

Fire Safety Management Design Practices, Hazard Study & its Prevention for Hazchem Warehouse Facilities

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Abstract

Fires in CCWH Warehouses account for a great percentage of total number of out- breaks in industrial occupancies and almost invariably assume serious proportions. If fire starts when the warehouse is closed, it often remains undetected for some time and by then, it assumes serious proportions. The principal causes of outbreak of fire in a CCWH are careless smoking, electrical sources, and spontaneous ignition. falling of sparks/embers from external source, carrying out of dangerous operations, like welding, cutting, spray painting, etc, either in the warehouse building or in buildings communicating with the warehouse, use of naked lights, faulty electrical installations, storage of different goods which would be hazardous in combination.

The three primary considerations, in providing adequate and reasonable fire protection and safe- guards for storage occupancies are, the fire behaviour of stored materials, their storage arrangement, and the type of warehouse building itself. Once a fire occurs in a hazardous material storage warehouse i.e. CCWH the fire propagation and duration depend primarily on these factors. The earlier a fire is detected, controlled and extinguished, the lesser the damage will result.

Frequency of fire outbreaks and losses suffered as a result, may be considerably reduced if proper attention is paid to various aspects affecting fire safety, such as fire resistive construction, compartmentation, proper layout, size and height of the warehouse building, provision of smoke and heat ventilation, drainage arrangements, regulating the quantity and type of stocks in any particular godown, segregation of stocks having a varying fire risk, size and height of piles, provision of adequate aisles, separation of storage and process activities, minimising exposure hazards by proper layout of the CCWH building, etc. Automatic fire detection, alarm and protection arrangements are of utmost importance because warehouses are normally occupied only by comparatively less number of people during working hours and hardly any or at all during non- working hours. When the value in a fire area is extremely high, it will be desirable to sub-divide it by one or more structurally independent fire walls.

Keywords: Good Engineering practices, Fire, and Explosion, Safety Management Program, catalyst chemical warehouse.

1. Introduction

Warehouse includes any building or part of a building which refers to the activities involving Storage of goods on a large scale in a systematic and orderly manner and making them available conveniently when needed. Means holding or preserving goods in huge quantities from the time of their purchase or production till their actual use or sale. Creates time utility by bridging the time gap between production and consumption of goods.

2. Need and Importance:

1. Regular supply
2. Quality
3. Stock of trade
4. Price stabilisation
5. Seasonal products
6. Perishable goods
7. Continuous production
8. Seasonal demand
9. Large - scale production
10. Quick supply
11. Protection and Preservation of goods
12. Easy handling
13. Useful for small business
14. Creation of employment
15. Facilitates sale of goods
16. Available of finance Fixed roof tanks

2.1 Basic reasons for need of Warehouse

- i) Raw materials
- ii) Work in progress
- iii) consumable stores & spares
- iv) Ready made components
- v) Finished goods

2.2 Characteristics of Ideal Warehouses

1. Convenient location
2. Adequate spaces
3. Cold storage facilities
4. Sufficient parking spaces
5. Latest Fire fighting equipments
6. Proper arrangement for protection
7. Round the clock security arrangements
8. Availability of mechanical appliances to load & unload goods

2.3 Functions of Warehouse

1. Storage of Goods
2. Protection of Goods
3. Risk Bearing
4. Identification of Goods
5. Financing Processing

2.4 Catalyst Chemical Warehouse (CCWH)

CCWH Warehouse constitutes a quite different kind of storage facilities. A wide variety of catalyst chemicals are stored in warehouse in many forms. Materials may be simply stored in a stockpile on the warehouse floor , but more often there are bays which hold discrete items such as drums , ISO tank , tote tank , pail , carboy and ms tank . Chemicals in packages & drums are also stored in warehouse.

2.4.1 CCWH Warehouse siting & layout

The siting of CCWH warehouses is often far from ideal . Many existing warehouses are located in a build - up area and close to housing. Siting of new warehouse should be such as to minimize the risks to the surrounding area . Likewise, there risks should be taken into account when considering an extension to an existing warehouse . Fire and explosion are the events which are most likely to present a threat to the surrounding population.

