FIRE RISK ASSESSMENT AND FIRE LOAD CALCULATION IN MANUFACTURING INDUSTRY

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ABSTRACT

This report presents the importance of fire. Fire is one of the major hazards which may occur due to natural or man-made causes. In general, fires may be classified into five categories depending on the fuel that is burning. In recent times, there is an increase in incidences of fires in urban population due to very densely populated areas. The losses associated due to fires can be classified as loss to the life of structure, loss of human life and loss to property.

Analysis of fire loads of different compartments and providing sufficient number of fire fighting equipments can help in reducing the severity of fires. The fire loads and fire densities were analyzed at some locations to determine the requirements of fire fighting equipments.

Fire risk assessment is the process of identifying the hazards present in the various places and the people who are at risk and evaluate and reduce the risk by discuss with the employees and taking corrective actions. The assessment activities are record and documented for the future purpose. This report includes study of various types of fire and fire extinguishers and calculation of fire load and risk assessment method in a manufacturingindustrytoreduceandcontrolth efireaccidentsasperIndianstandards.

LITERATURE REVIEW

Mrs. Lilly Grace (2014) has published a paper titled “Fire threat in Buildings”. This paper presents the fire accident in buildings is a threatening one now a day. The numbers of accidents are increasing in day by day. It creates heavy lives and property losses to the individuals and the nations. To find out the reasons, frequency and giving protection to all type of buildings became challenges to the professionals. A detailed study with analysis required to seek the solution. In this paper the segregation of fire load, the fire load is the main source fire threat and its calculation, the method of fire spread in the buildings discussed. The last twelve years number of fire accidents, property loss and lives losses are taken as survey. These statistical data are analyzed. The results are discussed. The results demand the proper fire load management to reduce the fire threat and avoid the possibilities of the fire occurrence in the buildings. This paper is concluded with few possible practical solutions to safe guard the building from fire in future

Shrivastava Preeti R (2013) has presented a paper titled as “Estimation of fire load for an education buildings”. This paper explained about In general, fires may be classified into five categories depending on the fuel that is burning. In recent times, there is an increase in incidences of fires in urban population due to very densely populated areas. The losses associated due to fires can be classified as loss to the life of structure, loss of human life and loss to property. It was observed that many options are available which help in early detection of fire and minimizing the losses. Smoke detectors and firefighting equipment‟s were studied for a public building i.e. an educational institution. Analysis of fire loads of different compartments and providing sufficient number of firefighting equipment can help in reducing the severity of fires. The fire loads and fire densities were

analyzed at some locations to determine the requirements of firefighting equipment.

INTRODUCTION ABOUT PROJECT

Fire

Fire is a major hazard, because it gives only limited time to address the issue. Fires start when a flammable or a combustible material, in combination with a sufficient quantity of an oxygen gas is exposed to a source of heat for the fuel mix, and is able to sustain a rate of rapid oxidation that produces a chain reaction. Fire cannot burn without one of these three components. These three components construct a triangle called fire triangle. The triangle illustrates the three elements a fire needs to ignite. The three elements are heat fuel and oxidizing agent (Usually oxygen).

Figure 3.1 Fire Triangle

To stop a combustion reaction, one of the three elements of the fire-triangle has to be removed. To remove fire extinguishers are used. The different types of fire extinguisher extinguish fires in different manner. The most commonly used extinguishing agents are pressurized water, carbon dioxide and dry chemical powder. The properties and extinguishing systems used in fire extinguisher differ with respect to extinguishing agent. Fire extinguishers generally required to be serviced and refilled and inspected by a fire protection service company before due date. The firefighting systems can be of both internally and externally. The external fire extinguishers are fire hydrants for high rise buildings and internal extinguishers are fire extinguishers and fire alarm system.

Fire alarm system is a system used in firefighting which sounds alarm when the fire is detected by means of smoke detector. This alarm system helps the human to notice the fire and take action on fire. Other main firefighting equipment used in firefighting is sprinkler systems which sprinkle the extinguishing agents when smoke detector detects the smoke. Below are the various types of fire and fire extinguishers.

