps and stairs having handrails throughout their length.		
4	Holes and edges from where people can fall more than 2m, having guardrails and toeboards, or barricaded off or covered and neatly marked.		
5	Materials stacked securely so that no part of stack collapses and obstructs the walkways.		
6	All waste timber stacked well away from walkways, after removing all protruding nails or hammering them flat.		
7	Trailing cables where unavoidable, collected together and positioned clear of walkways. Cable joints properly insulated.		
8	Walkways routed below and overhead working platform.		
9	Threads of steps and stairs in good condition, free from mud, grease etc.		

6.3 Suspended Access: It is a common practice at construction sites to provide suspended platforms from permanent structures to have an intermediate access, wherever the working platform is too high for the ladders. The following can ensure safety of such platforms:

Checklist for Suspended Access

S.No	Item	Yes	No
1	Integrity of suspended ropes certified by competent person before each days use.		
2	Safety of all joints for suspension ropes and other mechanical members of the suspended platform certified by competent person before each days use.		
3	Guardrails provided for the platform.		
4	Slides not used for material transport to be closed with mesh or intermediate rails.		

6.4 Excavations: Excavations are necessary in any construction sites for establishing foundations for the buildings and structure or for constructing the underground passages for underground stories of buildings etc. Steps must be taken to minimize accidents in relation to excavations.

Checklist for Excavations

S.No	Item	Yes	No
1	Provide clear access to the excavated work area from material supply location.		
2	Easy means of escape in the event of emergency through alternate access provided?		
3	Ladders placed in supported part of trench and secured to avoid slipping.		
4	Workmen engaged instructed clearly on the mode of escape in the event of emergency.		
5	Supervisors trained for rescue operations.		
6	In case excavated trench becomes a confined area, due to temporary platforms provided for other activities etc., all precautions taken for safe working.		
7	Continuous fresh air supply ensured independent of electrical power failure, in case of insufficient oxygen due to continuous welding operations or other flames in the excavated trenches.		
8	Edges of excavated portions protected by proper grid barriers to avoid collapse of sand or other material, leading to accident.		
9	Wherever foundations of adjacent buildings located close to excavated trenches precautions taken to avoid sand below such foundations slopping to newly excavated area.		
10	If excavated trenches are deeper than 2m, all gangways or platforms constructed above trenches have hand rails		
11	Stop blocks provided to avoid vehicles reversing into the excavated trenches.		

6.5 Ladders: Ladders are the most commonly used means of access at any construction site. Since chances of accidents are more, it is desirable to avoid or minimize the use of ladders at construction sites.

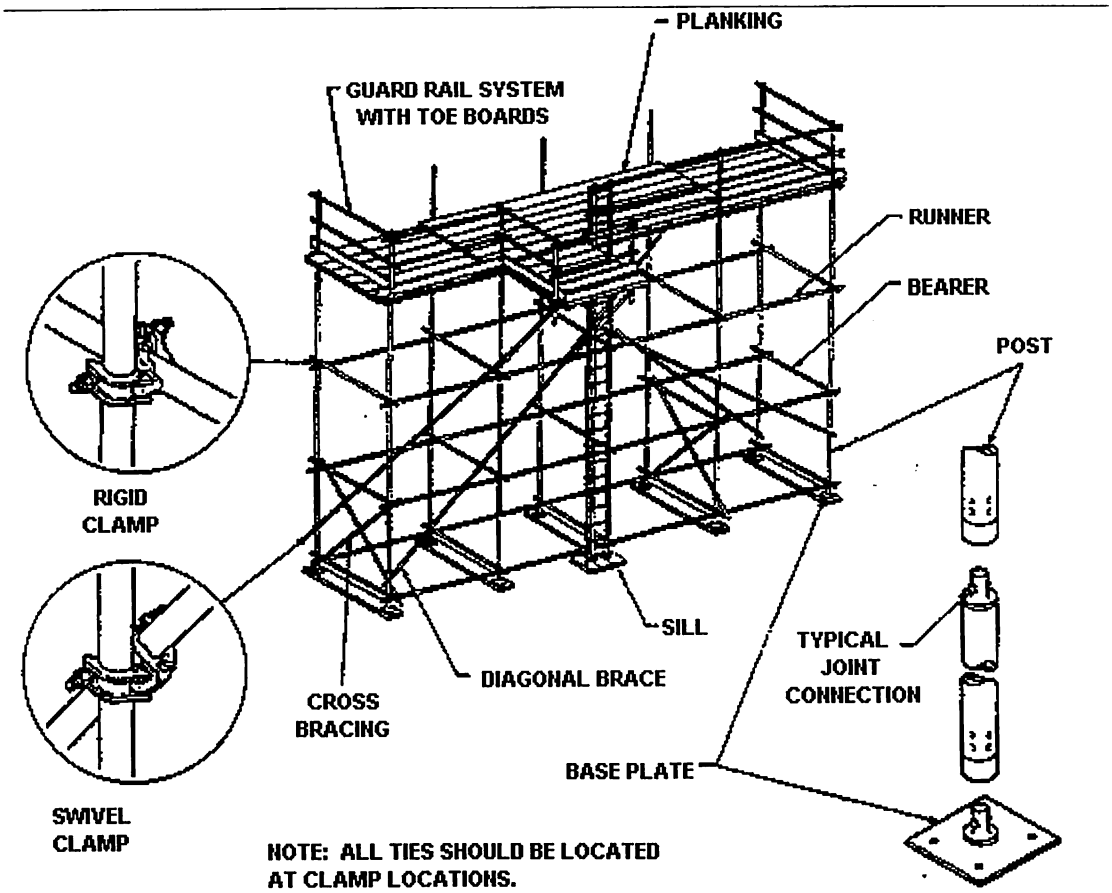
Checklist for Ladders

S.No	Item	Yes	No
1	Is ladder having missing rung?		
2	Ladder secured at the top and bottom to avoid slipping.		
3	Are sideways overreached from the top of the ladder?		
4	Ladder supported on oil drums or similar unstable objects.		
5	Ladders examined for their mechanical strength by competent person at regular intervals depending on the type of ladders, materials and type of construction.		
6	When using ladders on stairways proper steady base for both the support frames at the same level provided.		
7	Adjusting device provided on lower step if stairway doesn't provide sufficient width.		
8	Standby man present when ladder is used.		
9	Only one man working from the ladder at a time.		
10	Stop block provided for ladder frame if ladder support is on hard ground.		
11	Rope permanently tied to the ladder, in case work involves frequent transfer of materials and tools to the worker working on top of the ladder.		
12	Is the ladder maloperated?		
13	In sensitive operations, platform ladder having a built in platform or ladders with A frame structure used?		
14	One hard free for holding for safety while working on ladder?		
15	Tool belts used for carrying tools?		

16	Materials hauled up and not carried while climbing.		
17	Projection of ladder at least 1m above landing level, when ladder is used to provide access for a higher level.		
18	Metal Ladders used near electrical hazards?		
19	1:4 Ratio maintained when placing ladders?		

6.6 Scaffolds: The vast majority of accidents in the construction industry are resulting from falls of persons, and or materials. Falls of persons from heights can be prevented if scaffolds and working places are properly constructed and protected by the provision of guardrails and toe boards. The ideal scaffolding arrangement and the general principles involved in the construction and maintenance of scaffolds are described below:

1) The Base
2) Decking
3) Guard Rails and Toe Boards
4) Scaffold construction
5) Cantilever Scaffolds



The Base: Base of a scaffold is very important. Before erecting any scaffolding it is necessary to prepare the ground, which is to be the base. The ground must be leveled of and compacted so that there will be no movement once the scaffold is erected. Sole plates as bearers should be placed to receive the standards. These soleplates should be of bulk timber, such as old railway sleepers or similar material. On them the base plates should be placed and fixed and a nail driven into the hole provided for this purpose. It is necessary to take care in setting out the position of standards, before deciding the position of the sole plates.

The span between the standards should never be greater than 2m. Wherever chances of abnormal loading is anticipated the span between the standards should be brought down to carry the additional loading. All standards should be fixed in a vertical position-ledgers should be clamped to the standards using right angle couplers. All ledgers must be horizontal and either putlogs or transoms fixed to them, depending on the type of scaffold being erected.

ALSTOM

GAUTAMI POWER LIMITED IDA, PEDDAPURAM

SCAFFOLD INSPECTION CHECKLIST

SUB CONTRACTOR :

DATE & TIME :

LOCATION :

Sl. No.	PARTICULARS	YES	NO	REMARKS
1	Are experienced & trained scaffolders carrying out the erection and dismantling of scaffolding at site?			
2	Are scaffolding materials free from damaged and corroded being used at site?			
3	Are scaffolding materials stored in an identified location in neat and tidy?			
4	Are base plates or wooden pieces provided for all standards?			
5	Are couplers checked visually before using for erection purpose?			
6	Are cross bracing provided for scaffolding structure?			
7	Are adequate means of access (ladder) provided for scaffolding structure?			
8	Are proper work platform provided for carrying out work safely?			
9	Are handrails and mid rails provided for all work platforms?			
10	Are adequate transom provided below work platform?			
11	Are all workmen working at 2mtr elevation of scaffolding being used safety harness and anchored above the location?			
12	Are scaffold inspected for allowing workmen to use?			
13	Are scaffolding provided with SCAFF-TAG?			
14	Are all scaffolding structure inspected on weekly basis?			

Inspected by

Name & Sign:

Decking: For decking it is normal to use 40*225mm scaffold boards. The maximum span permitted for this board is 1500mm., and it is considered to be safer to have less than this span. The usual width of a putlog scaffold sometimes referred as bricklayers scaffold is five boards wide. As boards are 225mm wide this gives a width of 1125mm, but allowance must be made on the inside for the use of a level or plumb rule. This distance should not exceed 100mm, consequently when setting out; one must position the standard 1245mm from the wall. At any time the space between the platform and face of a building should be as small as possible. If the workmen have to sit on the edge of the platform, gap should not exceed 300mm. For a working place the minimum width permissible for the passage of person is three boards, for the passage of materials it should be four boards wide. For a gangway or run, the minimum width permissible is 430mm i.e., two boards and for the passage of materials it is 635mm, i.e., three boards.

Guardrails and Toe Boards: Any scaffold from which a person can fall a greater distance than 2m must be provided with guardrails and toe boards. The guardrails must be of adequate strength and be between a height of 900mm and 1140mm above the platform. The distance between any toe board and the guardrail above it should not exceed 750mm.

Scaffold Construction: All scaffolds must be built using materials of adequate strength suitable for the job and free from patent defect and properly maintained. The tubes used for scaffolding must be of a suitable quality and be in good condition. Tubes used should not be painted or treated in any way to conceal the defects. All scaffolds must be properly braced and adequately tied in to ensure stability. In the case of independent scaffolds or putlog scaffolds, it is as well to ensure that the building is strong enough to carry the loading that imposed by the scaffold. All scaffolds must be adequately tied into the building through out their length and height to prevent movement either towards or away from the building. This tying in should be done using double couplers. As far as possible all bracing should also be fixed using double couplers at alternate pairs of standards. If this is absolutely impossible then a swivel coupler may be used for bracing but no other type of fitting.

Cantilever Scaffold: It is some times necessary to build a scaffold over gateways or openings where it is impossible to build traditional scaffolding because means of access is to be provided fro traffic. This situation is some times met by building a cantilever scaffold, on others by a hanging scaffold. If a cantilever scaffold is used, then people who have specialized experience building such scaffolds should do the work. Before the works starts a thorough examination must be made to ensure that the building from which the cantilever is to be erected is strong enough and in good enough condition to bear the loadings.

6.7 Access to high levels: It is essential to carry out jobs at high levels, during concreting of the roof slabs, constructing the walls at higher levels, preparing the shuttering works for slabs, finishing activities in various floors etc. in a construction site. As the construction is in progress access to high levels shall not be in the final shape and there are chances of people falling due to inadequate and improper access to high levels. The hazards are having an additional serious dimension especially when the workmen engaged have to carry construction materials along with him to high levels.

Checklist for Access to high levels

S.No	Item	Yes	No
1	Access provided to roof or platform after inspection by competent person and issuance of certificate confirming mechanical strength for designated job, including the limitations, precautions etc.		
2	Notice displayed in case of any restriction for access.		
3	Instruction to all workmen on such notices.		
4	Sloping roof is dry and free from any growth of algae or oily material.		
5	Walking allowed on purlins and gutter brackets.		
6	Crawling ladders or boards used with ridge hooks on roofs sloping more than 30 degrees.		
7	Crawling ladder covering entire length of work		
8	Weather conditions favorable for roof sheet fixing.		
9	Safety individual lifeline provided for workmen		

6.8 Other Material Handling Equipment: With the advancement of material handling equipment, to the construction industry, newer types of hazards are being introduced. In an organized factory workers are generally skilled and more receptive to training and instructions on the use of material handling equipment and the hazards associated with them. In the case of construction industry a large number of contract labourers, majority of them unable to understand the risk involved in working with material handling equipment. Therefore in the case of construction industry the site supervisor's responsibility of training on such hazards much more than when compared with similar assignment in manufacturing unit.

Unsafe Acts: In the case of unsafe working conditions, the elimination of hazards is relatively simple due to the fact that the job involves mainly engineering revisions. However in the case of unsafe acts the elimination of hazard is really a tough job as it involves changing the attitude of an individual worker or a group of workmen. The well known prevention methods for unsafe acts are

1) Instruction, Persuasion, and Appeal.
2) Personal adjustment
3) Discipline

Any supervisor or safety engineer engaged to provide the necessary training, appeal and enforce the discipline at the construction site with the objective of minimizing unsafe acts on the part of the workmen engaged shall follow the checklist below:

- Identify different categories of work at site and the hazards involved in them.
- Decide the skill required for each category of work identified.
- Decide the skill required for a group leader, who shall be responsible for supervising 100% workmen in his group.
- Draw out a training program for each category of workmen including the group leader.
- Make sure that the group leader trains his workmen with random supervision or involvement from the site incharge.
- The training program shall emphasize the basic knowledge about the risk involved in each category of job.
- Establish an impression among the workmen that there is no scope for fooling around at the worksite.
- Ensure that the group leaders find out details on personal sickness and other injuries from an outside source of all the workers engaged at the site on a daily basis, before the physical engagement of the workers.
- If necessary sick workmen shall be given lighter jobs involving minimum hazards.