The layout of the CCWH warehouse site should be such as the facilitate the movement of vehicles that are unloading or loading , with adequate access and parking . The layout should aim to minimize collisions and to allow incidents such as spillage or small fires to be readily dealt with . It's layout should also assist security . Access should be gained only through access gates . Each separate warehouse building should be capable of being securely locked.

2.4.2 CCWH Warehouse buildings

The construction of a CCWH Warehouse building is subject to the Building Regulations. For Industrial storage buildings , there is an approved document which sets out standards for compartment size and fire resistance . Some high hazard substances require separation distances between the buildings and the boundaries in excess of those specified in the Building Regulations . These include flammable liquids, oxidizing & corrosive substances and organic peroxides.

2.4.3 Material Identification

There should be a formal system for identification and tracking of the dangerous substances handled. The system should be based on the classification system for dangerous substances. Most such substances arriving on site will be marked with the conveyance labels specified in the Chemical Hazard (Information & Packaging) Regulations (CHIP) and goods in international transit should be labeled with the United Nations labels . The supplier should normally provide in addition the information required under the CHIP supply labelling system.

2.4.4 Material Segregation

The most serious incident occurs when a small event escalates and involved large quantities of materials. The main cause of this is Fire. An effective means of preventing such escalation is the segregation of materials.

One purpose of segregation is to separate dangerous substances from materials which may ignite or burn readily in the early stages of a Fire. Another is to keep dangerous substances out of general storage where their presence is liable to aggravate the difficulties of firefighters.

Methodology Used:

3. Associated Hazard In CCWH

3.1 Hazard : Substances stored in the CCWH Warehouse may be hazardous by virtue of their being combustible , flammable , explosive , toxic, unstable , reactive with air and / or water , pyrophoric or liable to spontaneous combustion or oxidising which poses a level of threat to life , health , property or environment .

3.2 Types of Hazard

1. Physical hazards
2. Chemical hazards
3. Biological hazards
4. Psychological hazards
5. Ergonomic Hazard

3.3 Top 10 Warehouse Safety Hazards and How to Avoid Them

1. Heavy Equipment Accidents
2. Slips and Trips
3. Falls
4. Fires
5. Crushed
6. Exposure to Harmful Substances
7. Ergonomics
8. Moving Parts
9. Falling Objects

3.4 HAZCHEM Code

Hazchem is a warning plate system used in many countries like Australia, India, Malaysia, New Zealand and the United Kingdom for vehicles transporting hazardous substances, as well as on storage facilities. The top-left section of the plate gives the Emergency Action Code (EAC) telling the fire brigade what actions to take if there's an accident. The middle-left section gives the UN Substance Identification Number describing the chemical. The lower-left section gives the telephone number that should be called if special advice is needed. The warning symbol at top-right indicates what danger the chemical presents. The bottom-right of the plate carries a company logo (the flower is a sample logo).

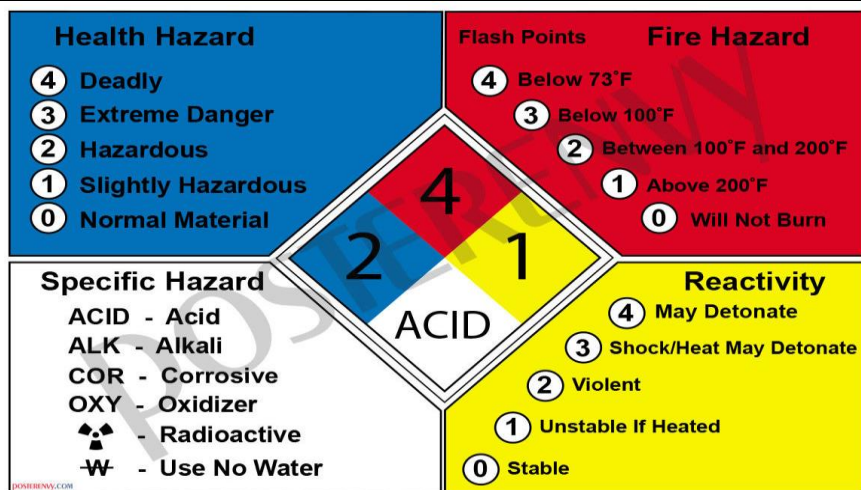


Emergency Action Code

The Emergency Action Code (EAC) is a three character code displayed on all dangerous goods classed carriers, and provides a quick assessment to first responders and emergency responders (i.e. fire fighters and police) of what actions to take should the carrier carrying such goods become involved in an incident (traffic collision, for example). EAC's are characterised by a single number (1 to 4) and either one or two letters (depending on the hazard).

