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Fire Protection System Effectiveness with NFPA Standard in Car Manufacturing Plant

M.Syed Abuthahir[1], Dr.M.Murugan M.E, Ph.D, F.I,E [2], S.P.Venkatesan M.E[3]
ME Student(Industrial Safety Engineering)[1], Professor, HOD[2], Associate professor [3]
Department of Mechanical Engineering
Excel College of Engineering and Technology. Namakkal, Tamilnadu, India

Abstract:
Fire safety refers to precautions that are taken to prevent or reduce the likelihood of a fire that may result in death, injury, or property damage, alert those in a structure to the presence of an uncontrolled fire in the event one occurs, better enable those threatened by fire to survive in and evacuate from affected areas, or to reduce the damage caused by a fire. Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing, and those that are taught to occupants of the building. Threats to fire safety are referred to as fire hazards. A fire hazard may include a situation that increases the likelihood a fire may start or may impede escape in the event a fire occurs. **Fire Safety Adequacy is to** ensure that a fire release anywhere in the plant can be adequately dealt with to prevent escalation of the emergency (fires or explosion).This enables assessment of the adequacy of the fire prevention, fire protection and firefighting measures.

- Assess the firefighting equipment with relevant standards
- Assessment of mitigation factors
- Suitability of fire extinguishers versus fire hazards of the occupancy

This report presents a review of fire protection system operating experience, safety relevant operating experiences and NFPA standards are discussed in a car manufacturing plant. Safety concerns with their systems are discussed. This information should be useful to safety standards following; effectiveness of fire protection system analyzed and gap analysis to be addressed.

I. INTRODUCTION

COMPANY OVERVIEW

Ford manufactures and exports vehicles and engines made at its integrated manufacturing facilities in Chennai, Tamil Nadu and Sanand, Gujarat. Since its entry in India in 1995, Ford has invested more than US$ 2 billion to expand its manufacturing facilities and sales & service footprint to meet the demand in one of the world's fastest-growing auto markets. Ford India's integrated manufacturing facility at Maraimalai Nagar, near Chennai, produces its award-winning range of products including the Ford Eco Sport and all-new Ford Endeavour. As part of its overall commitment, Ford inaugurated its US$ 1 billion state-of-the-art integrated manufacturing facility in Sanand, Gujarat in March 2015. With Sanand being operational, Ford India has doubled its annual installed manufacturing capacity to 610,000 engines and 440,000 vehicles. The sub-four-meter compact sedan, Ford Aspire, became the first car to roll out from the new Ford San and plant. The plant also manufactures Next-Gen Fig hatchback. Ford's biggest-ever product line-up in India today offers a vehicle to suit the needs of nearly every consumer. In 2016, Ford has also given Indian consumers their first opportunity to own the iconic Ford Mustang. Debuting ahead of the Delhi Auto Expo 2016 and set to hit Indian showrooms later this year, the new Mustang is all set to bring the world-class performance and refinement of Ford's iconic pony car to India's roads. As part of its strategy to Make in India for India and the World, Ford continues to strengthen India as a center of excellence for small cars and low displacement engines. The company has embarked on an accelerated export strategy and presently, exports Next-Gen Figo, Aspire, and EcoSport to over 40 markets around the world. Along with introducing new products, Ford continues to grow closer to customers with the continued expansion of its nationwide dealership network as well as world-class after-sales offerings. Presently, Ford has more than 376 sales and service outlets in 209 cities across India. To enhance affordability and accessibility, Ford has introduced many pioneering initiatives that reduce the cost of ownership including the Sub-assembly of parts, Pan-India Roadside Assistance, and Mobile Service Support. To ensure total transparency in service costs, Ford also introduced a unique Service Price Promise, which allows customers to calculate the vehicles' periodic maintenance costs even before booking the service at the dealership. Ensuring customer convenience, Ford has expanded the availability of Ford Genuine Parts with the appointment of distributors in Maharashtra, Goa, Karnataka, Kerala, Delhi, Tamil Nadu, AP, and Telangana. Ford's presence in India includes Ford Credit India, which started dealer wholesale inventory and retail financing in 2015 as a non-banking financial company. With five decades of global experience, Ford Credit's operations span in as many as 100 countries where it has emerged as a preferred automotive financier for both Ford customers as well as dealers. Ford Credit is known for its reliable and transparent loan products at competitive rates, flexible terms, and outstanding customer service. Continuing to generate employment and help the economy, Ford's operations currently employ more than 14,000 hard-working, dedicated men and women across its operations in India which also include Global Business Services, with offices in Chennai, New Delhi, and Coimbatore. Registered as Ford Motor Pvt Ltd. (FMPL) as a legal entity, Global Business Services provide innovative solutions to nearly every Ford locations around the world in areas of Information Technology, Product Engineering, Finance and Accounting, Automotive Financing, Material, Planning & Logistics, Marketing Sales and Service, Analytics, and Purchasing. Driving innovation from India,