- Those who plan and break the safety regulations shall be given model punishment to establish a good precedence at the site. However, if the worker is committing a mistake for the first time, he shall not be subjected to any formal punishment other than oral warning.
- Whenever a worker is newly engaged to a site or an existing workman is relocated to a new job the hazards associated with the new job should be briefed extensively in a formal session.
- All emergency signals and alarms should be familiar for all workmen and group leaders.
- The group leaders shall have additional training in rescue operations, first aid and use of fire extinguishers.
- All workman and group leaders shall be aware of the hazards of interfering with the electrical lines provided for lighting and other machinery.
- All workmen to be trained for using the correct tools for the respective job.
- There is no scope for blaming workmen, if he has met with an accident, so long as he has not bee briefed about the particular hazard of the job. Such a situation is indicative of the cleat defect on the part of the site incharge.
- Wherever jobs involving serious hazards the performance of a new worker to be observed on the job directly by the site incharge to verify the effectiveness of the training program.
- The site incharge shall be aware of the human factors, which can cause accidents.
- Smoking to be prohibited at all work sites to avoid any resulting fire, accidents and hazards to passive smokers.

6.9 Safety Belts, Harness, and Lanyards: If a person is at risk for falling three meters or more at a workplace, he should wear the appropriate fall protection equipment.

If the fall protection is required a complete fall protection program should be established, if one is not in place. The program should include the training of workers and the selection, fit testing, maintenance and inspection of the equipment.

Fall Protective Equipment:

- Equipment should be inspected daily.
- Defective equipment should be replaced. If there is any doubt about the safety of the equipment, do not use it.
- Replace any equipment, including ropes, involved in a fall. Refer any questionable defects to a trained inspector.
- A trained inspector should examine equipment at least yearly.
- It is advisable to use shock absorbers if the arresting forces of the lanyard alone can cause injury.

Inspecting the webbing:

- The entire surface of webbing should be inspected for damage. Beginning at one end, the webbing should be bent in an inverted "U." Holding the body side of the belt towards self, the belt should be grasped with our hands six to eight inches apart.
- Frayed edges, broken fibers, pulled stitches, cuts or chemical damage should be watched for. Broken webbing strands generally appear as tufts on the webbing surface.
- Replace according to manufacturers' guidelines.

Inspection of Buckle:

- Inspect for loose, distorted or broken grommets. Do not cut or punch additional holes in waist strap or strength members.
- Check belt without grommets for torn or elongated holes that could cause the buckle tongue to slip.
- Inspect the buckle for distortion and sharp edges. The outer and center bars must be straight. Carefully check corners and attachment points of the center bar. They should

overlap the buckle frame and move freely back and forth in their sockets. The roller should turn freely on the frame.

- Check that rivets are tight and cannot be moved. The body side of the rivet base and outside rivet burr should be flat against the material. Make sure the rivets are not bent.
- Inspect for pitted or cracked rivets that show signs of chemical corrosion.

Inspection of Rope:

- Rotate the rope lanyard and inspect from end to end for fuzzy, worn, broken or cut fibers. Weakened areas have noticeable changes in the original rope diameter.
- Replace when the rope diameter is not uniform throughout, following a short break-in period.
- The older a rope is and the more use it gets, the more important testing and inspection become.

Inspection for Hardware:

- Inspect hardware for cracks or other defects. Replace the belt if the "D" ring is not at a 90° angle and does not move vertically independent of the body pad or "D" saddle.
- Inspect tool loops and belt sewing for broken or stretched loops.
- Check bag rings and knife snaps to see that they are secure and working properly. Check tool loop rivets. Check for thread separation or rotting, both inside and outside the body pad belt.
- Inspect snaps for hook and eye distortions, cracks, corrosion, or pitted surfaces. The keeper (latch) should be seated into the snap nose without binding and should not be distorted or obstructed. The keeper spring should exert sufficient force to close the keeper firmly.

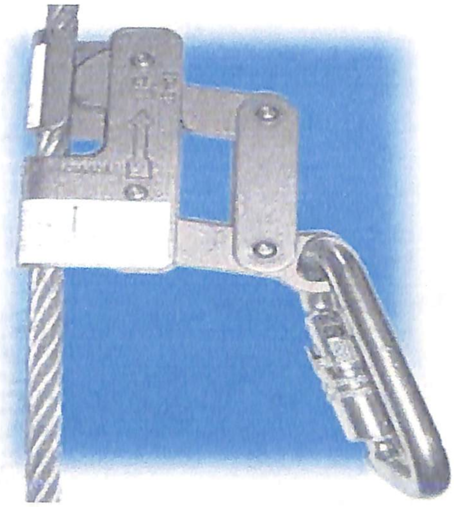
Safety Strap Inspection:

- Inspect for cut fibers or damaged stitches inch by inch by flexing the strap in an inverted "U." Note cuts, frayed areas or corrosion damage.
- Check friction buckle for slippage and sharp buckle edges.
- Replace when tongue buckle holes are excessively worn or elongated.

Cleaning of equipment:

- Wipe off all surface dirt with a sponge dampened in plain water. Rinse the sponge and squeeze it dry. Dip the sponge in a mild solution of water and commercial soap or detergent. Work up a thick lather with a vigorous back and forth motion.
- Rinse the webbing in clean water.
- Wipe the belt dry with a clean cloth. Hang freely to dry.
- Dry the belt and other equipment away from direct heat, and out of long periods of sunlight.

Store in a clean, dry area, free of fumes, sunlight or corrosive materials and in such a way that it does not warp or distort the belt.



7. MECHANICAL SAFETY

7. MECHANICAL SAFETY

The inventions of the twentieth century has given us a wide choice of tools and machines to be used by unskilled or skilled workers. But for mechanical invention, living standards would not have moved very far away from those of the cave where all work was manual. We live by machines and machinery: we work with machinery.

There is lack of knowledge of the special hazards associated with machinery. The many personal injuries, some leading to death, confirm that we don't fully understand the inventions for which we are responsible and that we are not in control of the machinery we use. By nature and use, there is conflict between the person employed with machinery and machine itself. Working with machinery is dangerous; control of danger is essential if we are to live with and profit by the use of machinery.

This section is divided into the following parts.

1) Hazards of working on Machinery
2) Hazards in welding operation.
3) Grinding wheels
4) Steam Boiler and pressure vessels.
5) Sling chains.

7.1 Hazards of working on machinery:

Guarding of machinery: Factories Act and rules framed under the Act by various states of the Indian Union has been a major factor in the control of hazard. The statutory requirement is that the machinery has to be safe without regard to the qualities of the operator who is likely to make an error. Guarding of machinery is used to indicate that which is required to prevent injury to those employed in connection with operating or maintaining the machinery. Each machine designer strives to produce machinery, which will perform its desired function without mishap to the machine or to people; there must be 100% accomplishment of this aspect of accidental personal injury is to be avoided. The designer should not give scope for those who use his machine to have to apply their experience and skill in using it safely; the designers duty is not carried out if there is need to guard dangerous parts of the machinery, the user has the advantage of deciding how when and for what purpose he will use the machine; he knows of the danger of machine-person relationship. If a machine is so segregated from the person that contact of any sort is impossible, there is little hazard to that person. This is why those engaged in accident prevention emphasize over and over again that the complete enclosure of the source of danger so as to exclude the person who may be at risk is the best method of controlling hazard. Secured fixed fencing of the dangerous part is only a satisfactory method.

Fixed guarding of dangerous parts, which doesn't enclose completely the dangerous parts, may be at times equally effective for preventing injuries. It has to be ensured that there is no possibility of access through any opening of guard, which will permit the worker to gain contact with the dangerous parts of the machinery. This method is used where it is necessary to feed a component or materials to a die and till or in an area like in running intakes of calendar machines.

Safeguarding by other than fencing: If all dangerous parts were required to be made safe by secure fencing it is certain that the commercial use of much useful machinery would be prohibited. Therefore a large number of devices have been designed which are equally satisfactory in the prevention of accidents. Machinery and production are so diverse that even these methods are not sufficient to control the hazards. There are occasions when the use of a machine precludes any secure fencing and the more usual methods of ensuring operator safety.

Interlocking devices are used to ensure that whenever access to the danger zone is possible, the machine or its dangerous parts cannot be in a state of motion. Once the fencing has been replaced in an effective position to exclude the operator, the machine can only be set into motion. Once the machine is in motion, the fencing cannot be removed, until the machine has come to rest. These devices use mechanical, electrical, electronic or light rays as interlocking system.

Trip devices are used wherever secure fencing is precluded by the very process requirement for which the machinery was designed. Such devices are often used in connection with partial fencing and with distance fencing, which permits operation of the process far away and enough to ensure safety, and controls inadvertent or other approach to danger zone. The devices are some times wholly mechanical or photoelectric cells controlled. A fixed barrier can be seen and its effectiveness assessed. A light beam can be seen but its effectiveness is not visible. A capacity device cannot be seen. However this defect has not prevented their effective development. Devices are available which automatically monitor by control circuits to ensure that the device will answer an emergency call. If this response is positive the machine controls come into operation; otherwise there is failure of safety. The success of such systems heavily depends on the effective routine maintenance and check systems prescribed in use.

Automatic guard: Operations of some machines involve complete exposure of the dangerous parts so that the fixed guards, interlocking, and trip devices are not practicable. In such cases rescue apparatus or automatic guards are used. Their function is simple: a person is in danger- they remove him forcibly. Such a device requires careful design. Its operation must not be so fierce as to inflict injury by itself; it must be able to work within a field in which there is adequate time and space for it effectively to perform its functional and its design must incorporate a safety factor so that it is always effective within the field of application. Here again maintenance is a vital feature of the success of its use.

Maintenance, Lubrication, Codes of practice: With all guards, safeguards and guarding systems, the reliability solely dependent on periodical maintenance and checkups. Any deficiency of the effective maintenance is view under Statute law as a clear breach of the prime requirement of that provision. Whenever any safety device is used, be it a simple fixed or more complex guard, it is essential that maintenance be provided, organized and supervised. With non-complex guards, like enclosures or encasements, purposeful careful inspection by supervisory staff is sufficient, but it should not be left at that. Management should lay down and enforce regulations regarding the period of inspection, the method of reporting and the correction of faults, and a record system which will ensure complete knowledge of the position by everyone concerned: worker, supervisor, and management,

The more complex the safeguarding system, the responsibility of the maintenance department increases and it is obligatory to engage more experienced and skilled persons to inspect, examine, repair and certify such systems periodically. It is essential that codes of practice detailing the duties to be performed and the records to be kept should be enforced.

Education and training of worker: Workers are not fully expected to the complexity, and the hazards of the machinery without proper education and training. This training must include orientation in industrial accident prevention. The advancement in the design and development of mechanical and electrical devices has left a large amount of acceptance of performance in the mind of worker without any clear idea of the reasons, the methods, the failures, faults, hazards and consequences. No worker should be put to work upon a machine unless he knows the full intent of safety devices provided to control the dangers and more than that, has sufficient knowledge to recognize the failures which lead to inefficiencies in the safety devices. The mist important person in the field of accident prevention is the first line supervisor. The supervisor becomes the accident prevention officer as what the operator lacks, he must have, and his training must include not only supervisory duties, but full implications of the risks of industry and safe practices required.

The Machinery, its purchase, and its performance: The workers cannot be selected to an exact specification. There is almost full control of the specifications of the machinery to be procured. The performance standards of the machinery are specified even at the time of floating enquiries and its suitability to climatic conditions etc. Safety standards required are either neglected or there is no precise knowledge, resulting in settling down to the standards provided by the manufacturer as a routine exercise. There is a serious divergence among machine designers and buyers of what is a desirable standard and how it should be attained. The same care in specification of safety standards must be taken as in production standards: perhaps a higher standard. This involves pre knowledge of how machinery is to be used and the hazards associated with the machinery as well as the safety requirements to avoid hazards.

7.2 Hazards in Welding Operations:

Precautions against electrical risks: Manually held electrode holders, semi automatic torches, or fully automatic machines are all used in electric arc welding. During welding the electrode and parts of the holder or torch are electrically alive and hot. The arc gives a visible light of high intensity: UV radiation and IR radiation being given off. Some fumes are given off, but these are not normally detrimental to health. However arc welding equipment and processes can be used with complete safety provided they are used correctly and with sufficient care: by taking precautions, which in general are simply matters of common sense.

Welding Equipment: Electric arc welding is normally carried out by transformers or motor generator sets which take their supply from electrical distribution systems in the factory, or alternatively by engine driven generators. Welding transformers, which may or may not incorporate rectifiers, are either oil cooled or air cooled, the latter some times being forced air cooled by fan. Care should be taken to ensure sufficient ventilation around the transformer to avoid exceeding the rated temperature rise and thereby causing dangerous overheating of the equipment. It should be noted that B.S.638 permits an oil temperature rise of 50 °C above an ambient of 35 °C: a total of 85 °C. This means that the outer casing of the transformer can be upto 85 °C maximum. In case of engine driven generators used indoors, care should be taken to ensure adequate ventilation to dispose of the exhaust fumes.

Electrical Circuit: In the majority of cases the electrical circuit is relatively simple, but it is important to understand the three essential connections for every welding circuit. These are a) The welding lead, b) welding return, c) welding earth.

The welding lead: As the welding lead is normally connected to the electrode holder, this cable has to be capable of carrying the full welding current without overheating, and must be sufficiently flexible and over designed to withstand everyday use.

The welding return or return current cable is often the most neglected part of the whole welding system. It is not the earth lead-it is the cable by which all the welding current returns to the welding set. Once this fact is realized the importance of its efficiency become obvious. It must be of equal cross sectional area to that of the welding cable, but it need not be as flexible. In some large installations, permanently installed bus bars may be a better proposition. In such installation it is advantageous to use multi-operator equipment incorporating a three-phase transformer and 3,6,9,12 separate regulators. Simplification of the return current system is one of the advantages of multi-operator welding equipment, which lends itself to the installation of a permanent return system. Normally the neutral terminal of the transformer can be connected to the bed plate, work bench, or structure to be welded by means of copper conductor of adequate cross section, thereby eliminating flexible return leads, in some circumstance common return system can be installed by means of a copper conductor of suitable cross section passing through the welding bay.