Fire hydrants and fire extinguisher must be installed where there is risk of fire. The suitable fire extinguishers must be kept so that incase of fire it can be easily suppressed. Fire hydrants must be installed outside to suppress the building of fire. Fire hydrants are external fire extinguishers and portable fire extinguishers are internal fire extinguishers

Table Classes of fire

CLASSES OF FIRE	COMBUSTILBLE MATERIALS	EXAMPLES
Class A	Solid	Wood, plastic, rubber
Class B	Liquid	Kerosene, petrol, liquid gases.
Class C	Gas and electrical appliances	Electrical appliances and combustible gases.
Class D	Combustible metals	Magnesium, potassium, titanium, and zirconium.

Classes of fire Class a

Class A fires consist of ordinary combustibles materials which are of solid type such as wood(all types of wood), paper, fabric, plastic and most kind of trash

Class b

Class B fires consists of fire which are of liquid type namely of liquid gas, petrol and kerosene which can cause fire easily when exposed to fire.

Class c

Class C fire consists of gaseous state and also electrical fires. Electrical circuit and appliances can be used to suppress the fire using class C Fire extinguishers

Class d

Class D fires are namely metals which are magnesium, potassium, titanium, and zirconium etc. These metals are combustible metals which come under class D fires.

National Standards

Indian Standards for Health and Safety (Fire)

• IS 1641.1988 – Code of Practice for fire safety of buildings(General)

• IS 3594.1991- Code of practice for fire safety of industrial buildings- general storage, warehouses

• IS1644.1988- Code of practice for fire safety of industrial buildings- Exit requirements

• IS 15381. 2003 – Fire Blanket Requirements

• IS 13039.1991 – External hydrant system provision and maintenance

• IS 15301.2003 –Installation and maintenance of firefighting equipments – codes of practice

• IS 2189. 2008 – Selection, Installation and maintenance of automatic fire detection and alarm system – codes of practice

• IS 1646. 1998–Code of practice for fire safety of building (general):Electrical installations

• IS 2190.1992- Selection, installation and maintenance of first aid fire extinguishers

Legal Requirements Factories act , 1948

Chapter IV Section 38 : Precautions in case of fire

(1) In every factory, all practicable measures shall be taken to prevent out break of fire and its spread, both internally and externally, and to provide and maintain--

(a) safe means of escape for all persons in the event of a fire, and

(b) the necessary equipment and facilities for extinguishing fire.

(2) Effective measures shall be taken to ensure that in every factory all the workers arefamiliarwiththemeansofescapeincaseoffirean dhavebeenadequatelytrainedinthe routine to be followed in such cases.

(3) The State Government may make rules, in respect of any factory or class or description of factories, requiring the measures to be adopted to give effect to the provisions of sub-sections (1)and

(4) Not with standing anything contained in clause (a) of subsection (1) or subsection (2),if the Chief Inspector, having regard to the nature of the work carried on in any factory, the construction of such factory, special risk to life or safety, or any other circumstances, is of the opinion that the measures provided in the factory, whether as prescribed or not, for the purposes of clause (a) of sub-section (1) or sub-section (2), are inadequate, he may, by order in writing, require that such additional measures as he may consider reasonable and necessary, be provided.

Section 40. Safety of buildings and machinery

(1) If it appears to the Inspector that any building or part of a building or any part of the ways, machinery or plant in a factory is in such a condition that it is dangerous to human life or safety, he may serve on 4[the occupier or manager or both] of the factory an order in writing specifying the measures which in his opinion should be adopted and requiring them to be carried out before a specified date.

(2) If it appears to the Inspector that the use of any building or part of a building or any part of the ways, machinery or plant in a factory involves imminent danger to human lifeorsafety,hemayserveon5[the occupier or manager or both] of the factory an order in writing prohibiting its use until it has been properly repaired or altered.

Section 40A. Maintenance of buildings

If it appears to the Inspector that any building or part of a building in a factory is in such a state of disrepair as is likely to lead to conditions detrimental to the health and welfare of the workers, he may serve on the occupier or manager or both of the factory an order in writing specifying the measures which in his opinion should be taken and requiring the same to be carried out before such date as is specified in the order.

The Tamil Nadu factories Rules, 1950 Rule 53,Schedule VI – All factories

A) Wherever practicable and considered necessary by the inspector service platformsandgangwaysshallbeprovidedforoverh eadshaftingandwhererequiredbyhim these shall ne securely fenced with guards rails and toe boards.