Ford recently announced plans to build a new global engineering and technology center in Chennai. Besides the establishment of a global engineering and technology center, the new Ford campus spread across 28 acres will host operations of Ford Global Business Services in areas of IT, Product Engineering, Finance and Accounting, Data Analytics, Manufacturing among others.

Mission and Vision
Ford's mission statement (One Ford) has three sections: One team, one plan, and one goal. The purpose is to help the organization define success. It serves as guidepost for the company's leadership team and its shareholders.

One Team
The One Team portion of the statement reads: People working together as a lean, global enterprise for automotive leadership as measured by: customer, employee, dealer, investor, supplier, union/council and community satisfaction. The purpose of this section is to foster teamwork among the key players in the creation of Ford's products.

One Plan
In the One Plan section, Ford seeks to "aggressively restructure to operate profitably at the current demand and changing model mix, accelerate development of new products ford customers want and value, finance the plan and improve balance sheet and work together effectively as one team." In this area, Ford wants to remain innovative and profitable.

One Goal
The One Goal section: "An exciting viable Ford delivering profitable growth for all."The goal is to deliver profits not only for the employees but shareholders and others in the Ford supply chain.

Current Models
- Ford Endeavor (launched 2003)
- Ford Classic (launched 2005)
- Ford Figo (launched 2010)
- All New Ford Fiesta (launched 2012)
- Ford Eco Sport (launched March 2013)

Dis continued models
- Ford Ikon (1999–2010)
- Ford Escort (1996–2001)
- Ford Mondeo (2001–2006)

Ford Fusion (2004–2010)

Exports
Ford India currently exports 40 percent of its engine production and 25 percent ofits car production to 35 countries, some of them are, South Africa, Nepal, Mexico, Kenya, Bahrain, Angola, Bermuda, Ghana, Iraq, Liberia, Lebanon, Malawi, Madagascar, Mauritius, Nigeria, Senegal, Tanzania, UAE, Zambia and Zimbabwe.

Corporate Social Responsibility
Ford India's CSR activities are focused primarily in four key areas: road safety, education, healthcare, and environment.

Driving Skills for Life (DSFL)
A regional initiative to raise awareness about safe, economic and eco-friendly driving through a free-training program that mixes classroom learning with practical hands-on sessions. DSFL program was launched in India in August 2009. In partnership with its dealers, Ford India has also trained 4500 drivers since launch of Ford Motor Company's successful Driving Skills for Life (DSFL) trainingprogramme that educates new and older licensed drivers of all ages on safer, economical and eco-friendly driving practices.

Global week of Caring (GWC)
The Global Week of Caring is celebrated during the month of September across Ford Motor Company markets globally in the spirit of responsible corporate citizenship and to give back to the society. Ford has also been named as the largest Voluntary Blood Donor in the Industrial Category in Tamil Nadu for 10 consecutive years (from 2000-2010) and has been the recipient of the Red Cross trophy.

II. COMPANY PROCESS

Ford India Pvt. Ltd. is a leading car manufacturing unit in Tamilnadu. Its following processes.

- **Blanking**
- **Stamping**
- **Body Shop**
- **Paint Shop**
- **Engine Assembly Plant (PTO)**
- **Trim, Chassis & Final Assembly**
- **Testing**

BLANKING & STAMPING

• **Fully automatic press line** featuring cross bar technology with twin pad N.C. cushion system.
• Fully enclosed line for noise reduction and dirt protection. Blanking as shown in Fig

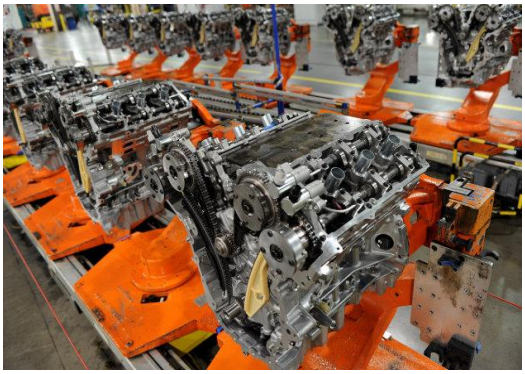
Four die stacking with die grabber attachment, 2000 Ton Hydraulic **dietryout press** for die trials
• Thorough checks for perfection in dimensions and surface quality.