The welding earth is essential to ensure that the welding circuit is adequately earthed. The cross section of the welding earth should be capable of carrying the full welding current. In the majority of cases the earth should be as near to the work as possible, but the choice of earthing at the source of welding current supply or at the works depends on the consideration of the welding return circuit. However with the welding earth supplied at the source of supply a condition can arise in the event of a break in the welding return whereby some or all of the welding current returns to the supply by other paths while welding is continued. This can affect portable tools, conduits, and pipes in the vicinity. With the welding earth applied to the work there is no alternative route for the return cable and the arc cannot be maintained and the welding stops.

Electrical Joints: It must be emphasized that the welding circuit is frequently carrying currents of several hundred amperes. In addition to ensuring adequate capacity cables for the welding lead, welding return, and earth return, it is important to ensure that poor connections or poor joints are avoided. All joints, whether in the welding cable, the return cable, or the earth cable must be efficient at the equipment, the electrode holder, and at the work. If a cable is joined throughout its length, coupling should be effected by plug and socket cable connectors or efficient cable joints, and not be nuts and bolts which often work loose, become corroded, and result in an inefficient circuit with danger to personnel and equipment. On multi operator equipment the use of distribution boxes is recommended. These ensure good electrical connections and avoid hazards to personnel. The return and earth clamps are also an important part of the electrical circuit but again are often neglected. The preferable type of clamp is one, which works on the clamping principle, which can be screwed down to ensure good contact with the work or bedplate. The cable should be efficiently joined to the clamp and the clamp firmly fixed to work that should be cleaned to ensure good contact. The use of angel iron and the bare end of the cable weighted down at the job are to be avoided at all costs. Loose connections or temporary connections are hazards that are to be avoided. Cables should not be dragged over floors and rough surfaces, and as it doesn't happen, the condition of the cable must be examined frequently for insulation defects. Cables with damaged insulation must be discarded. Cables should not be a source of trip hazards.

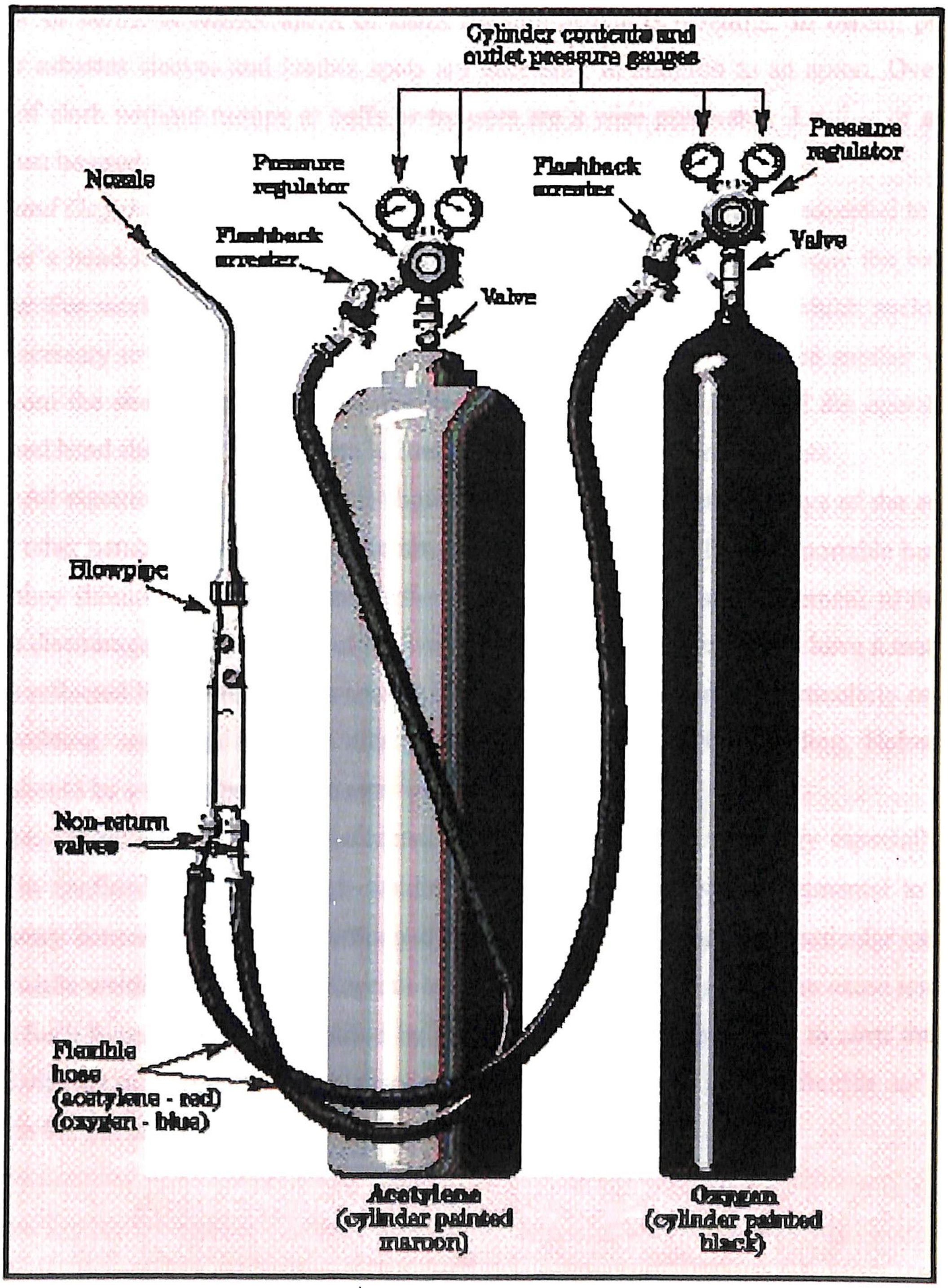
Electrode Holders should be of sufficient capacity to hold the largest electrode to be used, and carry the maximum welding current without overheating. The holder must be provided with an insulating handle as reliance must not be placed on the welder's gloves for insulating the operator's hands from live parts. A fully insulated type of holder helps to prevent inadvertent contact or short circuit between the holder and the earthed part. Care is necessary when leaving the holder when welding is temporarily suspended. Safest procedure is to make the holder isolated from supply by means of a plug and socket near the holder or at the transformer or regulator alternatively by disconnecting the complete equipment.

Safety Devices: The open circuit voltage of welding systems used in India ranges upto 100 V which is considered safe for many applications. However under certain circumstances such as working in confined spaces, work at heights or under damp conditions, this voltage could be a source of danger. It is wise to fit a low voltage device to the output side of the welding set. This reduces the open circuit voltage to approximately half the full normal open circuit voltage. When the electrode is touched to the work the higher voltage is automatically restored to enable the arc to be struck, where upon the voltage across the arc drops to a much lower figure in the normal way. Equipment must not be pulled around by the cables, hoses etc. Damage or risk by contact of cables to hot welds should be avoided.

Gas Welding or Cutting: In using Gas welding or cutting sets the following factors should be observed:

1) Knowledge of construction, distinctive colours, valves and filling of cylinder.
2) Care in storage of cylinders
3) Care in handling and use of cylinders
4) Care in connecting pressure regulators and manifolds
5) Care in use of apparatus
6) Maintenance of equipment
7) Care in operation according to locating and nature of work.

Oil or gas will ignite violently in the presence of oxygen, if the oxygen is under pressure an explosion may result. Cylinder and fittings must be kept away from all sources of contamination such as oil barrels, overhead shafting cranes or belts. Hoses confirming to BIS 3572 of 1968 should be used. While fitting nipples etc, on to a hose, fire should never be used for testing leakage, but soap solution should be used. Hose should be firmly attached to blowpipes and other connections by suitable worm clips. Tying of the hoses on to connections by the use of pieces of wire is dangerous, as such points may slip and cause serious accidents. Setting of pressures must be accurate as per the recommendations of the manufacturers of the particular equipment. Sometimes the nozzle of the blowpipe may make a noise when it is tried to be lighted up or during actual use. This phenomenon is known as backfire. This is caused through incorrect pressures or application of light before the flow of fuel gas has been properly established. If allowed to continue this develops into a condition when with a hissing noise the mixture of oxygen and fuel gas starts traveling backward being forced into the fuel gas pipe due to excess pressure of oxygen. This dangerous condition is known as flash back. Flash backs are also caused apart from incorrect pressure due to the passage of the nozzle having been obstructed, the nozzle being held too close to the work or the nozzle becoming overheated. If not arrested properly in times by shutting off the oxygen valve a flash back may result in the fire traveling through the hose to the cylinder through the regulators. Providing special non-return valves on the nipples that are called hose protectors can effectively prevent this type of flash back.



Precautions against other risks: The welding arc is a source of great heat and this together with hot spatter and the hear of the plates being welded can easily cause fires, inflammable materials such as oils, rags, paint, shavings etc., must be removed from the vicinity of welding operations. It is necessary to clear both sides of the work to be welded, and cover all openings to ensure that spatter doesn't fall through. Personnel must be protected during welding against the heat and the possibility of burns. A leather apron or other suitable device is essential. In certain positions leather or asbestos sleeves and leather spats are necessary in addition to an apron. Overalls of flameproof cloth without turnips at cuffs or trousers are a wise precaution. Leather or asbestos gloves must be used; rubber gloves are not suitable.

Helmets and Goggles: For all welding work either a helmet or hand shield is essential to protect the welder's head from radiations, spatter, and hot slag. For many applications the helmet is preferable. For working on aluminum or close to other welders, a helmet which encloses the head is necessary to protect the back of the neck, otherwise light reflected from another welding arc, or from the sheet metal may burn the back of the neck or the scalp of the operator. All helmets and hand shields are fitted with a filter glass and a protective cover glass.

Screens: All electric welding operations should be screened to prevent the rays of the arc from affecting other persons working in the vicinity. Screens can be either fixed or portable but where portable they should be of sturdy construction and yet sufficiently easy movement so that their use is not discouraged. The surfaces of the welding booths and screens should have a matt finish to reduce reflected light. Precautions against reflected light are important, particularly on heavy current welding, and high intensity arcs such as semiautomatic CO2 welding. Helmets and goggles should be worn to protect the eyes when removing slag.

Ventilation: Wherever welding is performed adequate ventilation is necessary especially when welding in confined space. Although welding fumes are not normally detrimental to human health, heavy concentration over a prolonged period can cause discomfort. Particular care must be taken while welding galvanized materials as inhaling the fumes given off can cause temporary sickness. Such fumes should be extracted by exhaust fans suitably positioned to clear the fumes from the vicinity of welding. Certain gases such as argon, nitrogen, carbon dioxide etc., which are used in the gas shielded process, involve certain hazards because:

a) There is no practicable way of detecting the presence of argon or nitrogen.
b) Argon and carbon dioxide are heavier than air and so will accumulate in the bottom of a vessel, which may appear safe because the top is open.
c) The gases are odorless and give no warning to workmen.
d) Men employed in confined spaces such as large tanks may be out of sight of their fellow workers, and there may be considerable delay before any one appreciates that these gases have affected them.

If inert gas is being used or is liable to be accidentally discharged in any area, adequate ventilation should be provided to ensure that the gas couldn't accumulate in that area. As a further precaution, where argon or carbon dioxide is being used as the shielding gas in particularly confined spaces, breathing apparatus of the airline type should normally be used.

Radiographic Inspection: Examination of the welded joints by X-rays is now a common practice, and personnel undertaking this work are usually fully aware of the hazards of radiation and the precautions. The harmful effects of X-ray testing are delayed actions, without any immediate effect. Therefore everybody not engaged in the radiography work must be kept away from the danger zone stipulated by the technician. The precautions to be taken by those engaged in the actual inspection are not the concern of the welder or supervisor, other than to adhere strictly to the instructions of the specialized technician in charge of the radiographic inspection work.

7.3 Grinding Wheels: Grinding operations are very common in any fabrication shop. Serious accidents are possible on account of a wheel failure during grinding operations. To understand the reasons for wheel failure, and the purpose of maximum speed restrictions and other safety precautions, it is essential to know about the composition of grinding wheels and the system used for identifying them.

Composition of Grinding Wheels: A wheel is constructed with two ingredients, abrasive grains and bonding material. In the manufacture of wheels, abrasive and bonding materials are varied to produce wheels of different qualities for an almost unlimited range of grinding conditions and requirements. In majority of the wheels the abrasive grains are wither aluminium oxide or silicon carbide. Bonds are classified under the headings: vitrified, resinoid, rubber, and shellac. Most wheels are made with a vitrified bond composed of clays and feldspar that are fused into a porous glassy structure. Resinoid bonded wheels have the abrasive grains held in thermosetting phenolic resins. Rubber bonded wheels consist of a mixture of abrasive grains and raw rubber.

Shellac bonded wheels use shellace as the bonding medium. Wheel construction can be varied by controlling the basic ingredients to provide a wheel of dense or open structure to suit specific grinding conditions as follows:

Grain Size: The size of the grains used as cutting particles are classified according to the sieve through which they will pass, high numbers represent fine grit and low numbers represent coarse grit. Fine grits are used to grind hard and brittle materials, coarse grits fir soft ductile materials.

Wheel Grade: This refers to the tenacity with which the bonding material holds the abrasive pieces in place and not to the hardness of the abrasive. Wheels are graded as soft or hard according to the ease with which the abrasive particles can be dislodged. Hard wheels for soft materials, soft wheels for hard materials.

Structure: This is the relationship between spaces or voids separating the abrasive grains within a particular bond. Hard and brittle material requires close grain spacing, soft ductile materials require wide grain spacing, but within a particular range, the wide grain spacing removes stock rapidly and the finer grain spacing is used for fine finishes.

Handling and Storage: Grinding wheels must always be handled carefully. Wheels are fragile to a degree that varies according to specification. Resinoid, rubber, and shellac wheels, although having other limitations are more resistant to damage from handling then vitrified bonded wheels. Often wheel breakage can be attributed to careless handling and storage. Wheels damaged from these causes appear perfect yet represent a danger to operatives. Manufacturers inspect wheels prior to packing to ensure that they are dispatched in perfect condition. On receipt they must be inspected properly to determine if they have been damaged in transit by means of ring test. All abrasive wheels should be stored under responsible supervision in racks in a central store room, which will be dry and not subject to extreme temperature change. Although some types of bonded wheels may not be adversely affected by exposure to dampness or changes in temperature, others may be rendered unsafe.