B) Safe accesses shall be provided to all bearing clutches belt shifting levers and all such other applications which required to be handled or operated while the machinery.

C) All ladders used in replacing belts or in attending similar overhead machinery shall be specially made for that work and provide with books or an effective non skid device.

D) No transmission machinery in motion shall be cleaned with cotton waste, rags or similar materials held in hand

E) All belts shall be regularly examined to ensure that the joins are safe and the belts are kept in proper tension.

F) Each water gauge glass of a boiler shall be fitted with an efficient guard.

G) All condenser pipers of steam engines and exhaust pipes of oil engines shall be adequately guarded.

Section 61. Fire Protection

(1) Processes, equipment, plant, etc., involving serious explosion and serious fire hazards.

(a) All processes, storages, equipments, plants, etc., invoking serious explosion and flash fire hazards shall be located in segregated building where the equipment shall be so arranged that only a minimum number of employees are exposed to such hazards at any one time.

(b) All industrial processes involving serious fire hazard should be located in buildingsorworkplacesseparatedfromoneanother bywallsoffire-resistantconstruction.

(c) Equipment and plant involving serious fire or flash fire hazard shall, wherever possible, be so constructed and installed that in case of fire, they can be easily isolated.

(d) Ventilation ducts, pneumatic conveyors and similar equipment involving a serious fire risk should be provided with flame-arresting or automatic fire extinguishing appliances or fire resisting dampers electrically interlocked with heat sensitive/smoke detectors and the air-conditioning plant system.

(e) In all workplaces having serious fire or flash fire hazards, passages between machines, installations or piles of material should be at least 90 cm wide. For storage piles, the clearance between the ceiling and the top of the pile should not be less than 2m.

(2) Access for firefighting

(a) Buildings and Plants shall be so laid out and roads, passage-ways, etc., so maintained as to permit unobstructed access for firefighting.

(b)Doorsandwindowopeningsshallbelocatedin suitablepositionsonallexternal walls of the building to provide easy areas to the entire area within the building for firefighting.

(3) Protection against lighting

Protection from lighting shall be provided for

(a) buildings in which explosive or highly flammable substances are manufactured, used, handled or stored;

(b) storage tanks containing oils, paints or other flammable liquids;

(c) grain elevators;

(d) buildings, tall chimneys or stacks where flammable gases ,fumes, dust or lint are likely to be present; and

(e) Sub-station buildings and out-door transformers and switchyards.

(4) Precautions against ignition

Wherever there is danger of fire or explosion from accumulation of flammable or Explosive substances in air:-

(a) all electrical apparatus shall either be excluded from the area of risk or they shall be of such construction and so installed and maintained as to prevent the danger of their being a source of ignition;

(b) effective measures shall be adopted for prevention of accumulation of static charges to a dangerous extent;

(c) workers shall wear shoes without iron or steel nails or any other exposed ferrous materials which is likely to cause sparks by friction;

(d) smoking, lighting or carrying of matches, lighters or smoking materials shall be prohibited;

(e) transmission belts with iron fasteners shall not be used; and

(f) all other precautions as are reasonably practicable, shall betaken by (sic) prevent initiation of ignition from all other possible sources such as open flames, frictional sparks overheated surfaces of machinery or plant, chemical or physical chemical reaction and radiant heat.

(5) Spontaneous ignition

Where materials are likely to induce spontaneous ignition, care shall be taken to avoid formation of air pocket and to ensure adequate ventilation. The material susceptible to spontaneous ignition should be stored in dry condition and should be in heaps of such capacity and separated by such passage which will prevent fire. The materials susceptible to ignition and stored in the open shall be at a distance not less than 10 meters away from process or storage buildings.

(6) Cylinders containing compressed gas

Cylinders containing compressed gas may only be stored in open if they are protected against excessive variation of temperature, direct rays of sun, or continuous dampness. Such cylinders shall never be stored near highly flammable substances ,furnaces or hot process. The room where such cylinders arc stored shall have adequate ventilation.