BODY SHOP
• **Single line flow** from underbody to BIW line
• U/Body is Flexible, Framing / Re-spot lines are with 95% automation
• **Servo drive Robot guns** for the highest quality welds
• B, C & CD Car in same line
• Doors - **Robots roller hemming**
• **Automated sealing application** for closure line for best fill rate
• **Automated Hydraulic clinching** for highest quality wheel arch clinching

• **Automated transfer** of heavy and skin parts for better surface quality
• Overall automation in Body Shop is 30%
• Entire shell checked with military precision for dimensions. Body shop as shown in Fig

PAINT SHOP
• **Latest generation of Electro coat** product that provides High edge corrosion protection and much better surface smoothness (Ra) – from 0.46to 0.21.
• Effective underbody protection by **PVC sprays using Robotic application.**
• Exterior surface painting is fully automated using Robots.
• Energy efficient Ovens and Equipments.
• Global standard Spray booth facility.
• Ford's **first plant** to launch **3-Wet High Solid technology** on Passenger cars with flexibility of 11 colors.
• Ford's Global suppliers BASF, PPG and DURR
• Painting so complete that even underside gets full PVC coating for corrosion protection.
• Baking done to Ford's global paint specifications. Paint shop as shown in Fig

POWER TRAIN OFFICE
• Consists of Engine Shop and Assembly shop, where the Engine parts are sent through various machining processes and then sent in assembly.
• Assembly shops with various zones assemble the entire engine from whereat moves to TCF for final assembly of the vehicle. Engine assembly plant as shown in Fig



TRIM, CHASSIS &FINAL ASSEMBLY (TCF)

• Interiors taken care of, before doors and seats come on in Trim zone.
• In Chassis area, professionals use high power tools to fit in engine, front suspension, bumpers etc.
• Once nuts and bolts are tightened to perfection, the car gets its wheels.
• Rolls into final line for remaining parts and filling of fluids.
•**Automatic torque control** & recording system, **Automated glass glazing** system, **Automated ski removal** system
• **Part feeding conveyors** to clear line side space and save operator time
• **Automated guided vehicle** for combined engine and rear axle decking
• Centrally controlled vehicle configuration and electrical check out system
• Non-contact wheel base and wheel size adjustable **LAZER wheel alignment** machine

TESTING

• Stringent testing ensures every car is at its best, even in trying conditions.

• All Ford cars compile with Bharat III emission standards, notified by the Government of India.

• A global standard **Squeak & Rattle track -** to check Clear vision test, Reverse gear and Lock to Lock test, Steering input **Underbody check** in hot condition after Squeak & Rattle

• **Hydro pulsar (4 Post facility)**to simulate drive in static conditions to identify Squeak and Rattle concerns.

• **25 mile Dynamic drive validation track** to test vehicles

- Road surfaces simulating Indian road conditions
- Straight stretch to test Clear Vision, Vehicle pull, Wind noise and Brakes
- Parking brake check and simulating hill drive
- Enhanced dynamic **water wading test**

• **Shipping gate facility** for AC check, Battery check, Tyre pressure check prior to shipment to meet Vehicle gate release process. Testing tracks as shown in Fig

SUBSTATION:

In Ford substation is a 110/11KV distribution system. 110 KV is step down to 11KV by (25mVA) Power Transformer. 3 number of power transformers are available & each having 24KL transformer oil. Similarly 11KV is step down to 415V by (2mVA/1mVA) Distribution Transformer. Totally 26 distribution transformer were available (6 no. of 2mVA & 20 no. of 1mVA) in each shop floor as shown in Fig (2.10).