Mounting of Wheels: every wheel before it is mounted on a spindle must be closely inspected again and rung. The center bushing should be examined carefully for evidence of looseness or movement, particularly if the user has rebushed the wheel. The bushing must be extend beyond the side of the wheel and must fit easily on to the machine spindle without binding. If the bush binds, no attempt must be made to alter the size of the hole. Wheels should not be used larger than the size for which the spindle and machine are designed. Flange plates must be of the same diameter as each other and be preferably of steel. The inner plate should be keyed, shrunk, or pressed on to the spindle and the bearing surface of the inner flange run true with the spindle. All flanges are relieved in the center so that the bearing surface will be on the outer unrelieved portion of the flange. Diameter of the insertion washers with compressible paper or rubber shall not be less than that of the flange plates and fitted between the wheel and flanges. The nut on the spindle should be tightened against the flange to hold the wheel sufficiently firmly to prevent slipping and to transfer the torque. Overtighting must be avoided, as it is possible to approach the ultimate crushing strength of the wheel.

Operational Hazards: The hazards associated with grinding operation are mainly due to wheel breakage. Every grinding machine is provided with wheel guards, which normally guard the major portion of the wheel. The common causes of wheel breakage are:

a) Centrifugal force due to rotation.
b) Heat of grinding.
c) Mounting strains.
d) Work pressure.
e) Accidents.

The major cause of wheel breakage is accidents; the incidence of breaking due to the first four causes is small.

Centrifugal force due to rotation: The important velocity is at the wheel periphery. As the speed of a wheel increases the stress on the wheel increases at a rate proportional to the square of the speed. Wheels are tested by manufacturers at higher speeds than the recommended maximum operating speed, but it is most important that the figure quoted on the wheels for its maximum speed at its diameter when new should not be exceeded. Machine tools equipped with speed adjustment control of the spindle must be operated with extreme care. Before increasing speed to compensate the reduction in diameter resulting from wear and dressing, the peripheral speed of the wheel must be checked to ensure that it does not exceed the maximum safe speed quoted by the manufacturer for that particular grade and bond of wheel.

Heat of Grinding: The cause of heat results from variation in temperature within the structure if the wheel. During the grinding operation, the mass at the periphery of the wheel is at a higher temperature than the mass adjacent to the hole. This results in compression in the outer zone and tension in the inner zone. If the temperature gradient is sufficiently steep a radial crack may start from the hole, this applies particularly to vitrified wheels when used for severe dry grinding operations such as snagging. There is practically no danger of breakage due to heat if there is a generous flow of coolant on the wheel.

Mounting Strains: The importance of mounting wheels correctly has already been covered. Any condition, which puts the wheels under stress, must be avoided. These conditions include absence of blotters, unequal diameters of flanges non-flat lands on flanges and lack of flatness in the back plate.

Work Pressure: Normal work pressures, applied as intended in an approved design set up doesn't produce serious mechanical stress. Excessive work pressure can be dangerous. Heavy continuous pressures on the periphery of the vitrified wheels must be avoided when grinding dry.

Accidents: Accidents account for most wheel breakages. The majority of accidents result from:

a) Mechanical shock before or after mounting
b) Unchecked traverse of the work into the side of the wheel.
c) Unchecked high rate of feed of work towards the wheel, on precision machines.
d) Wedging of a work piece or other metallic objects between the wheel and work rest, or guard, on an off hand grinding machine.

Operator safety: Abrasive wheels must never be operated art a speeding excess of the maximum speed recommended by the maker, as shown on the label or tag. In every room where grinding wheels are used, a notice should be displayed to provide the following information:

a) The safe working peripheral speed of every class of abrasive wheel
b) The speeds of the shafts or spindles upon which the wheels are mounted
c) The diameters of the pulleys necessary to secure the safe working speed on such shafts and spindle.

The operator or setter responsible for setting up a grinding machine must check against production layouts or wheel charts that the correct wheel is being used for the intended grinding operation. A wheel manufactured for removing metal on its periphery should not be used for an application in which grinding takes place on its side. Similarly a cup type wheel designed for face grinding should not be used in an application in which grinding will occur in the periphery. Safety spectacles must be worn by the operator in all dry grinding and cutting operations using fixed or portable machines. Alternatively suitable transparent screens should be fitted to the machine to intercept effectively sparks and particles. It is also desirable to provide suitable eye protection for operators on wet grinding work. Safety guards and hoods should be mounted to maintain proper alignment with the wheel and the method of fixing must be strong enough to hold the guard in place under all circumstance. The operator must ensure that the guards are correctly positioned before commencing work. The degree of wheel exposure necessary for grinding operations depends on the nature of work in hand, but at all times the guard should be adjusted so that the whole of the wheel is enclosed except for that part which need exposing for operational purposes. In off hand grinding work-rests must be adjusted close to the wheel and clamped securely after each adjustment. It is most important to avoid any personal contact or to allow clothing to come into contact with a moving wheel or work piece. Whenever starting a wheel the operator should stand on one side and new wheels should be allowed to run for at least 1 min, before using them. When fluid is used, fluid supply should be turned on after the wheel has reached speed and should be turned off before switching off the wheel spindle. A magnetic chuck is used for holding the work piece on machines such as surface grinders. The chuck must be kept clean and the operator should test it before starting the machine.

7.4 Steam Boilers and Pressure Vessels: The design and construction of boilers and pressure vessels is carried out by experts in the field but the installation, operation and maintenance is carried out by personnel with relatively less expertise. A large amount of potential energy is contained by the boilers and pressure vessels which if released suddenly will cause serious damage to the surrounding equipment and personal often resulting in fatality. It is therefore essential that suitable precautions be taken to ensure that failures do not occur.

Installation and Fittings:

Safety Valves: The safety valves on a steam boiler shall be separate from any stop valve and if the valve is of a lever and weights type, the weight must be secured on the level in the correct position. The important considerations that should govern the choice of safety valves are summarized below:

a) The capacity of the safety valves fitted to any vessel should be such that the maximum pressure rise and fall for blow-off condition should be limited to 10%.
b) The safety valve should always be fitted with hand operating easing gear so that the freeness of the seat can be checked without the necessity of raising the pressure to blow-off. This is particularly important when the safety valve is down stream of a reducing valve setting to blow-off the valve normally.

c) Safety valves should be locked so that un-authorized personnel cannot tamper with them.
d) No packed glands should be fitted to a safety valve spindle.
e) The vent pipe fitted with a safety valve should be satisfactorily drained to avoid condensation forming in the pipe. The runs of the pipe should also be checked to ensure that no blockage of the pipe is possible due to an accumulation of deposits etc. Finally the vent pipe should be of sufficient area.

Pressure gauges: The important safety requirements for pressure gauges are as follows:

a) The range of the gauge used should be suitable for the working pressure. It is recommended that the graduation used should not be less than one and a half times but not greater than twice the operating pressure.
b) A stop pin should be provided to prevent multiple revolution of the pointer,
c) The gauge should be clearly marked and mounted in a easily readable position.

Water and liquid level gauges: In addition to the requirement that at least one water gauge be fitted to a steam boiler the factories act requires that its type be approved by the chief inspector and where the gauge is of the glass tubular type and the working pressure is greater than 40psi is protected by an efficient guard so as not to obstruct the reading of the gauge. At least one, preferably two water gauges should be fitted directly to the boiler, if possible without any intervening cocks or valves and no other fittings should be taken off the connections for a water gauge; it is particularly undesirable if the automatic control float chambers are on the same connections as a water gauge.

Fusible Plugs: A fusible plug consists of a brass gun metal or steel holder into which is cast a low melting point white metal plug. These devices are fitted to both boilers and air receivers and perform different functions.

a) Fusible plugs on boilers: When fitted in the furnace of a shell boiler the melting point of the alloy is chosen so that it will not melt when the boiler is being fired but if the water level falls below the level of the fusible plug the metal will melt with the results that water and steam will escape giving warning to the boiler operator of the low water condition. However fusible plug will only give warning of a low water condition in the boiler and is unlikely to extinguish the fire even in a hand fired solid fuelled boiler and certainly not in a gas or oil fired boiler. As a low water safeguard it is only effective if the boiler is continually manned and if the boiler operator is trained to recognize the distinctive hissing sound of the fusible plug blowing.

b) Fusible Plugs on air receivers: When air is compressed, its temperature rises and is liable to become mixed with oil vapour escaping from the compressor and there is a possibility of developing an explosive mixture in the air receiver. However if a fusible plug is fitted which melts at a temperature well below the flash point of the particular oil, the chances of an explosion is restricted and whereby warning in advance of a possible explosive condition. It is possible that a charged air receiver may be disconnected from its source of compressed air which is fitted with necessary safety valves etc and if it is subject to a fire in the locality it may explode due to overpressure combined with the weakening of the materials by heat. This can be prevented by fitting of a fusible plug to the air receiver that will melt when it is subject to the heat of a fire.

Reducing Valves: the purpose of the reducing valve is to control the pressure downstream to a set value lower than that of the steam or gas upstream of the valve. It is then possible to use equipment, which is suitably constructed only for reduced pressures. It is essential for safety that a relief valve and pressure gauge are fitted downstream of the reducing valve. The relief valve should be sized so that it is able to relieve the full discharge of the reducing valve in the fully open position. This will involve use of a relief valve of larger diameter than the reducing valve. In designing the pipe runs for reduced pressure lines it is essential to ensure that the steam or gas flow through the relief valve is not restricted by an opening of lesser diameter than the relief valve size.

Water Level controls and Alarms: As the majority of serious accidents to industrial pressure plants are due to the failure to maintain the correct water levels in boilers, it is very important to stress on the necessity of ensuring safe conditions in either hand or automatically controlled boilers. It is recommended to provide an audible low water alarm fitted in addition to visual indications.

Vents to atmosphere: In many low or non-pressurized systems it is usual for an atmospheric vent to be fitted. Where this method of protection is adopted the following points should be noted:

a) The vent should be connected directly from the boiler or vessel concerned.
b) The vent pipe should be protected from frost or blockage through its run.
c) No valves should be fitted in the vent line.

d) If a feed tank is fitted no non-return or non-returns type stop valve should be fitted.

e) The vent should be of sufficient area considering the maximum volume of discharge.

In the interests of safety a safety valve should always be fitted in addition to the vent.

Drain or Blowdown: When constructing drain systems to handle hot liquids and especially when considering the blowdown from boilers, care must be taken to ensure that adequate allowance is made for expansion. Where a common blowdown is fitted to a range of boilers, the blow off valve or tap in each boiler should be so constructed that it can only be opened by a key, which cannot be removed until the valve, or tap is closed and there should be only one key. This is to ensure that only boiler can be connected to the blowdown system at a time.

Operation and Maintenance:

This shall consist of:

a) Regular functional checks on all safety controls.

b) Regular visual examination looking for early signs of trouble such as slight leaks, discolouration of vessel or lagging, slight distortion, unusual sounds.

c) Thorough inspections to locate any actual growing of latent defects that could affect the plants safety.

Regular functional checks on safety controls. The frequency at which these should be carried out will vary with the type of plant and the use to which it is put. However, a suggested schedule of tests with explanatory notes based on an automatically controlled shell boiler should be as follows, and could serve as a guide for other boilers and pressure plants.

Daily:

A qualified boiler inspector should carry this out.

a) Blow down and check the operation of all water gauges.

b) Check the operation of the water level control by blowing down the feed control float chamber with the feed pump stopped and note that it starts and then stops when the drain valve is closed again.

c) Check normal and independent firing controls and alarms by blowing down the requisite float chambers with the burner in operation and note that the cut out operates.

Weekly:

The engineer in charge should carry this out.

a) Check the operation of all water level controls, firing controls, and alarms by lowering and raising the water level in the boiler.

b) Check the pressure operated firing controls by raising and lowering the boiler pressure.

c) Check the safety valves by lifting with the hand easing gear.

Quarterly:

The respective service engineers should carry this out:

a) Service all controls.

b) Examine and clean out any float or control chambers.

c) Lift the safety valve under steam pressure.

A log should be kept of all the tests made any repairs carried out.

Regular visual examinations: Looking for any signs of trouble such as slight leaks, discolouration of the vessel or its lagging, unusual noises etc., is important. With a boiler, the inspection frequency should be at least once a day, but with equipment such as a steam or air pipe work, once a week may be quite adequate.

Through inspections: Generally, the interval between these examinations is governed by the requirements of the Factories Act or other legislation. This inspection consists of the removal of all access doors into the inside of the vessel and a detailed visual examination of all the internal and external surfaces of the vessel to locate any corrosion, cracking, or any latent defect. This examination may be supplemented by the removal of lagging or brickwork, accurate thickness measurements by drill tests or ultrasonic means, non-destructive flaw detection, sampling for chemical or metallurgical examinations. These inspections must be carried out by a specialist and as stipulated by Factories act.

Access for maintenance and manholes: Any pressure vessel should be open to the atmosphere before any cover bolt is removed. A pressure gauge reading zero is not a satisfactory check for this. This is also particularly important in the case of autoclaves and other vessels where it is necessary to use rapid opening doors and its recommended that interlocks be fitted to prevent the door opening mechanism being opened until the vent is open to the atmosphere. The excessive clearance between manhole and its frame shall be repaired in order to avoid blowing out of the packing from manhole doors.

7.5 Sling Chains:

Selection of sling chains:

The following five recommendations to be considered in selecting sling chains or chains for related lifting job,

1) The maximum loads to be lifted. Estimate on heavy side. Overloading is the most common cause of damage to sling or hosting chains.
2) Operating environments: Extremely high temperatures can affect working load limits. Excessive or prolonged exposure to dust, moisture, chemicals and acids can affect wear, durability, and performance.
3) Usage frequency: Continuous or very frequent use means greater abrasion and wear. Chain manufacturers should be given your evaluation of use frequency to help them recommend chain of proper hardness.
4) Chain hardness: In general, chain manufacturers harness specifications should be followed.
5) Angle and Load: The working load limits of single-leg sling chains remain constant as long as chains lift balance loads straight up in normal temperatures. However many applications require use of sling chains with two, three or four leg, or branches. These branches are attached to horizontal loads at varying angles, or inclinations. As these angles of inclinations to the load grow narrower stresses on the chain increase. To ensure proper working load limits specifications of all chains-from single-leg up through four-leg slings or special slings-make your selections with a chain manufactures technical guidance.