(7) Storage of flammable liquids

(a) The quantity of flammable liquids in any work room shall be the minimum required for the process or processes carried on in such room. Flammable liquids shall be stored in suitable containers with close fitting covers: Provided that not more than 20liters flammable liquids having a flash point of 21° Corless shall be kept or storedinany work room.

(b) Flammable liquids shall be stored in closed containers and in limited quantities inwellventilatedroomsoffireresistingconstructio nwhichareisolatedfromtheremainder of the building by fire walls and self closing fire doors.

(c) Large quantities of such liquids shall be stored in isolated adequately ventilated building of fire resisting construction or in storage tanks, preferably under ground and at a distance from many building gas required in the Petroleum Rules,1976.

(d) Effective steps shall be taken to prevent leakage of such liquids into basements, sums or drains and to confine any escaping liquid within safe limit.

(8) Accumulation of flammable dust, gas, fumes or vapour in air or flammable material on the floors.

(a) Effective steps shall be taken for removal or prevention of the accumulation in the air of flammable dust, gas, fume or vapour to an extent which is likely to be dangerous.

(b) No waste material of a flammable nature shall be permitted to accumulate on the floors and shall be removed at least one in a day or shift, and more often, when possible. Such materials shall be placed in suitable metal containers with covers wherever possible.

(9) Fire exists

(a) in this sub-paragraph

(i) "Horizontal exit" means an arrangement which allows alternative egress from a floor are a to another floor at or near the same level in anad joining building oranad joining part of the same building with adequate separation; and

(ii) “travel distance" means the distance an occupant has to travel to reach an exit.

(b) An exit may be a doorway, corridor, passageway to an external stairway or to a verandah or to an internal stairway segregated from the rest of building by fire resisting walls which shall provide continuous and protected means of egress to the exterior of a building or to an exterior open space. An exit may also include a horizontal exit leading to an adjoining building at the same level.

(c) Lifts, escalators and revolving doors shall not be considered as exits for the purpose of this sub-paragraph.

(d) In every room of a factory exits sufficient to permit safe escape of the occupants incase of fire or other emergency shall be provided which shall be free of any obstruction.

(e) The exits shall be clearly visible and suitably illuminated with suitable arrangement, whatever artificial lighting is to be adopted for this purpose, to maintain the required illumination in case of dilute of the normal source of electric supply.

(f) The exits shall be marked in a language understood by the majority of the workers.

(g) Iron rung ladders or spiral staircases shall not be used as not be used as exit.

(h) Fire resisting doors or roller shutters shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke, particularly at the entrance of lifts or stairs where funnel or flue effect may be created inducing an upward spread of fire.

(i) All exits shall provide continuous means of egress to the exterior of a building or to an exterior open space leading to a street.

(j) Exits shall be so located that the travel distance to reach at least one of them on the floor shall not exceed 30 meters.

(k) In case of those factories where high hazard materials are stored or used, the travel distance to the exit shall not exceed 22.5 meters and there shall be at least two ways of escape from every room, however small, except toilet rooms, so located that the points of access thereto are out of or suitably

Shielded from areas of high hazard.

(l) Wherever more than one exit is required for any room space or floor, exits

Shall be placed as remote from each other as possible and shall be arranged to provide direct

access in separate directions from any point in the area served

(m) The unit of exit width used to measure capacity of any exit shall be 50 cm. A clear width of 25 cm. shall be counted as an additional half unit Clear width of less than 25cm shall not be counted for exit width.

(n) Occupants per unit width shall be 50 for stairs and 75 for doors.

(o) For determining the exits required, the occupant load shall be reckoned on the basis of actual number of occupants within any floor area or 10 square meter per person, whichever is more.

(p) There shall not be less than two exits serving every floor area above and below the ground floor, and at least one of them shall be an internal enclosed stair way.

(q) For every building or structure used for storage only, and every section thereof considered separately shall have access to at least one exit so arranged and

located as to provide a suitable means of escape for any person employed there in and in any such room where in more than ten persons may be normally present, at least two separate means of exit shall be available, as remote from each other as practicable.

(r) Every storage area shall have access to at least one means of exit which can be readily opened.

(s) Every exit doorway shall open into an enclosed stairway, a horizontal exit on a corridor or passage way providing continuous and protected means of egress.