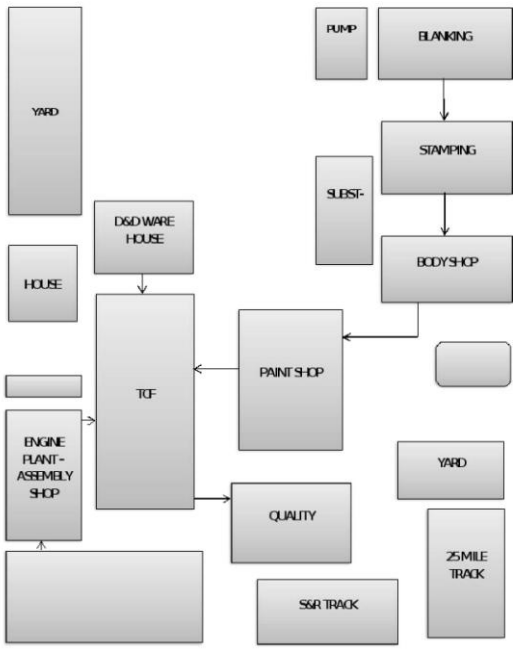
The following fire protection systems available in yard,

- Deluge System
- Sprinkler system
- Oil drain system

In control panel room,

- Smoke Detectors
- Fire Extinguishers
- Manual Call point

COMPANY OVERVIEW & PROCESS:



PUMP HOUSE:

In this plant having two number of water storage over tank. Each one tank having Capacity of 13.5m height. 1m height approximately consumed 260KL.From the height of 8.5m in tank, using industrial water & 1m height of tank using Fire protection system. Fire protection system is maintaining the pressure at 9 to 10.5bar. They having two number of **Jockey pump.** One is Auto & another one is Manual. Jockey pump will run automatically attain water at 9bar pressure & maintaining to support the pressure of 9 to 10.5bar. Jockey pumps Capacity – 12m3/hr. And also available three number of Diesel **Engine Pump**. DEP is working under the different level of pressure as follows 8.5bar, 8bar & 7.5bar. Diesel Engine Pump capacity – 570m³/hr as shown in Fig

III. FIRE PROTECTION SYSTEM

Fire protection is the study and practice of mitigating the unwanted effects of potentially destructive fires. It involves the study of the behavior, compartmentalization, suppression and investigation of fire and its related emergencies, as well as the research and development, production, testing and

application of mitigating systems. Buildings must be constructed in accordance with the version of the building code that is in effect when an application for a building permit is made. Building inspectors check on compliance of a building under construction with the building code. Once construction is complete, a building must be maintained in accordance with the current fire code, which is enforced by the fire prevention officers of a local fire department. In the event of fire emergencies, Firefighters, fire investigators, and other fire prevention personnel called to mitigate, investigate and learn from the damage of a fire. Lessons learned from fires are applied to the authoring of both building codes and fire codes.

TYPES OF FIRE PROTECTION SYSTEM:

There are two types of fire protection system.

- Active fire protection system
- Passive fire protection system

PASSIVE FIRE PROTECTION SYSTEM:

Passive fire protection (PFP) is an integral component of the three components of structural fire protection and fire safety in a building. PFP attempts to contain fires or slow the spread, through use of fire-resistant walls, floors, and doors. Passive Fire Protection, which includes compartmentalization of the overall building through the use of fire-resistance rated walls and floors. Organization into smaller fire compartments, consisting of one or more rooms or floors, prevents or slows the spread of fire from the room of fire origin to other building spaces, limiting building damage and providing more time to the building occupants for emergency evacuation or to reach an area of refuge.

FIRE SEPARATION

The distance in meters measured from the external wall of the building concerned to the external wall of any other building on the site, or from other site, or from the opposite side of street or other public space for the purpose of preventing the spread of fire.

FIRE SEPARATING WALL

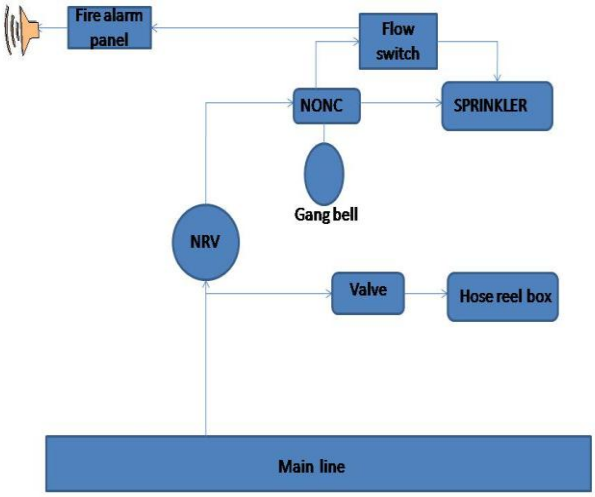
The wall provides complete separation of one building from another or part of a building from another or part of a building from another part of the same building to prevent any communication of fire or heat transmission to wall itself which may cause or assist in the combustion of materials on the side opposite to that portion which may be on fire as shown in Fig

MEANS OF EGRESS

A continuous and unobstructed way of travel from any point in a building or structure to a place of comparative safety.