Once the proper sling chain has been selected for the right job, it should be used correctly to foster safe and efficient operations.

Guidelines for using Sling Chains:

1) Always balance loads.
2) Never overload
3) Always be sure chain hangs straight, with no kinks before lifting.
4) Make sure chain is properly seated on hooks, never at their pnts.
5) Never force chain into hooks by hammering.
6) Be sure to pad sharp edges or corners of loads.

7) Use recommended devices to shorten chains.
8) Don't drag chains beneath loads or allow loads to rest on chains.
9) Don't lift loads with sudden jerks or shock,
10) Don't allow hook-up operators or screws to stand beneath moving loads.
11) Don't allow chains to be thrown or to lie on floors. Store them correctly from "A" frames ready for cleaning or inspection. Oil chains, before prolonged storage and hang in a clean, dry place.
12) Clean chains regularly to remove grit.
13) Give all chains regular link-by-link inspections.
14) Arrange with chain manufacturers for regular plant wide chain surveys to accompany or supplement your own plant inspections.
15) Inspections should seek to detect broken or twisted links, nicks, or gauges, excessive wear at load-bearing points of hooks, stretched links, spread distortion, or damage to hooks, master links, coupling links or other attachments,
16) Remove worn, damaged or stretched chains from service.
17) Return all worn or damaged alloy steel chains to chain manufacturers for re-conditioning or alterations. Don't anneal or alter alloy steel chain.
18) Keep careful identification records of chain in use; worn or damaged chains undergoing repairs, and chains returned to service after repairs.

7.6 DRILL PRESS AND MILLING SAFETY

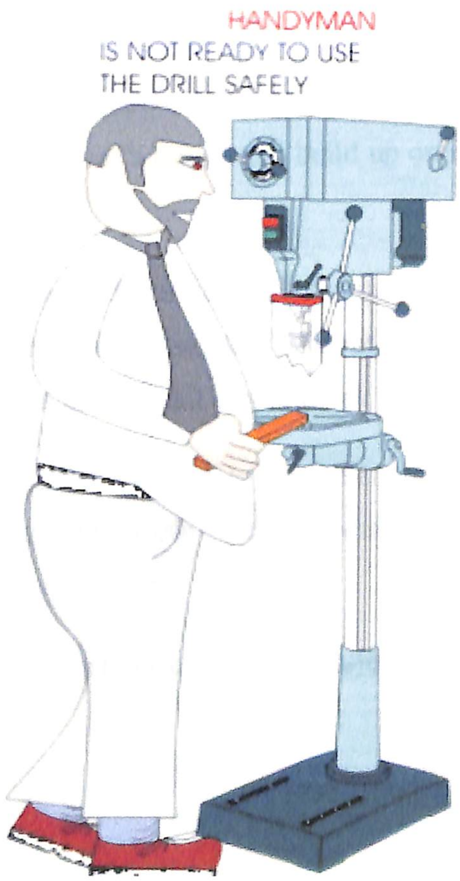
1. Remove neckties and tuck in loose clothing so there is no chance of them becoming entangled in the rotating drill!

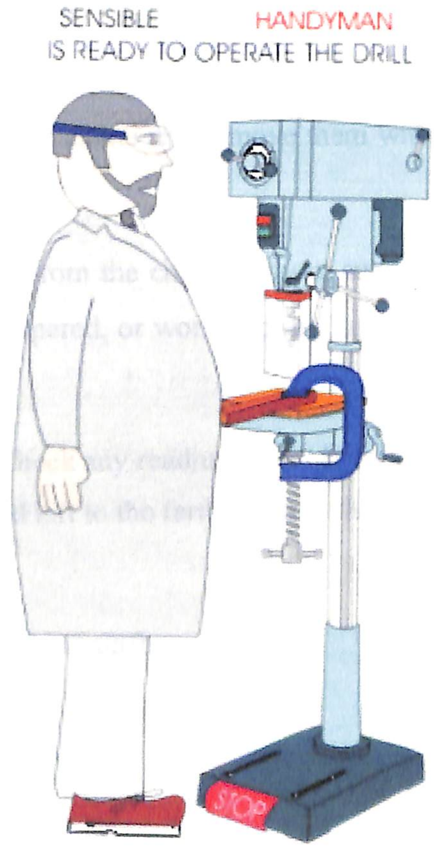
2. Check out the machine! Are all guards in place? Do switches work? Does the machine operate properly? Are the tools sharpened for the material being worked?

3. Clamp the work solidly. Do NOT hold work with your hand. A "merry-go-round" can inflict serious and painful injuries.

4. Wear goggles!

5. Place a piece of wood under drills being removed from the machine. Small drills can be damaged when dropped and the larger tools can injure you if dropped.
6. Use sharp tools
7. Clean chips from the work with a brush, NOT your hands!
8. Treat cuts and scratches immediately!
9. Always remove the key from the chuck BEFORE turning on the power.
10. Let the drill spindle stop on its own after turning off the power. Do NOT attempt to stop it with your hand!
11. Keep the work area clear of chips.
12. Wipe up all cutting fluid that spills on the floor right away.
13. Avoid trying to clean the tapered opening in the spindle while it is rotating.
14. After using a drill, wipe it clean of chips and cutting fluid. Replace the tool to proper storage.





7.7 LATHE SAFETY:

1. No attempt should be made to operate a lathe until you know the proper procedures and have been checked out on its safe operation by your instructor.
2. Dress appropriately! Remove necktie, necklace, wristwatch, rings and other jewelry, and loose fitting sweaters. Wear an apron or a properly fitted shop coat. Safety glasses are a must!
3. Clamp all work solidly! Use the correct size toot and work holding device for the job. Get help when handling large sections of metal and heavy chucks and attachments.
4. Check work frequently when it is being machined between centers. The work expands as it heats up and could damage the tailstock center.
5. Be sure all guards are in place before attempting to operate the machine.
6. Turn the faceplate or chuck *by hand* to be sure there is NO binding or danger of the work striking any part of the lathe.
7. Keep the machine clear of tools!
8. Stop the machine before making measurements and adjustments.
9. Remember--chips are sharp! Do NOT try to remove them with your hands when they become "stringy" and build up on the tool post. Stop the machine and remove them with pliers.
10. Do NOT permit small diameter work to project too far from the chuck without support from the tailstock. Without support, the work will be tapered, or worse, spring, up over the cutting tool and/or break.
11. Be careful NOT to run the cutting tool into the chuck. Check any readjustment of work or tool for ample clearance when the cutter has been moved left to the farthest point that will be machined.
12. Stop the machine before attempting to wipe down, a machine surface.

13. Before repositioning or removing work from the lathe, move the cutting tool clear of the work area. This will prevent accidental cuts from the cutter bit.

14. Avoid talking to anyone while running a lathe! Do NOT permit anyone to fool around with the machine while you are operating it. You are the only one who should turn the machine on or off, or make adjustments to the lathe.

15. If the lathe has a threaded spindle nose, never attempt to run the chuck on or off the spindle using power. It is also dangerous- practice to stop such a lathe by reversing the direction of rotation. The chuck could spin off and cause serious injury to you. There is also the danger of damaging the machine.

16. You should always be aware of the direction of travel and speed of the carriage before engaging the half-nuts or automatic feed.

17. Always remove the key from the chuck. Make it a habit NEVER to let go of the key until it is out of the chuck and clear of the work area.

18. Tools must NOT be placed on the lathe ways. Use a tool board or place them on the lathe tray.

19. When filing on the lathe, be sure the file has a securely fitting handle.

20. Stop the machine immediately if some off sounding noise or vibration develops during operation. If you cannot locate the trouble, get help from your instructor. Under no condition should the machine be operated until the trouble has been corrected.

21. Remove sharp edges and burrs from work before removing it from the machine.

22. Plan your work thoroughly before starting. Have all needed tools on hand.

23. Use care when cleaning the lathe. Chips sometimes stick in recesses. Remove them with a brush or short stick. NEVER clean a machine tool with compressed air.

8. ELECTRICAL SAFETY

8.0 ELECTRICAL SAFETY

8.1 Electrical Hazards: Electrical energy is the most versatile form of energy, and the society cannot think of living without using electricity. The modern accessories generally provide adequate safety for the users of electricity. However it is essential to provide a general awareness of the hazards associated with electrical energy and the preventive measures.

Electrical hazards are broadly classified into four groups:

1) Hazards to human beings.
2) Fire hazard of static electricity
3) Lighting for safety
4) Lightning hazards

8.2 Hazards to human beings: As long as humans can adequately insulate themselves, there cannot be any shock hazard from electrical live conductors. Human body can only safely withstand only very low values of passage of electrical energy. The current passing through human body is directly proportional to the voltage encountered and inversely proportional to the body resistance. In the event of any encounter with an electrical system, the current passing through the body increases with increase of voltage of the system, the body resistance remaining the same. However for the same voltage a man with higher body resistance will allow only less current pass through his body, compared with a man with a lower body resistance. The body resistance varies from individual to individual. It also varies for the same individual from time to time.

Current Values Affecting Human beings

Current Values	Effect
1 ma or less	Not felt-Causes no sensation
1-8ma	Sensation of shock, not painful, muscular control not lost.
8-15ma	Painful shock, not painful, muscular control not lost
15-20ma	Painful, severe muscular contradictions, breathing difficulty
50-100ma	Possible, ventricular fibrillation. No known

	remedy.
100-200ma	Ventricular fibrillation
200ma and above	Sever burns, severe muscular contractions resulting on chest damping heart and stopping it during shock.

Human Resistance to Electric Current

Type of resistance	Resistance value-ohms
Dry Skin	1,00,000-6,00,000
Wet skin	1,000
Normal body-hand to foot	400-600
Ear to ear	About 100

Classification of effects of Electric Shock

There are three distinctive effects on the passage of current through the human body.

a) Burns
b) Asphyxiation
c) Heart Disorder

a) Burns: The burn suffered from electrical contact is not quite like that of a heat burn. Heat burns causes destruction of the local surface and the flesh beneath, while the electrical burns cause destruction of tissues becoming cone shaped and spreading to the surface. As a result it becomes very difficult to determine the seriousness of an electrical burn simply by examining the surface area and the wound is difficult top cure.

b) Asphyxiation: The general effects of the passage of electrical current through the body are first of all that the muscles are thrown into a spasm. Next a paralysis occurs of the higher nerve center, resulting in stoppage of breathing.

c) Heart Disorder: The passage of current through the body in the region of the heart may produce what is known as a ventricular fibrillation, a condition wherein the heart ceases its steady rhythmic pumping action and instead is thrown into an ineffectual flutter or quivering. It is claimed from certain quarters that ventricular fibrillation is more frequently present in low voltage shocks, the cause being due to respiratory or cardiac failure.

Precautions against electric shock: The precautions necessary to protect persons and equipments from electrical hazards are given below.

- All wires are treated as live wires unless it is positively known that they are dead.
- Repairs on electrical equipment are to be made by qualified and authorized electricians.
- Electric light extension cord is to be used only if has a standard lamp guard and approved insulated handle.
- Power must be cut off before cutting concrete around electric conduits.
- Tag or lock main switch before carrying out repairs.
- Safety belts are to be used while working on electric poles or towers.
- Only one hand is to be used when handling circuit that is live.
- Unless there is a line clear, switches of a line should not be closed.
- Line clear taken by one man should not be returned by another.
- To know if current is there in a line, touching of line should not be done.
- Ground wires should not be removed prior to written authorization.
- Cutting by crowbars during excavation should be stopped if layers of sand and bricks are found.
- Tags or locks of main switches if any should be places that are easily accessible.
- Careless handling of machinery should not be done.
- Earthing rods or chains for earthing dead lines must be used, before commencing work.
- All portable equipment must be grounded.
- Wires must be taped and tagged when motors and electrical apparatus are disconnected.
- All insulating and protecting devices must be used.
- Rubber gloves must be worn while working around circuits if 110V.
- When pulling fuses, make sure switch is open, and fuse puller is to be used.

- A ground man must accompany an electrician when working on poles having live currents.
- Job is complete after cleaning is done. Work has to be inspected and checked for safety.
- Pipelines shall not be used for grounding purpose, especially lines carrying any gas.
- Motors must be kept clean and dry and only dry air at suitable pressure must be used to blow out the windings.
- Motors should not be over oiled. Appropriate lubricants have to be used.
- Motors have to be inspected frequently for bearings.
- Motors have to be serviced yearly and insulation resistance has to be recorded periodically to check deterioration.
- Control equipment must be clean and dry. Covers have to be kept closed.
- Electrical connections have to be kept tight.
- Main switchgear rooms must be kept clean, free from combustibles and properly ventilated.
- Equipment must be checked for overheating and overloads.
- Circuits must not be overloaded and over-fused.

Additional precautions for maintenance:

Isolation: The line or equipment involved should be effectively isolated from power supply.

Tagging and locking: The switches or circuit breakers, controlling the supply to the equipment or line should be tagged. If practicable it should be locked also. Caution boards stating MEN ONLINE should be hung on the circuit breakers or switches controlling the supply to them and cautioning against closing them.

Discharging: The line or equipment should be discharged before grounding.

Grounding: The line or equipment must be effectively grounded.

Testing: The line or equipment must be tested for any leakage of power before starting the maintenance works.

Protective equipment: The persons discharging or grounding the line or equipment should protect themselves with appropriate insulating gloves and insulating shoes. Men working on high locations and electrical posts are required to wear safety belts properly secured to the post.

Clearance: Before starting the repair works clearance should be obtained from proper authority. Before resuming power supply it should be ensured that the grounding of the line or equipment at the work spot has been removed and all men are off the line or equipment. Before resuming supply clearance has to be sought from proper authority.