(t) No exit door way shall be less than100cm in permitted(sic)

(u) Exit doorways shall open outwards, that is, away from the room but shall not obstruct the travel along any exit. No door when opened shall reduce the required width of stairway or landing to less than 90 cm overhead or sliding doors shall not be installed for this purpose.

(v) An exit door shall not open immediately upon a flight of stairs. A landing

at least 1.5 m. x 1.5 m. in size shall be provided in the stairway at each doorway. The level of landing shall be the same as that of the floor which it serves.

(w) The exit doorways shall be open able from the side which they serve without the use of a key.

(x) Exit corridors and passage ways shall be of a width not less than the aggregate required width of exit door ways leading from there in the direction of travel to the exterior.

(y)Where stairways discharge through corridors and passage ways, the height of the corridors and passage ways shall not be less than 2.4meters.

(aa) A staircase shall not be arranged round a lift shaft unless the latter is totally enclosed by a material having a fire resistance rating not lower than that of the type of construction of the farmer.

(bb) Hallow combustible construction shall not be permitted.

(cc) The minimum width of an internal staircase shall be 100 cms

(dd) The minimum width of treads without nosing shall be 25 cm. for an internal staircase. The treads shall be constructed and maintained in a manner to prevent, slipping.

(ee) The maximum height of a risor shall be 19 cm. and the number of risors shall be limited to 12 per flight.

(ff) Hand rails shall be provided with a minimum height of 100 cm and shall be firmly supported.

(gg) The use of spiral staircase shall be limited to low occupant load and to a building of height of 9 meters, unless they are connected to platform such as balconies and terraces to allow escapees to pause. A spiral staircase shall be not less than 300 cm.in diameter and have adequate head room.

(hh) The width of a horizontal exit shall be same as for the exit doorways.

(ii) The horizontal exit shall be equipped with at least one fire door of self closing

type.

(jj) The floor area on the opposite or refuge side of a horizontal exit shall be

sufficient to accommodate occupants of the floor areas served, allowing not less than 0.3 square meter per person. The refuge area shall be provided with exits adequate to meet the requirements of this sub-rule at least one of the exits shall lead directly to the exterior or street.

(kk) Where there is difference in level between connected areas for horizontal exit, rams not more than1 in 8 slope shall be provided. For this purpose steps shall not be used.

(ll) Doors in horizontal exits shall be open able at all times (mm) Ramps with a slope of not more

than 1 in 10 may be substituted for the requirements of staircase. For all slopes exceeding 1 in 10 and wherever the use is such as to involve danger of slipping, the ramp shall be surfaced with non-slipping materials..

(nn) In any building not provided with automatic fire alarm a manual fire alarm system shall be provided if the total capacity of the building is over 500 persons, or if more than 25 persons are employed above or below the ground floor, except that no manual fire alarm shall be required in one-storey buildings where the entire area is undivided and all parts thereof are clearly visible to all occupants.

(10)First-aid fire-fighting arrangements

(a) In every factory there shall be provided and maintained adequate and suitable firefighting equipment for fighting fires in the early stages, those being referred to as first- aid firefighting equipment in thi srule.

(b) The types of first-aid firefighting equipment to be provided shall be determined by considering the different types of fire risks which are classified as follows:

(i) "Class 'A' fire" Fire due to combustible materials such as wood, textiles, paper, rubbish and the like.

(ii) "Class 'B' fire"- Fire involving flammable liquids or liquefiable solids or the like where a blanketing effect is essential

(iii) "Class 'C' fire"- Fire involving flammable gases under pressure including liquefiedgases,whereitisnecessarytoinhibitthebu rninggasatfastratewithaninert gas, powder or vaporizing liquid for extinguishment

(iv) "Class 'D' fire" Fire involving combustible metals, such as magnesium, aluminium, zinc, sodium, potassium, etc., when the burning metal are reactive to water and water containingagents

and incertain cases carbon dioxide,

halogenated hydrocarbons and ordinary dry powders. This type of fire requires special media and techniques to extinguish

(c) The number and types of first aid firefighting equipment to be provided shall be as per Bureau of Indian Standards recommendations for installation of fire

extinguishers given in Annexure B of IS 2190:1992. The types are detailed in Schedule-I.]

(d) The first-aid firefighting equipment shall conform to the relevant Indian Standards.