1. As the liquid changes to a gas it expands - this expansion in a vented container would cause the gas and liquid to take up more space. In a sealed container the gas and liquid are not able to take up more space and so the pressure rises. Pressurized vessels containing liquids can reach an equilibrium where the liquid stops boiling and the pressure stops rising. This occurs when no more heat is being added to the system (either because it has reached ambient temperature or has had a heat source removed).

2. The boiling temperature of a liquid is dependent on pressure - high pressures will yield high boiling temperatures, and low pressures will yield low boiling temperatures. A common simple experiment is to place a cup of water in a vacuum chamber, and then reduce the pressure in the chamber until the water boils. By reducing the pressure the water will boil even at room temperature. This works both ways - if the pressure is increased beyond normal atmospheric pressures, the boiling of hot water could be suppressed far beyond normal temperatures. The cooling system of a modern internal combustion engine is a real-world example.



IV. DELUGE SYSTEM

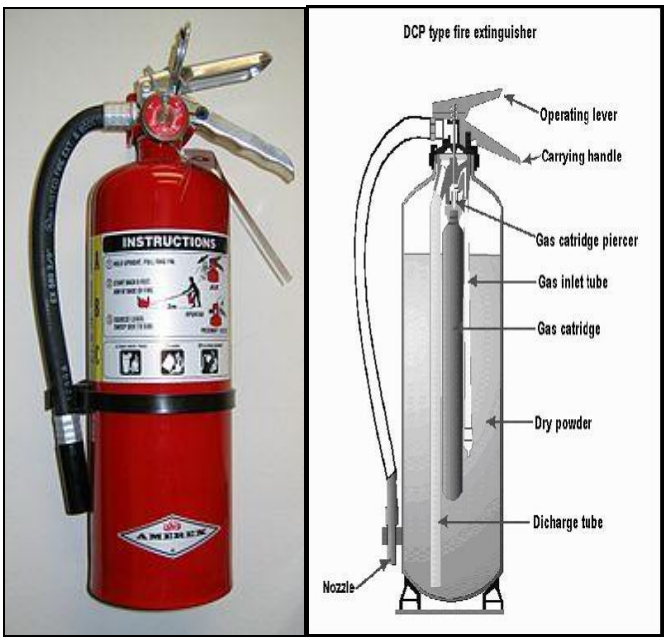
"Deluge" systems are systems in which all sprinklers connected to the water piping system are open, in that the heat sensing operating element is removed, or specifically designed as such. These systems are used for special hazards where rapid fire spread is a concern, as they provide a simultaneous application of water over the entire hazard. They are sometimes installed in personnel egress paths or building openings to slow travel of fire (e.g. openings in a fire-rated wall). Water is not present in the piping until the system operates. Because the sprinkler orifices are open, the piping is at atmospheric pressure. To prevent the water supply pressure from forcing water into the piping, a "deluge valve" is used in the water supply connection, which is a mechanically latched valve. It is a non-resetting valve, and stays open once tripped.
Because the heat sensing elements present in the automatic sprinklers have been removed (resulting in open sprinklers), the deluge valve must be opened as signaled by a fire alarm system. The type of fire alarm initiating device is selected mainly based on the hazard (e.g. smoke detectors, heat detectors, or optical flame detectors). The initiation device signals the fire alarm panel, which in turn signals the deluge valve to open. Activation can also be manual, depending on

the system goals. Manual activation is usually via an electric or pneumatic fire alarm pull station, which signals the fire alarm panel, which in turn signals the deluge valve to open. Operation - Activation of a fire alarm initiating device, or manual pull station, signals the fire alarm panel, which in turn signals the deluge valve to open, allowing water to enter the piping system. Water flows from all sprinklers simultaneously as shown in Fig (3.9). In this plant, four areas available in deluge system. There are as following,