8.3 Static Electricity:

Hazard from static electricity: Static electricity is recognized as a possible fire hazard in the petroleum, chemical and explosive industries and where flammable gases, vapours, and dust clouds are present. The generation of static electricity is a surface phenomenon associated with the contact and separation of dissimilar surfaces. For the recognition of the type of industrial process in which static electricity will be generated it is only necessary to recognize that contact between dissimilar bodies causing a disturbance of the electric charge at the interface. Positive charge is localized on one body and negative charge on the other. Separation of the bodies can leave excess positive charge on one body and excess negative charge on the other. If both the surfaces are electrically conducting the charge can move relatively easily and both bodies are virtually restored to their original electrically neutral state by the movement of charge through the last point of contact as they separate. When metals separate little, if any excess charge is retained on each body after separation. Static electricity is a low current high voltage phenomenon. The fire hazard occurs when the generated charge accumulates on an object and increases its potential to a value greater than the breakdown potential of the surrounding atmosphere and causes an electrical spark. Sparks produced in this way have sufficient energy to ignite many different types of flammable material. The ability of the spark to cause ignition-its incendivity-depends not only upon the amount of charge stored on the object and the sensitivity of the flammable material but also on the electrical characteristics of the object on which the charge accumulates. Sparks from electrically conducting objects tend to be more incendive than sparks from electrically non-conducting objects.

Safety precautions: Static electricity can cause a fire or explosion only under the following conditions:

a) An inflammable or explosive atmosphere must be present.

b) An electric charge must have been generated, must have accumulated on plant, product or operator, and produced an electric field greater than the breakdown field strength of the surrounding atmosphere.

c) The resultant spark must have energy greater than the minimum spark ignition energy of the surrounding atmosphere.

An explosion or fire cannot occur if one of the above conditions is not satisfied. In any situations the safety precautions must aim at the elimination of one or more of the factors with the minimum interference with the operation of the plant and process. The general form of precautions against electrostatic hazard may be grouped as follows:

a) Control of charge generation by suitable design of plant, and operating procedures.
b) Control of charge accumulation on plant, product and personal.
c) Elimination of flammable atmospheres.
d) Design of operating procedures to minimize the possibility of spark.

Safety precautions that have virtually universal application shall be discussed first. The others that have limited application and are best described with reference to industrial operations specifically.

8.4 Lighting for Safety: Lighting installations mostly are not considered as an important system. Many seem to believe that they can perform various assignments without proper lighting. Most of the electric lighting installed over the shop floor and offices of industry, commercial buildings etc. can be described without much hesitation as a hazard rather than and aid to safety. Without light the visibility is affected leading to unsafe operations and the resultant accidents. On the other hand, light itself can be hazardous. Good lighting is lighting which promotes safety and performance efficiency. Lighting can be considered as good only when it is designed specifically to suit the requirements of the job, the employees and the location. The lighting should be kept modified in line with all improvements undertaken after the original layout within a factory to increase productivity and efficiency. There is evidence to believe that poor lighting contributes directly or indirectly to a significant proportion of the falls and the resultant injuries and loss of man hours which form a high proportion of the total number of industrial accidents world wide where many accidents are due to lapses on the part of employees. Employees have little control over the standard of lighting provided for their work. Therefore it's a management responsibility to provide safe lighting.

Defects in lighting: There are a number of lighting defects, which are found in a factory. These defects are broadly classified under the following headings:

a) Insufficient light.
b) Shadows
c) Glare

a) *Insufficient light*: Darkness can often conceal real danger. It can lead to misinterpretation of visual information because the position, shape, or speed of an object is misjudged if the illumination provided is insufficient for the task that is being attempted. In total darkness, it is safer not to attempt any task other than probably an emergency escape or similar operations that cannot wait till proper lighting. Although the eye can function over a very wide range of brightness values, there is a limit below which a task cannot be performed safely. Eyes also take time to adapt to variations in the intensity of lighting, especially where there is a change from a high level of illumination to a lower one.

b) *Shadows*: Shadows result if lighting fittings are too widely spaced in relation to their mounting height, or if they are in the wrong position. Unless the presence of bulky obstructions obviously requires precautions to be taken, shadows will generally be unobjectionable if the spacing height ratio of the light fittings doesn't exceed the maximum recommended by the manufacturer. This is normally between 1.5:1 and 1:11 depending on the type of fitting selected.

c) *Glare*: Glare is experienced in three different forms:

   1) Disability glare: This is the visually paralyzing effect caused by bright, bare lamps directly in the line of sight. This kind of glare is seldom experienced in working interiors because most bright lamps e.g., filament and mercury vapour, are usually at least partially screened by some kind of fitting.

   2) Discomfort glare: This is caused mainly by too much contrast of brightness between and object and its background and is a common by product of poorly designed lighting. Since discomfort glare doesn't cause any immediate adverse reaction bi-one is unduly concerned, but, over a period of times, discomfort glare can cause eyestrain, headaches, and fatigue, this in turn can be a contributory cause of an accident.

3) Reflected glare: This is the reflection of bright light sources on shiny or wet work surfaces such as glass or plated metal. Even a modest amount of glint can almost entirely conceal the detail in or behind the object which is glinting and where there is likely to be similar hazards, it is necessary to use light sources of low brightness, or to arrange the geometry of the installation so that there is no glint in the particular viewing direction or both.

Lighting Standards: The following standards provide the schedule of minimum illumination requirements:

a) Illuminating Engineering society code (1968) (UK)
b) Code of practice for industrial lighting-IS 6665
c) Code of practice for interior illumination-IS 3646

The above standards provide illumination level in flux.

It should be noted that the code recommendations are based on the visual recommendations of people about 40 years of age, having good eyesight and enjoying reasonable general working conditions. Where the task contrasts and reflectance's are low or where the consequences of wrong perception maybe serious, or where protective goggles must be worn, the service values of illumination should be increased by 50%. Most of the recommendations of the code are directly related to the difficulty of the visual task.

Good Lighting: Good lighting installations can be planned after a detailed study of the operational requirements of the respective area. The study shall identify all possible operations called for by the manufacturing process its microscopic nature of activity, the possible obstructions of light sources etc. the limitations of the fixing the light fittings are also to be studied along with the possible extreme exposures for the light fitting such as fumes, dusts, corrosive vapours etc. after considering the above mentioned factors, most suited light fittings including the type of lamp can be selected. Over a period of time the out of lamps come down by 80-50%. Therefore the final illumination level computation shall take into account this aging factor also. Equally it is desirable to directly check the illumination level with portable light meter. Readings can be taken at all important at all important working points and places of potential danger.

8.5 Lightning protection:

Lightning Discharges: Clouds develop static electric charges as they travel in the sky. These charges can reach upto millions of voltage before it is discharged to the general mass of earth or otherwise neutralized.

Principle of Lightning Protection: The basic principle of protection of buildings and structures against lightning hazard is to provide effective conducting path between the general mass of the earth and the atmosphere above the building by which a lightning discharge may enter the earth, without producing dangerous potential differences in or near the building and also without passing through a non-conducting part of the building or structure, for example parts which are made of wood, brick, tile, stone or concrete.

Effects of lightning discharges: There are three effects of lightning discharge, they are

a) Electrical
b) Mechanical
c) Thermal.

These effects are determined by the current that is discharged to the building, structure or earth. The discharge currents are unidirectional and vary in amplitude from a few hundred amperes to 200KA. The current in any lightning discharge rises steeply to its peak value in a few milliseconds. Many lightning discharges consist of a single stroke but many other involve a sequence of strokes which follow the same path and which discharge separate currents, the amplitudes depends on the static voltage build up for the respective cloud formations. A complete lightning discharge can therefore last a second or even longer.

a) Electrical Effects: The principal electrical effects of a lightning discharge are two fold.

1. The lightning current which is discharged to earth through the resistance of the lightning conductor and earth electrode provided for a lightning protective system, produces a resistive voltage drop which momentarily raises the potential of the protective system with respect to the absolute earth potential to a very high value. The lightning current also produces, around the earth electrode, a high voltage gradient that may be dangerous to persons and animals.
2. The lightning current rises steeply to its peak value and as a first approximation may be regarded as equivalent to high frequency discharge. A vertical conductor of the dimensions generally used in a lightning protective system has an

inductance of about $15*10^{-5}$ H/100m. The rate of rise of current in conjunction with the inductance of the discharge path produces an inductive voltage drop which due to regard to the time relationship, to the resistive voltage drop across the ohmic system.

b) Thermal Effects: The thermal effect of lightning discharge results in rise in temperature of the conductor through which the lightning current is discharged to the earth. Although the amplitude of the lightning current may be very high its duration is so short that the thermal effect on a lightning protective system is usually negligible. This ignores the fusing or welding effects, which occur locally consequent upon the rupture of a conductor, which was previously damaged, or of inadequate cross sectional area. In practice the cross sectional area of a lightning conductor is determined by mechanical considerations.

c) Mechanical Effects: When a high electric current is discharged through parallel conductors, which are in close proximity to each other, these are subjected to large mechanical forces. The lightning conductors should therefore be provided with adequate mechanical fittings. A second mechanical effect exerted by a lightning discharge is due to the air channel that is, the space between the thundercloud and the lightning conductor along which the discharge is propagated, is suddenly raised to a very high temperature. This results in a strong air pressure wave, which is responsible for damages of building and other structures. It is not possible to provide protection against such effects.

Design considerations: Lightning protective devices should be designed to offer the least impedance to the passage of lightning current between the air terminals and the earth. Therefore the shortest direct path is considered to be the best. The impedance to the earth is inversely proportional to the number of alternate paths. From each air terminal there must be atleast two paths to the earth and more if practicable. The number of paths may be increased and the impedance decreased by connecting the conductors to form a cage enclosing the building. Earth connections must be distributed symmetrically, preferably outside and around the circumference of the structure. This is because when a stroke is about to take place the surrounding surface of the earth for a radius of several kilometers carries an electric charge. As the lightning stroke takes place, this surface charge moves radially towards the earth end of the air path, forming an electric current in the earth. At the point where the discharge enters the earth, the current density becomes high, and if flow takes place through the foundation wall of a building, it may result in damaging the building. With earth connections properly distributed the current will be collected at the outer extremities, and the flow underneath the building will be minimized. In every case two earth connections should be made at the opposite ends of the structure except for small buildings.

Where there are metal objects within 2m of the lightning protective system, there will be tendency for sparks or side flashes to jump from the conductor to the metal objects. To prevent damage, interconnecting metal conductors should be provided at all places where side flashes are likely to occur. Mechanical construction of lightning protective system should be strong and the materials used should resist corrosion as these systems are expected to remain in working condition for long time.

Protection of structures with explosive or flammable material: Following precautions should be taken for the protection of structures and their contents from lightning:

a. Storage of flammable liquids and gases in all metal structures, essentially gas tight.
b. Closure or protection of vapour or gas openings against entrance of flames.
c. Maintenance of container in good condition is far as potential hazards are concerned.
d. Avoidance so far as possible of accumulation of flammable air-vapour mixtures within or around such structures.
e. Avoidance of spark gaps between metallic conductors at points where there may be an escape or accumulation of flammable vapours or gases.
f. Location of structures not inherently self-protecting in positions of lesser exposure with regard to lightning. Elevated positions to be avoided.
g. In connection with structures not inherently self-protecting the establishments of zones of protection through use of earthed rods, masts, or the equivalent.
h. Recommendations of IS 2309 should be followed for structures in which explosive or flammable liquids/gases are stored.

ALSTOM

GAUTAMI POWER LIMITED IDA, PEDDAPURAM

ELECTRICAL SAFETY INSPECTION CHECKLIST

Name of Site : Gautami 469 MW CCPP
Inspected By :
Date :

Sl. No.	Points	Observation	Measures
	CABLES		
1	Whether the condition of Cable is checked?		
2	Are Cables received form other site checked for Insulation Resistance before putting them into use?		
3	Are all main Cables, taken either underground / Overhead?		
4	Are welding Cables routed properly above the Ground?		
5	Are welding & Electrical Cables overlapping?		
6	Is any improper jointing of Cables wires prevailing at Site?		
	DBs / SDBs		
1	Is earth conductor continued upto DB / SDB?		
2	Whether DBs & extension boards are protected from rain / water?		
3	Is there any overloading of DBs / SDBs?		
4	Are correct / proper fuses & CB's provided at main boards & sub- boards?		
5	Is energised wiring in junction boxes, CB panels & similar places covered all times?		
	ELCB		
1	Whether the connections are routed through ELCB?		
2	Is ELCB sensitivity maintained at 30 mA?		
3	Are the ELCB numbered & tested periodically & test results recorded in a logbook countersigned by competent person?		
	EARTHING		
1	Is neutral earthing ensured at the source of power (Main DB at Gen. or Transformer)?		
2	Whether the continuity & tightness of earth conductor are checked?		
3	Mention the gauge of earth conductor used at site.		
4	Mention the value of Earth Resistance.		
	ELECTRICALLY OPERATED MACHINES / ACCESSORIES		
1	Whether the plug top provided everywhere?		
2	Are all metal parts of electrical equipment's & light fittings / accessories grounded?		
3	Is there any shed / cover for welding machines?		
4	Are Halogen lamps fixed at proper places?		
5	Are Portable power tools maintained as per norms?		
6	Any other Information		

Signature:

Date:

9. RISK ASSESSMENT AT ALSTOM

9.0 RISK ASSESSMENT PROCEDURE AT ALSTOM

9.1 Aim: To identify and define the hazards existing on site, the risks they represent and the precautions and controls which need to be put in place to protect against them.

9.2 Area of Application: ALSTOM Power Turbo-Systems (ALSTOM PT), Plant Business, Civil Construction / Erection and Commissioning Unit.

9.3 Responsibilities:

- ALSTOM PT Site EHS Manager will ensure that:
  - this document is brought to the attention of the appropriate ALSTOM PT Site Management, ALSTOM PT Partners and Subcontractors
  - where local requirements are not met by this work instruction that the document is amended to suit or other suitable provisions are made
  - this work instruction is audited at appropriate intervals
- ALSTOM PT line management and line managers of ALSTOM Partners will ensure that the workers, over whom they have direct control, comply with this procedure and that subcontractors are managed accordingly
- All Site EHS and Supervisory Personnel will:
  - monitor compliance and report any breech of procedure to the appropriate manager
- ALSTOM PT Unit Head of EHS will continually review the adequacy of this procedure and revise as appropriate.

9.4 Procedure:

9.4.1 What is Risk Assessment?

An identification of the hazards present in a workplace and an estimate of the extent of the risks involved, taking into account whatever precautions are already being taken. It involves:

- Identification of ALL the hazards;
- Identification of people at risk;
- Evaluation of the risks and of existing precautions;
- Recording and communication of the findings;
- Periodic review.

9.4.2 *When to Conduct a Risk Assessment*

A Risk Assessment must be undertaken before the commencement of the activity so that control measures, as determined by the assessment can be put in place from the start. Hazards should be identified during the planning stage of the activity. This will keep cost for any subsequent modification to a minimum. We must be sure that any article we design or supply is safe and without risk to health.