(e) As far as possible the first-aid firefighting equipment shall all be similar in shape and appearance and shall have the same method operation.

(f) All first aid fire fighting equipment shall be placed in a conspicuous position and shall be readily and easily accessible for immediate use. Generally, these equipment shall be placed as near as possible to the exits or stair landing or normal routes of escape.

(g) All water buckets and bucket pump type extinguishers shall be filled with clean water. All sand buckets shall be filled with clean, dry and fines and.

(h) All other extinguishers shall be charged appropriately in accordance with the instructions of the manufacturer.

(i) Each first-aid fire-fighting equipment shall be allotted to a serial number by which it shall be referred to in the records. The following details shall be

Painted with white paint on the body of each equipment:

(1) Serial number:

(2) Date of last refilling; and

(3) Date of last inspection.

(j) First-aid firefighting equipment shall be placed on plat-forms or in cabinets in suchawaythattheirbottomis750trim, above the floor level. Fire buckets shall be placed on hooks attached to a suitable stand or valve in such away

that their bottom is 720 mm. above the floor level. Such equipment if placed outside the building, shall be under sheds

(k) All extinguishers shall be thoroughly cleaned and re-charged immediately after discharge. Sufficient refill material shall be kept readily available for this purpose at all times.

(l) All first-aid fire-fighting equipment shall be subjected to routine maintenance, inspection and testing to be carried out by properly trained persons. Periodicity of the routine maintenance, inspection and test shall conform to the relevant Indian Standards.

(11)Other fire-fighting arrangements

(a) In every factory, adequate provision of water supply for firefighting shall be made and where the amount of water required in liters per minute, as calculated from the formula A plus B plus C Plus D divided by 20 in 550 or more power driven trailer pumps of adequate capacity to meet the requirement of water as calculated above shall be provided and maintained.

CHAPTER IV
PROBLEM IDENTIFICATION

Fire hazard

Fire is one of the common hazards in the manufacturing industry. It can lead to a major disaster for the industry. By doing fire safety audit we can identify the risks and control it by taking proper actions. A fire safety audit is an examination of the buildings / structures and relevant documents to ascertain how the buildings are being managed regarding fire safety. Depending on the requirements of the occupancy, the audit can focus attention on various aspects of fire safety system such as fire and explosion prevention, protection and emergency management

Fire hazard include all type of live flames causes of sparks, hot object, and chemicals that are potential for ignition, or aggravate a fire to become large and uncontrolled. Fire hazard includes all type of potential threats to fire prevention practices, firefighting, built in fire safety system and situation that restrict the escape of people from an affected building or area in the event of fire.

The Major Fire hazards in the industries are

- LPG yard
- Gas storage area
- Petrol yard
- Diesel yard
- Paint Booth

CHAPTER V
METHODOLOGY

Estimation of combustible material of a building can be determined by three methods.

- direct measurement of mass, with conversion based on the net heat of combustion
- direct measurement of volume (with conversion based on a combination of density and net heat of combustion)
- energy release measurement by calorimetry of an item sufficiently

Fire load density is defined as the amount of heat liberated from a combustible material per square meter in floor area. Fire load is to determine the severity and building up of fire. Fire load is a useful in determining the growth and severity of fires. The mass of the material is calculated in kg. The calculated mass is multiplied by its calorific value in MJ/kg to get fire load. The calculated valve is then divided by area of the floor to give fire load density.