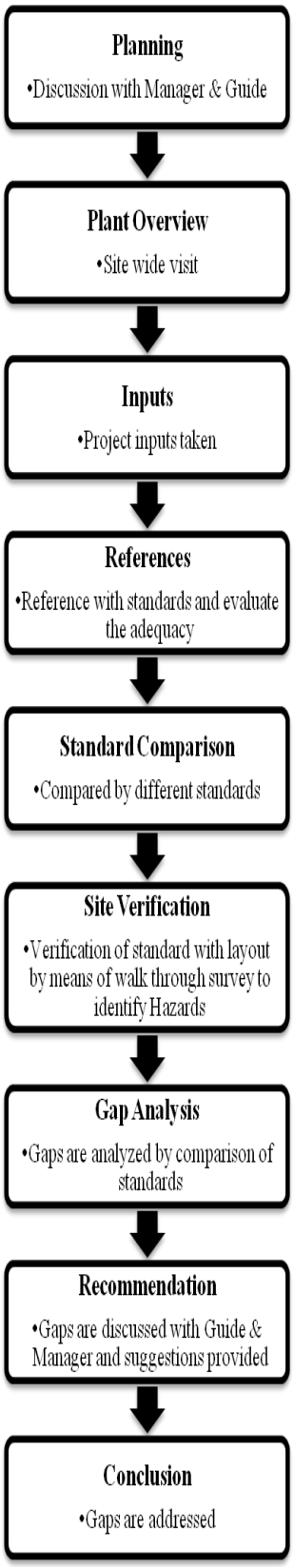
- Propane yard
- Cooling tower
- CFS area
- Paint Mixing Area

V. FIRE EXTINGUISHERS:

A **fire extinguisher** is an active fire protection device used to extinguish or control small fires, often in emergency situations. It is not intended for use on an out-of-control fire, such as one which has reached the ceiling, endangers the user (i.e., no escape route, smoke, explosion hazard, etc.), or otherwise requires the expertise of a fire department. Typically, a fire extinguisher consists of a hand-held cylindrical pressure vessel containing an agent which can be discharged to extinguish a fire. Fire extinguishers manufactured with non-cylindrical pressure vessels also exist, but are less common. There are two main types of fire extinguishers: stored-pressure and cartridge-operated. In stored pressure units, the expellant is stored in the same chamber as the firefighting agent itself. Depending on the agent used, different propellants are used. With dry chemical extinguishers, nitrogen is typically used; water and foam extinguishers typically use air. Stored pressure fire extinguishers are the most common type. Cartridge-operated extinguishers contain the expellant gas in a separate cartridge that is punctured prior to discharge, exposing the propellant to the extinguishing agent. This type is not as common, used primarily in areas such as industrial facilities, where they receive higher-than-average use as shown in Fig



VI. METHODOLOGY



VII. RECOMMENDATION

In this plant, Overall fire protection system effectiveness is good as per reference standards like NFPA, IS standard & Ford global/local standards. In overall fire protection system, we are taking sample analyze of fire extinguishers distance standard as per NFPA in (Vehicle Operation) all shop floor Most of the fire extinguishers are kept at required location and it's satisfied with standard distance. We are identified, some of the fire extinguishers are available in excess requirement as

per NFPA standards. They are listed below Tab This recommendation is used to sustain the safety standards in fire extinguisher in this plant. We are recommended, some of the excess fire extinguisher to be removed. Because, parallel fire protection equipments like hydrant system, sprinkler system, detection system, emergency exit, fire alarm and hooters are active very effectively. Then it's may be cost savings also.

VIII. CONCLUSION

- In a nutshell, neither active or passive fire protection system plays an important role to protect a plant when a fire breakdown. The main goal of fire protection systems are protect to lives, assets and property.

- The First aid firefighting equipments are designed for fighting the incipient stage of fire instantly by the nearest person in the place of an event. As we know that "Prevention Is Better Than Cure". By adopting better Housekeeping and Safe practices we can eliminate the possibilities of fire hazard.

- Fixed installation Fire Hydrant system is designed in case of major fire accidents Corrosion is s bigger challenge.

- Mock drills in frequent intervals are certainly helpful in handling minor or major fire accidents.

- Audit on Fire safety has conducted periodically, but repeated hazards are found. Sustainability is required.

- Fire trainings are essential to guarantee that employees know what to do in the case of fire. Fire equipment and training can also minimize the tremendous damage as a result of that unexpected fire.

- **Finally this project concludes,**
    - Fulfillment of Legal requirements & Other Standards.
    - Overall Extinguisher Maintenance timing is reduced.
    - Cost factor reduced for Extinguisher.
    - Maintenance perspective (AMC – Annual Maintenance Contract)
    - Standard Adherence
    - HPT (Hydrostatic Pressure Test) of Extinguisher.
    - Refilling of pressure dropped cylinder.
    - EOL (End of Life) of Extinguisher.

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