A Risk Assessment shall be carried as follows:

- When required by legislation;
- For all new engineering design work and specifications;
- For all new / different site activities that could be deemed as hazardous;
- For all hazardous activities;
- When required by a Permit to Work.

As well as this general risk assessment there may also be more specific requirements relating to the following:

- Manual Handling;
- Personal Protective Equipment;
- Display Screen Equipment;
- Noise;
- Hazardous Substances;
- Asbestos;
- Lead;
- Fire.

9.4.3Who should Carry Out a Risk Assessment

The risk assessment is a duty of the employers towards the employees and other persons affected by the organization's activities. The assessment should be conducted with the involvement of person(s) who is/are familiar with and understand(s) the task to be assessed. Specialist EHS guidance on certain aspects may be sought from an appropriate person i.e. the Site EHS Manager / Qualified Medical Practitioner.

9.4.4 *Conducting the Assessment*

Hazard Survey

All activities together with methods and systems of work should be subjected to a hazard survey. The extent and depth of this survey will be dependent on the potential losses arising from the activity. Important criteria to be considered include:

- Exposure of people (both the workforce and the public) to any dangers that may arise;
- The value of the plant or equipment in financial and economic terms;
- The value of the plant or process in terms of its possible interdependence with other processes;
- Any inherent toxic, explosive or fire risk associated with any stage of the activity.

The hazard may have been pointed out by other persons, it may have been highlighted as the result of a safety inspection, it may be immediately obvious or it may be mandatory that a risk assessments is conducted on this for a particular activity or aspect. When considering the exposed people ensure that consideration is given to people that are not there at the time of the assessment.

Below is a series of key questions to assist in hazard identification which can be applied in many situations:

- What can happen?
- How can it happen?
- What will happen in the event that there is too much or too little (pressure/heat/cold/air/vacume/ventilation/noise/flow/supply/reactants/containment etc.).

To these questions one can add:

- Who could be affected?
- Why is the risk necessary?
- Where will it take place?

Hazards can result in different forms of harm. It is useful to record both the hazard and the harm so that it is easier to identify the correct precautions to take. Hazard identification can be helped by:

- Viewing a situation or activity;
- Discussing it with those involved in the activity;

- Referring to manufacturers' or suppliers' manuals or data sheets;
- Referring to a checklist of hazards as an aide-memoir;
- Referring to accident/incident reports;
- Reviewing of legislation and legislative guidance notes.

Persons at Risk

The risk associated with a particular situation or activity will differ with the individual exposed to the hazard, this must be considered during the assessment. Individuals or groups who may be particularly at risk include:

- Employees;
- Contractors;
- Lone Workers;
- Young People;
- Expectant Mothers;
- Members of the public;
- Those with literacy difficulties (cultural or learning difficulties);
- Those with physical disabilities.

Only consider those with a real likelihood of being exposed to the hazard.

Hazard Analysis

The hazard identification must be analysed. The main elements of this are probability, frequency and severity

Probability and Frequency

These are related and can be decided using previous data where available or where not on the basis of the following:

Probability & Frequency	***Score***
Negligible	1
Low	2
Moderate	3
High	4
Definite	5

Severity

This is classified as follows:

Severity	***Score***
Minor	1
Serious	2
Major	3
Catastrophic	4

Hazard Evaluation Scorecard

We use the following scorecard assessment based upon the above concepts of probability, frequency and severity. The following timeframe should be adhered to with regards to the timeframe to resolve the hazards:

a) Medium Priority – to be resolved within 5 days
b) High Priority - to be resolved within 2-3 days
c) Immediate - to be resolved immediately without delay

Probability & Frequency	Definite	**5**	5	10	15	20
	High	**4**	4	8	12	16
	Moderate	**3**	3	6	9	12
	Low	**2**	2	4	6	8
	Negligible	**1**	1	2	3	4
			1	**2**	**3**	**4**
			Minor	Serious	Major	Catastrophic
			Severity			

Key to Priorities:		
Medium Priority (5 days)	High Priority (2-3 days)	Immediate

Control Measures

If the risk assessment has determined that something needs to be done then the following two questions need to be considered and appropriate control measure implemented:

a. Can the Hazard be removed altogether?

b. If not how can the risks be controlled so that harm is unlikely?

In answering these questions the below "Hierarchy of Control" should be considered:

1. Elimination;
2. Substitution;
3. Isolation;
4. Engineering control;
5. Administrative control;
6. Use of PPE.

Once the control measures have been implemented the Risk Assessment process should be repeated to quantify the residual risk, and the risk from any new hazards introduced inadvertently by the control measures. These risks should now be tolerable.

<u>9.5 Reviewing the Assessment</u>:

The assessment must be reviewed and revised as necessary, for example if there is a significant change to the work area or for any other reason you suspect that the assessment is no longer valid.

ALSTOM	PERMIT TO WORK				PERMIT NO:	
Work Activity : (delete as applicable)	General	Hot Work	Excavations	Confined Space Entry	Blocking Site Access	Use of O/H Cranes

A. Application (to be completed by contractor)

Requesting Company:		Request by:		Date:	

Plant Area:	Description of work: (attach drawing/sketch as necessary)

Permit is required from:	Time	Date	To:	Time	Date

B. Precautions to be taken prior to commencement and during the work (delete/add as appropriate)

General

Have Method Statement and Risk Assessment been prepared & approved

Hot Work	Excavations	Confined Spaces
Have Method Statement and Risk Assessment been prepared & approved Area to be cleared of flammable waste Fire extinguisher readily available Overhead work to have area below roped off and fire watch present Pipelines, drums etc. to be certified gas/liquid free Fire blanket provided to arrest sparks, flames etc. Welding screens in use to protect eyes of other persons Permit drawn for confined space working Has local exhaust been provided	Have Method Statement and Risk Assessment been prepared & approved Have appropriate measures been taken considering location and depth of excavation Shoring Guardrails Confined space assessment	Have Method Statement and Risk Assessment been prepared & approved Isolation of Valves Spading of Valves No smoking/Naked Lights Adequate Ventilation/Extraction Monitoring Lighting Standby Man Lifeline Breathing Apparatus

C. Issue (to be completed by Alstom P T-S)

Permission is given for the work to proceed subject to the conditions specified above:

	Sign:	Print:	Date:	Time:	Company:
Signed (Permit Controller):					

D. Performing Authority Acceptance (to be completed by contractor)

I certify that have read and understood this permit and that the work will be carried out in accordance with its requirements.

	Sign:	Print:	Date:	Time:	Company:
Signed :					

E. Completion of Work (to be completed by contractor)

I hereby declare that all work for which this permit was issued has been completed, all personnel under my control have been withdrawn and the work area and any associated equipment has been left in a safe condition.

	Sign:	Print:	Date:	Time:	Company:
Signed :					

F. Cancellation

This permit is cancelled.

	Sign:	Print:	Date:	Time:	Company:
Signed :					

ALSTOM	PERMIT FOR RADIOGRAPY	PERMIT NO:	

A. Application (to be completed by contractor)

Requesting Company:		Request by:		Date:	

Permission is requested to conduct radiography as follows (A plan showing precise area affected by the radiography must be attached):

Plant area:		Location	
Size of source to be used:		No of shot to be performed:	
Type of source to be used:		Type of equipment to be used:	

	Time	Date		Time	Date
Permit is required from:			To:		

B. Precautions to be taken prior to commencement and during the work (delete/add as appropriate)

Work to be conducted in accordance approved Method Statements and Risk Assessments.

C. Issue (to be completed by Alstom P T-S)

Permission is given for the work to proceed subject to the conditions specified above and that a "Notification of Site Radiography" has been prepared and site distribution arranged:

	Sign:	Print:	Date:	Time:	Company:
Signed (Permit Controller):					

D. Performing Authority Acceptance (to be completed by contractor)

I certify that have read and understood this permit and that the work will be carried out in accordance with its requirements.

	Sign:	Print:	Date:	Time:	Company:
Signed :					

E. Completion of Work (to be completed by contractor)

I hereby declare that all work for which this permit was issued has been completed, all personnel under my control have been withdrawn and the work area and any associated equipment has been left in a safe condition.

	Sign:	Print:	Date:	Time:	Company:
Signed :					

F. Cancellation

This permit is cancelled.

	Sign:	Print:	Date:	Time:	Company:
Signed :					

ALSTOM	RISK ASSESSMENT FORM

Location:	**Main plant**	Date of Assessment:		Assessment No:	**APIL/EHS/RA - 001**
Assessor(s):	**SANJAY MISHRA/Venkat**		System/Activity:		**EXCAVATION**

Probability &Frequency	Definite	5	5	10	15	20
	High	4	4	8	12	16
	Moderate	3	3	6	9	12
	Low	2	2	4	6	8
	Negligible	1	1	2	3	4
			1 Minor	2 Serious	3 Major	4 Catastrophic
			Severity			

Medium priority (5days) High priority (2-3 Immediate

Hazards Identified (include the exposed groups)	Probability 1-5	Severity 1-4	Risk 1-20	Control Measures to be Implemented	Residual Risk	Date Action Completed
• Damage of underground utilities (cable, drainage, gas pipe line etc.)	4	4	16	• Permit to work, initial survey (trial hole)	Implementations are under progress.	Daily site EHS inspections, daily & weekly EHS meetings, in-house training, motivation programmes are carrying out by EHS officer to control the hazards.
• Collapse of loose soil/cave –in	4	4	16	• Shoring/sloping/benching methods		
• Usage of damaged/broken hand tool	2	1	2	• Good hand tools to be ensured.		
• Fall of person inside pit	3	2	6	• Barricade to be ensured (1mtr away from pit)		
• Fall of excavated soil	3	2	6	• Soil to be stacked 1.5mtr away from pit		
• Struck against earth moving machineries	4	3	12	• Away from swinging area.		
• Electric shock due to damage of live cable	5	4	20	• Manual digging or existing drwg. Reference		
• Slip, trip.	3	2	6	• Good house keeping, proper stacking.		
• Improper means of access &egress	3	2	6	• Proper access &egress to be ensured.		
• Toppling of earth moving machine.	4	4	16	• During excavation machine shall be kept away from edge of excavation pit		

Assessor	Print:		Sign:		Date:	

ALSTOM	RISK ASSESSMENT FORM

Location:	**Main plant, Switchyard, Cooling tower**	Date of Assessment:		Assessment No:	**APIL/EHS/RA - 002**
Assessor(s):	**SANJAY MISHRA/Venkat**		System/Activity:	**EARTH MOVING MACHINERIES &VEHICLE MOVEMENT**	

Probability &Frequency	Definite	5		5	10	15	20
	High	4		4	8	12	16
	Moderate	3		3	6	9	12
	Low	2		2	4	6	8
	Negligible	1		1	2	3	4
				1	2	3	4
				Minor	Serious	Major	Catastrophic
				Severity			

Medium priority (5days) High priority (2-3 days) Immediate

Hazards Identified (include the exposed groups	Probability 1-5	Severity 1-4	Risk 1-20	Control Measures to be implemented	Residual Risk	Date Action Completed
• Unauthorized /unlicensed person operation.	4	3	12	• Authorized/ licensed person shall be operated.	Implementations are under progress.	Daily site EHS inspections, daily & weekly EHS meetings, in-house training, motivation programmes are carrying out by EHS officer to control the hazards.
• Exceeding the construction site speed limit of 20 km/hr.	3	2	6	• 20 km/hr shall be strictly observed.		
• Operating machineries without reverse alarm.	5	4	20	• Reverse alarm shall be installed.		
• Entertaining a group of workmen in earth moving vehicle while movement.	3	2	6	• Only one person only shall be allowed in earth moving machineries.		
• Utilizing poor maintenance of vehicle for carrying out construction work.	4	3	12	• Periodic maintenance shall be ensured to all vehicle& machineries.		
• Uneven & overloading of the vehicle with excavated soil.	4	3	12	• Adequate excavated soil shall be allowed.		
• Toppling of vehicle due to improper unloading of soil.	4	3	12	• During unloading Banks man shall be provided for proper signal & communication.		

Assessor	Print:		Sign:		Date:	

ALSTOM	RISK ASSESSMENT FORM

Location:	Main plant, Switchyard	Date of Assessment:		Assessment No:	APIL/EHS/RA - 003
Assessor(s):	Sanjay Mishra/Venkat		System/Activity:	SHUTTERING, STEELFIXING & CONCRETING	

Probability &Frequency						
	Definite	5	5	10	15	20
	High	4	4	8	12	16
	Moderate	3	3	6	9	12
	Low	2	2	4	6	8
	Negligible	1	1	2	3	4
			1 Minor	2 Serious	3 Major	4 Catastrophic
			Severity			

Medium priority (5days) ☐ High priority (2-3 days) ☐ Immediate ☐

Hazards Identified (include the exposed groups	Probability 1-5	Severity 1-4	Risk 1-20	Control Measures to be implemented	Residual Risk	Date Action Completed
• Person may be received wound due to poor handling of shuttering materials.	2	1	2	• Toolbox meeting shall be organized.	Implementations are under progress.	Daily site EHS inspections, daily & weekly EHS meetings, in-house training, motivation programmes are carrying out by EHS officer to control the hazards..
• Poor stacking of materials.	2	1	2	• Neat stacking shall be ensured.		
• Usage of broken hand tools.	3	1	3	• Standard hand tools to be ensured.		
• Improper and poor design of access and egress.	3	2	6	• Work platforms with handrail to be ensured.		
• Dermatitis may be received due to concrete mixing.	3	2	6	• Gumboot, rubber gloves shall be ensured to all concrete mixing workmen		
• Hand, leg, head, eye injuries.	3	1	3	• Personal protective equipment shall be ensured.		
• Giddiness, dehydration, heat stroke due to continuous exposure to high temperature.	4	3	12	• Lot of water intake, time changes, rotation of work cycle, air movement to be provided.		
• Slip, trip hazards.	3	2	6	• Good house keeping to be ensured.		
• Protruding nails on shuttering materials	3	3	9	• De nailing shall be ensured.		