Formula

Where,

$$q_c = \frac{\sum m_v H_v}{A_f}$$

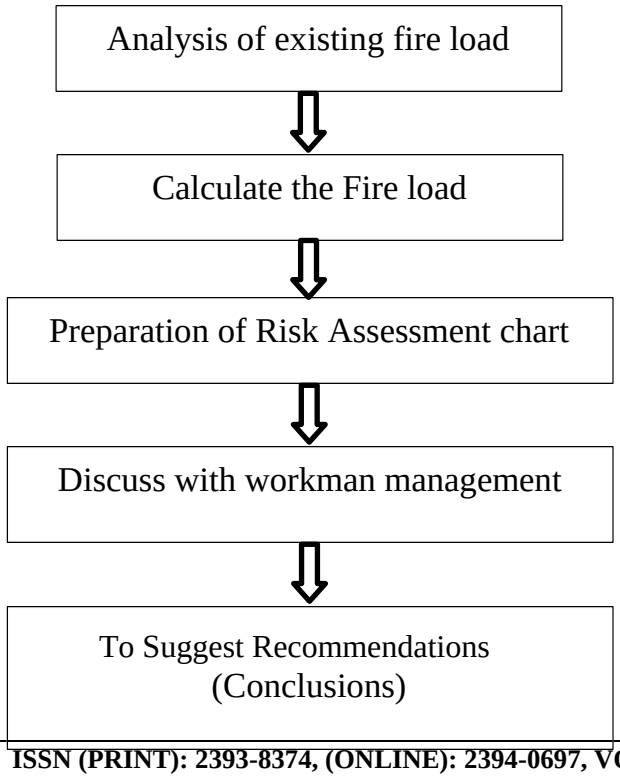
Qc= Fire Load density inMJ/m2

mv = Total mass of vth combustible material in kg

Hv= Calorific value of vth combustible material in M

Af= Area of floor in m*2

Methodology of the project



Methodology

Calorific values

Table Calorific valves

Materials	**Calorific value in MJ/kg**
Polythene cover	17.5
Wood	18.6
Carton box	16.9
Paper	16.3
Clothes	23
LPG	46.1
Paint & Varnishes	>2000KJ/Kg

•

The mass of combustible products is calculated by digital weight meter. If the mass is unknown, volume of the material is calculated in m3and the calculated volume is multiplied by density of the material in kg/m3. So the formula for calculating mass is given as,

Mass = Volume * Density

Need for safety assessment

Now-a-days safety is the challenging tasks in order to assessing the system prevent the employees from the machine. In other words, the challenge is to develop ways to better grasp in foresight what is being interpreted in hindsight or to move from a study of past failures to an anticipation of future one.

As a safety professional our main aim is to reduce the accidents in the work place. For this we have to assess safety and reduce the risk to tolerable level. That below represents the accident investigation we need to analysis the past accident/incidents

Figure Need for Safety assessment

Safety assessment needs to consider future problems. To tackle this we have the risk analysis tools that include HIRA, HAZOP, FMEA, FTA, ETA, etc.

Hazard Identification and Risk Assessment (HIRA)

HIRA means Hazard identification and Risk Assessment. Hazard as relates to

„Accident" is defined as the potential for causing harm to persons, damage to property or environmental degradation. It will particularly cause unwanted transfer of energy and can occur in random variations of normal operations or from changes in physical or human factors. An HIRA is a systematic way to identify and analyses hazard to determine their scope, impact and the vulnerability of the built environment to

such hazards and its purpose is to ensure that, there is a formal process for hazard identification, risk assessment and control to effectively manage hazards that may occur within the workplaces. The challenge is to be faced by emergency planners is how to prevent, prepare, mitigate, respond and recover from a myriad of hazards. The frequent questions come from their facing this situation is:

- What are all the hazards present in my area?
- How frequently do they occur?
- How severe can their impact be on the community, infrastructure, property, and the environment? Which hazards pose the greatest threat to the community?

A Hazard Identification and Risk Assessment (HIRA) give a solution for emergency planners in an swering these questions. It is a systematic risk assessment tool that can be used to identify the hazard and assess the risks. The reason for a HIRA is useful to the emergency planning:

- Prepare for the worst risks.
- Prepare for Training programs.
- Allow for the creation of exercises

CHAPTER VI RESULT

Fire Load calculation in Admin Building

Table Fire load calculation in admin building

S.No	Name	Item	Weight in Kg	Calorific Value in MJ/Kg	Area in m^2	Fire load
1	Ground Floor	Paper	800	15.4	2304	5.35
		Wood	750	17.6	2304	5.73
		Plastic	25	18.6	2304	0.2
		Cloth	40	35	2304	0.61
2	First Floor	Paper	4000	15.4	2304	26.74
		Wood	2750	17.6	2304	21
		Plastic	60	18.6	2304	0.5
		Cloth	50	35	2304	0.76
3	Second Floor	Paper	2000	15.4	2304	13.37
		Wood	1350	17.6	2304	10.31
		Plastic	40	18.6	2304	0.32
		Cloth	35	35	2304	0.53
4	Total					85.42