3.5 NFPA (704M) Pictorial representation of hazard

NFPA pictorial representations consist of a diamond as shown in the figure below, divided into 4 parts. These parts, starting from left block (in clockwise direction), represent Health Hazard, Flammability Hazard, Reactivity Hazard and Space for additional information such as water reactivity, oxidant and radiation hazard. The colour codes for these hazards are : blue for health, red for flammability, yellow for reactivity and colourless for additional information. These are rated on a scale of 0 (no hazard) to 4 (extreme hazard). The ratings for individual substances can be found in the NFPA Fire Protection Guide to Hazardous Materials



4. Handling Of Hazardous Chemicals

Safety at storage and handling of hazardous chemicals depends on a considerable extent on effective safety education / training following safety procedures and efficient supervision. The operating staff must be aware of the hazards involved, the location and operation of safety equipment installed in the CCWH premises .

Carrying and use of ordinary mobile phone in storage, operation and handling area shall be prohibited. Only intrinsically safe communication equipment shall be allowed.

4.1 Storage of Hazardous chemicals

1. Storage in bulk
2. Storage Of Chemicals In Drums / Other Container (Tote tank , MS tank , Carbouy)

4.2 Handling of hazardous chemicals

1. Unloading Of Tank Trucks / Tank Wagons
2. Unloading Of Drums / Containers (Tote tank , MS tank , Carbouy)

4.3 Safe disposal of empty containers of hazardous chemicals

4.4 Safe disposal of stock of expired hazardous chemicals

4.5 Spillage & leakage management of catalyst chemicals in CCWH

5. Fire prevention & protection measures at CCWH

CCWH Warehouses represents a unique fire challenges to both Fire suppression system and manual fire-fighting forces called upon to deal with a Fire. Modern warehouses and storage occupancies are especially subjected to rapidly developing fires of great intensity because complex configuration of storage are conducive to rapid fire spread , presenting numerous obstacles to manual fire suppression efforts . The only proven method of controlling a warehouse fire is with properly designed and maintained efficient systems. Due to the nature , quantity and arrangement of inventory commodities in these occupancies , fire can develop quite rapidly into an uncontrollable state . Developing and implementing a comprehensive fire prevention & protection plan are essential.

5.1 Fire prevention

Fire Prevention and control shall apply to the commonly recognised management techniques and fire control methods used to prevent or minimize the property loss from Fire or explosion in CCWH storage facilities. The wide range in size , design and location of storage facilities shall preclude the inclusion of detailed fire prevention and control methods applicable to all such facilities.

5.1.1 Control of Ignition Sources

Precautions shall be taken to prevent the ignition of Hazardous materials in CCWH warehouses such as the following:

- Open flames
- Lightning
- Cutting and Welding
- Static Electricity
- Electrical sparks

5.1.2 Management of Fire Hazard

The extent of fire prevention and control provided for CCWH Warehouse shall be determined by an engineering evaluation of the installation and operation, followed by the application of sound fire protection and process engineering principles. The evaluation include, but not be limited to the following:

- (i) Analysis of Fire and explosion hazards of the facility.
- (ii) Analysis of local conditions, such as exposure to and from adjacent properties, flood potential or earthquake potential.
- (iii) Fire department or mutual aid response.

5.1.3 Emergency Planning & Training

5.1.4 Inspection and Maintenance

5.2 Fire Protection

When designing the fire protection system(s) for warehouse-type occupancy, in addition to commodity classification and storage configuration, there are many other variables to consider, such as storage height versus building height, aisle width, and specific design features of Protection systems. Fire protection facilities at CCWH has been provided with adequate Passive and Active Fire Protection System to ensure the business risk and adequately protected and to minimize the consequences. All Fire Protection systems are designed and installed meeting with relevant NFPA, API, OISD and TAC norms / codes & standards whichever is more stringent.