Assessor	Print	JAFFAR	Sign:		Date:	

ALSTOM	RISK ASSESSMENT FORM

Location:	FABRICATION YARD	Date of Assessment:		Assessment No:	APIL/EHS/RA - 001
Assessor(s):	SANJAY MISHRA/Venkat		System/Activity:	STEEL FABRICATION	

Probability & Frequency	Definite	5	5	10	15	20
	High	4	4	8	12	16
	Moderate	3	3	6	9	12
	Low	2	2	4	6	8
	Negligible	1	1	2	3	4

1	2	3	4
Minor	Serious	Major	Catastrophic
Severity			

Medium priority (5days) ☐ High priority (2-3 days) ▒ Immediate ☐

Hazards Identified (include the exposed groups	Probability 1-5	Severity 1-4	Risk 1-20	Control Measures to be implemented	Residual Risk	Date Action Completed
• Slip, trip hazards.	2	1	2	• Good house keeping shall be ensured.	After taking all said control Measures residual risk is minimised Implementations are under progress.	Daily site EHS inspections, daily & weekly EHS meetings, in-house training, motivation programmes are carrying out by EHS officer to control the hazards.
• Lying fabrication materials haphazardly.	3	1	3	• Proper stacking of materials to be ensured.		
• Electric shock	4	3	12	• RCCB shall be ensured to all electrically operated tools.		
• Usage of mutilated hoses for gas cutting sets.	3	1	3	• Hoses to be checked periodically		
• Hand, leg, eye injuries due to welding, cutting and grinding operations.	3	2	6	• Personal protective equipment shall be ensured.		
• Unauthorized personnel operations. (Welding, grinding)	3	3	9	• Authorized personnel operations.		
• Poor manual handling.	3	1	3	• Toolbox meeting shall be arranged.		
• Struck against material	2	1	2	• Proper access and good house keeping.		
• Operating grinding wheel without guard.	4	2	8	• Standard guard shall be provided.		
• Fire, gas leak hazards.	3	3	9	• Good house keeping, monitoring the gas cylinders on daily basis..		

Assessor	Print		Sign:		Date:	

ALSTOM	RISK ASSESSMENT FORM				
Location:	Main plant, fabrication yard	Date of Assessment:		Assessment No:	APIL/EHS/RA - 005
Assessor(s):	SANJAY MISHRA/Venkat		System/Activity:	Electrical installations.	

Probability							
	Definite	5		5	10	15	20
	High	4		4	8	12	16
	Moderate	3		3	6	9	12
	Low	2		2	4	6	8
	Negligible	1		1	2	3	4

Medium priority(ays) High priority (2- s) Imme

1	2	3	4
Minor	Serious	Major	Catastrophic
Severity			

Hazards Identified (include the exposed groups	Probability 1-5	Severity 1-4	Risk 1-20	Control Measures to be implemented	Residual Risk	Date Action Completed
• Electric shock, burn, fire, overheating of electrical equipment.	5	4	20	• RCCB, MCB shall be ensured to all electrical panels and hand operated electrical tools.	Implementations are under progress.	Daily site EHS inspections, daily & weekly EHS meetings, in-house training, motivation programmes are carrying out by EHS officer to control the hazards.
• Slip &trip hazards	3	2	6	• Good house keeping shall be maintained.		
• Unauthorized personnel carrying out electrical work	4	3	12	• Qualified and experienced personnel shall be allowed to do electrical work.		
• Overloading of socket and fuses.	4	3	12	• Isolation shall be provided.		
• Electrical cable and wire routed haphazardly all over work area.	3	2	6	• Proper dressing and cable routing to be done.		
• Insertion of live wire inside the socket.	4	3	12	• Plug to be provided.		
• Operating hand tools without earthing.	4	4	16	• Effective earthing shall be ensured.		
• Usage of defective electrical equipment.	4	3	12	• Periodic inspection shall be done.		

Assessor	Print:		Sign:	Date:	

ALSTOM

RISK ASSESSMENT FORM

Location:	**Fabrication Yard**	Date of Assessment:		Assessment No:	**APIL/EHS/RA - 007**
Assessor(s):	**SANJAY MISHRA/Venkat**		System/Activity:	**Sand blasting.**	

Probability	Definite	5		5	10	15	20
	High	4		4	8	12	16
	Moderate	3		3	6	9	12
	Low	2		2	4	6	8
	Negligible	1		1	2	3	4

1	2	3	4
Minor	Serious	Major	Catastrophic
Severity			

Medium priority (5days) High priority (2-3 days) Immediate

Hazards Identified (include the exposed groups	Probability 1-5	Severity 1-4	Risk 1-20	Control Measures to be implemented	Residual Risk	Date Action Completed
Dust due to activity.	4	3	12	• Considered the wind direction while selecting the location for sand blasting. • Isolate that area from others. • Ensure proper housekeeping periodically. • Ensure suitable and adequate dust mask is provided.	Minimised.	

Assessor	**Print:**		**Sign:**	**Date:**	

Location:	CCB	Date of Assessment:		Assessment No:	RA-8
Assessor(s):	SANJAY MISHRA/Venkat	System/Activity:	Civil activity (Scaffolding)		

Probability & Frequency						
	Definite	5	5	10	15	20
	High	4	4	8	12	16
	Moderate	3	3	6	9	12
	Low	2	2	4	6	8
	Negligable	1	1	2	3	4
			1	2	3	4
			Minor	Serious	Major	Catastrophic
			Severity			

Key to Priorities

Medium Priority (5 days) High Priority (2-3 days) Immediate

Hazards Identified (include the exposed groups)	Probability 1 - 5	Severity 1 - 4	Risk 1 - 20	Control Measures to be Implemented	Residual Risk	Date Action Completed
Damage / rusted Scaffolding materials	3	4	8	Check that all the components are present and undamaged.	Minimise	
Erection of scaffolding by un competent person.	3	4	12	All scaffoldings must be erected and dismantled by only competent person. All bracing, coupler shall be adequately fastened . While erection of scaffolding tower shall be rest over firm base plate .	Negligible	
Improper means of access	2	4	8	Only steel ladders are permitted to uses. stiles of ladder shall be firmly fastened with post at base and top. Distance between rungs should be not more than 300 mm. Use of ramp / staircase for access above 4M height.	Minimise	
Improper height of ladder	2	3	6	Proper height of ladder shall be needed (1st step300mm above ground and 1 meter above access)	Minimise	

Assessor	Print :		Sign:		Date:	

Hazards Identified (include the exposed groups)	Probability 1 - 5	Severity 1 - 4	Risk 1 - 20	Control Measures to be Implemented	Residual Risk	Date Action Completed
Fall of material from scaffold.	2	4	12	All loose materials should be removed immediately from working platform. Don't allow to work parallel beneath and upper to scaffold. Suitable and sufficient toe guard (ie150mm) shall be provided.	Minimise	
Slippage and fall of person from working platform	3	6	16	Guard-rails & Mid rails shall be provided. Walk way Challi shall be adequately tied and care shall be taken for minimum bearing. There should not be any opening left in work platforms.	Minimise	
Unstable platform / Over turning / Toppling effect	2	4	8	Scaffold shall be used only on a firm and even surface. Footing timber must be provided in case of soft soil condition.	Negligible	
Periodic inspection is not being done	3	6	12	Site Engineer /supervisor to identify the non -conformity and ensure the specification of the same. Weekly inspection should be done for all scaffoldings. Green / Red tag shall be placed to declare the scaffold is Safe / Unsafe for work & ensure that the team knows the nomenclature. After each Shifting / Dismantling it shall be treated as new inspection.	Minimise	

Assessor	Print :		Sign:		Date:	

Location:	Generic	Date of Assessment:	08/03/2006	Assessment No:	RA-017
Assessor(s):	Sanjay Mishra/Venkat	System/Activity:	Risk Assessment for CONFINED SPACE ENTRY.		

Probability & Frequency						
	Definite	5	5	10	15	20
	High	4	4	8	12	16
	Moderate	3	3	6	9	12
	Low	2	2	4	6	8
	Negligable	1	1	2	3	4
			1	2	3	4
			Minor	Serious	Major	Catastrophic
			Severity			

Key to Priorities

Medium Priority (5 days) High Priority (2-3 days) Immediate

Hazards Identified (include the exposed groups)	Probability 1 - 5	Severity 1 - 4	Risk 1 - 20	Control Measures to be Implemented	Residual Risk	Date Action Completed
1) Unauthorized personnel in confined space area..	4	3	12	Confined space must be isolated. Only trained person must carry out confined space entry and must have a confined space entry permit. Site must be labeled. There must be proper access and ingress. No unauthorized person must be allowed near the site.	Minimisedl	
2) Hazardous atmosphere inside the confined space	4	4	16	Confined space must be emptied and flushed with fresh air. Sludge must be removed. Fresh air intake should not be contaminated. Source of air must be protected from interference. Confined space must be continuously monitored for OEL, and LEL. A standby person should always be outside the confined space and should have constant communication with the person inside.	Moderate	
3) Lack of PPE.	3	3	9	Safety belt or harness to which a roped is securely attached and with the other in the hands of a person who can pull out must be there. SCBA's must be provided.	Minimised	

4) Fire Hazard	4	3	12	Smoking is prohibited. Only 24 V lamp is to be used. Electrical equipment must be explosive proof and intrinsically safe. Tools must be non metallic and ignition sources must be absent. Oxygen must not be provided as breathable air. Only hoses should be used to supply gas and air from the respective cylinders. Hoses must be turned off when not in use.	4 Minimised	
5) Person/ Equipment left behind after completion of confined space entry.	3	3	9	Personnel doing confined space entry must be identified along with tools and equipments. All personnel, tools and equipments must be removed from the confined space after completion of job and accounted for. Physical inspection must be carried out after the job.	3 Minimised.	

Assessor	**Print :**		**Sign:**		**Date:**	

Location:	HRG-2	Date of Assessment:	01/03/2006	Assessment No:	RA-019
Assessor(s):	Sanjay Mishra/Venkat	System/Activity:	Risk Assessment for Stack Shell Lifting Above 35 Mtrs.		

Probability & Frequency						
	Definite	5	5	10	15	20
	High	4	4	8	12	16
	Moderate	3	3	6	9	12
	Low	2	2	4	6	8
	Negligable	1	1	2	3	4
			1	2	3	4
			Minor	Serious	Major	Catastrophic
			Severity			

Key to Priorities

Medium Priority (5 days) | High Priority (2-3 days) | Immediate

Hazards Identified (include the exposed groups)	Probability 1 - 5	Severity 1 - 4	Risk 1 - 20	Control Measures to be Implemented	Residual Risk	Date Action Completed
1) Failure of lifting accessories.	4	3	12	SWL of accessory must be higher than the load. Status of inspections must be ascertained. Visual checks of slings, hooks, and other machinery should be carried out. Foundation of crane must be strong and must be able to bear the weight of the crane. Proper communication must be maintained if simultaneous operations are being carried out. Sharp edges should be avoided. Crane operator must be competent and free from influence of medicines and alcohols. Lifting should not be done fast. Hook should be secured when not in use.	Moderate.	02/03/06
2) Falling objects	4	4	16	Load should not be freely suspended. Lifting must not be carried out in bad weather conditions. Stack should be lifted only after all works are completed on it. There should not be ay person on the stack at the time of lifting. Area should be barricaded and no unauthorized personnel must be present in the lifting area. Objects should not be hanging loosely.	Minimised.	02/03/06

3) Falling of personnel from heights.	3	2	6	No person should be on top of the stack at the time of lifting. Personnel must wear Safety Helmets, Boots, Safety belt and Lanyards and must avoid working on HRG-2 when lifting is going on. Mesh must be used after stack is placed to prevent falling of personnel.	Moderate	02/03/06
4) Fire	4	3	12	Welding must be carried out after it is ensured that there are no flammable materials in and around the area. Proper precautions must be taken during welding. Fire extinguishers must be present close to welding areas.	Minimised.	02/03/06

Assessor	**Print :**		**Sign:**		**Date:**	

Location:	Generic	Date of Assessment:	11/03/2006	Assessment No:	RA-017
Assessor(s):	Sanjay Mishra/Venkat	System/Activity:	Risk Assessment for CONFINED SPACE ENTRY.		

Probability & Frequency	Definite	5	5	10	15	20
	High	4	4	8	12	16
	Moderate	3	3	6	9	12
	Low	2	2	4	6	8
	Negligable	1	1	2	3	4
			1	2	3	4
			Minor	Serious	Major	Catastrophic
			Severity			

Key to Priorities

Medium Priority (5 days) High Priority (2-3 days) Immediate

Hazards Identified (include the exposed groups)	Probability 1 - 5	Severity 1 - 4	Risk 1 - 20	Control Measures to be Implemented	Residual Risk	Date Action Completed
1) Improper Storage of oil drums	4	3	12	There must be no leakage and spillage of oil drums. Oil drums must be staked properly in designated area. Oil drums should be covered. Area around oil drum should be barricaded.	Minimised	11/03/06
2) Fire	4	4	16	No hot work should be carried out near the oil drums. Adequate fire fighting systems should be placed to counter any fire hazards. Electrical appliances should not have any faults. Appliance used in that area should be of non-sparking type and intrinsically safe.	Moderate	11/03/06
3) Lifting of oil drums	4	3	12	Lifting of oil drums should be done carefully. Crane operator must be competent. Crane should be checked before use.	Minimised	11/03/06
4) Flushing operation	4	3	12	Flushing operation should be carried out under the supervision of competent persons. There should be no spillage during filling of oil spillages if any should be cleared immediately. The turbine parts should be checked and flushing should be stopped in case of any leakage.	Moderate	11/03/06

Assessor	Print :		Sign:		Date:	

10. CONCLUSIONS

10.0 CONCLUSIONS

1) EHS Policy and Management system of Alstom was understood.
2) The procedure of Alstom Road Map was comprehended.
3) Pre-audit preparation of site was carried out.
4) The construction features of Combined Cycle Power Plants were understood.
5) Safety during construction was comprehended and checks where made on scaffolds for their stability.
6) Workmen were checked for proper PPE during work at heights.
7) Inspection of mechanical equipments such as Welding Machines, Grinding Machines, Gas Cutters, and Drilling machines were carried out.
8) Electrical checklists were filled up after daily checks.

11. REFERENCES

11.0 REFERENCES

1) Alstom Work instructions.

2) Hand Book of Fire Technology-Gupta.

3) Safety Manual.

4) www.osha.gov.

5) www.epa.gov.

6) How Stuff Works.

7) www.niosh.org