The above table represents the fire load calculation in admin building for various sources of fire

- Fire Possibilities in Admin floor area is solid fire and electrical fire.
- As per Indian standards IS 2189:2008 – Selection, Installation and maintenance of automatic fire detectors and alarm system – code of practice the fire fighting equipments such as Fire extinguisher and type of detectors based on the risk, sprinkler system are to be installed where large quantities of combustible material and it should be interlinked with manual call point and Fire alarm panel
- The Carbon- dioxide extinguisher and DCP Fire extinguisher are to be installed as per Indian standards
- MM Forgings kept suitable fire extinguisher as CO2 fire extinguisher for not less than 15m distance for each other and it is portable to use and maintenance are done as per Indian Standards IS 2190:1992 – Code of practice for Selection, Installation and Maintenance of Portable fire extinguishers
- MM forgings also provides the fire detection system as fire sprinkler and smoke detector which are connected to fire alarm panel

Fire Load calculation in LPG Yard

Table Fire load calculation in LPG yard

S.No	Name	Item	Weight in Kg	Calorific Value in MJ/Kg	Area in m^2	Fire load
1	LPG Yard	LPG Bullets -2	15000	46.1	1521	454.7

The above table represents the fire load calculation in lpg yard

Fire Possibilities in LPG Yard is due to leakage of LPG gas in the yard As per Indian standards IS 60441-1:2000 - Code of practice for liquefied petroleum gas cylinders installed outdoors on ground level only and maintain minimum distance of 3m between an installation & building

- The firefighting equipment's are to be provide such as 5 extinguishers (DCP & ABC), and single outlet type fire hydrant, leak detector and sprinkler system are provided
- The Firefighting equipments are maintained periodically by the interested parties
- But the LPG bullets are in underground of the factory which may leads to Corrode the bulletin tank and results into explosion. so the LPG tanks are to be lifted above the ground and the bullet tanks conditions are to be examined periodically

Fire Load calculation in Gas Cylinder Storage area

Table Fire load calculation in gas cylinder storage areas

S.No	Name	Weight in Kg	Calorific Value in MJ/Kg	Area in m^2	Fire load
1	Hydrogen	1500	140	361	581.7
2	Nitrogen	1000	52.2	295.84	176.5

The table represents the fire load calculation for various types of gas cylinders in gas cylinder storage areas

☐ The gas cylinder consists of Hydrogen gas Nitrogen gas Oxygen gas

Carbon – dioxide gas Acetylene

☐ Hydrogen gas is highly flammable and it has the highest calorific value is 140MJ/ Kg and it can burn in air.

☐ Carbon – dioxide gas cylinders are stored near the hydrogen gas cylinders with3m high thick wall

☐

CO2canbeusedasafireextinguishingagentbutit shouldnotattainatemperature of 125˚F (52 ˚C) because cylinder can rupture above the temperature

☐ Ammonia is a non flammable gas but it can react with other gases and may ignite

☐ Acetylene gas is also a flammable one and its calorific value is 49.9 MJ/Kg

☐ As per Gas cylinder storage rules the Cylinders should stored in Minimum 25% Perimeter of Open Space Stored in Upright position

Kept clear of dry vegetation

☐ At least 20feet far away from combustible materials

☐ Should not store on ground or on surface where water can accumulate

☐ Covered with canopies of non combustible construction

☐ Store the empty cylinders and full load cylinders in a separate area

☐ Color code for identification of gas cylinders should be followed as per Indian standards IS 3933:1966 – Color Identification of gas cylinders

☐ The Identification tag should be in the cylinders which include Name of the cylinder, Identification color and weight of the cylinder etc.

☐ The review was done in the area and the storage method was properly followed as per gas cylinder rules

CONCLUSION

Though fire accidents are likely to occur in combustible atmosphere. Early control if fire at initial stage helps to prevent explosion and property damage. Therefore, to detect fire and alert ERT team when they are involved in work at different areas. The Fire safety audit and risk assessment method helps to preserve human life and property from fire through speedy communication. Fire load density calculation in the whole industry is done and the study gives following conclusion. Therefore, I am going to proceed with my project in Royal Enfield plant for my phase II project.

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