The principle objectives of providing the Active & Passive Fire Protection systems at CCWH are :-

- Minimise the consequences of the fire.
- Ensure adequate means of escape are provided.
- Minimise escalation and fire spreading into neighbouring units.
- Minimise the potential for pollution of the environment from fire water run-off.
- Ensure safe havens are provided for personnel who work in process areas where there is a risk of Fire.
- Rapidly bring under control and extinguish any reasonably foreseeable Fire which could develop during normal operations.

5.2.1 Active Fire Protection Systems

Active Fire Protection (AFP) is a group of systems that require some amount of action or motion in order to work efficiently in the event of a fire. Actions may be manually operated, like a fire extinguisher or automatic, like a sprinkler, but either way they require some amount of action. AFP includes fire/smoke alarm systems, sprinkler systems, and fire extinguishers as well as firefighters. Fire/smoke alarm systems are used to detect whether there is fire and/or smoke in a warehouse building. Sprinkler systems are used to help slow the growth of the fire. Fire extinguishers and firefighters are used to help put out the fire altogether.

1. Fixed fire protection systems
2. Portable Fire protection systems
3. Mobile Fire protection systems

5.2.2 Passive Fire Protection Systems

Passive Fire Protection (PFP) is a group of systems that compartmentalize a building through the use of fire-resistance rated walls/floors. Compartmentalizing warehouse building into smaller sections helps to slow or prevent the spread of fire/smoke from one part to the next. PFP helps to limit the amount of damage done to a warehouse building and provides its occupants more time for evacuation. PFP includes fire/smoke dampers, fire doors, and fire walls/floors. Dampers are used to prevent the spread of fire/smoke throughout the warehouse building through its ductwork. Fire doors help to compartmentalize a warehouse building. Fire stopping helps to separate the building into compartments.

1. Fire Door
2. Fire Wall
3. Fire Proofing
4. Fire Separation
5. Emergency Evacuation
6. Drainage System

5.3 Fire detection in warehouse facilities

The application of fire detection devices used to provide early warning and notification of incipient warehouse fire events is being considered as a component of modern warehouse fire protection.

In general, a fire can be detected by the presence of smoke, heat, or flames. Sprinkler actuation currently serves as a form of heat detection, as the sprinkler is activated by excessive heat and the sudden flow of water can be monitored and used to provide notification of a fire event to occupants and/or fire departments. In the absence of sprinklers, fires are often detected by the visible presence of smoke or flames to occupants or a passerby. Due to the high potential for rapid fire growth, these methods often are not capable of detecting fires early enough to provide a fire department adequate response time to prevent large fire loss events. Other available technologies may be capable of faster detection times and may reduce the overall fire fighter response times. The suitability of certain types of detection will depend upon the size of fires they are intended to detect, the duration of the incipient period of the fires, the fire growth rate after incipient development, and the size and configuration of the space they are designed to protect.

Conclusion

The hazards and accidents that had been occurring in warehouses have been reviewed in this paperwork. The data are collected from various published reports. It has been found the major accidents have taken place in Oil & Gas sector as compared to a petrochemical plant, storage terminals and other facilities like gas plants, power plants, and fertilizer industry. This work explains the different causes of events that is explained above which was responsible for incidents happened that lead to the different fire scenarios as worse case which can be prevented if proper mitigation measures have been taken into account or proper SOPs and SMPs is followed.

Various Preventive barriers have been taken into account with different threats and proactive/recovery barriers or mitigation measures with consequences with escalation factors for both threats and consequences.

Refinery or any chemical plant needs many different chemicals to run uninterruptedly round the clock. These chemicals can be the raw material or a supportive agent to reactions or may be the part of maintenance work. All those chemicals then identified and their storage locations are categorised. Most of the Industries store the chemicals in warehouse depending on their environmental stability and sensitivity. This paper work gives the detail on the study of Fire Safety Management plan , Design , Hazard and Safe Practices of such type of warehouse also known as CCWH (Catalyst Chemical Warehouse). This also illustrates the Fire Safety Management requirement of any ideal CCWH right from its hazardous inventory to the Fire Prevention and Protection facilities. All the requirements to be taken from the recognised and well known standards including some legal standards as well.

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