Warehouse fire prevention – maintenance strategy

Risktopic 2-5.002

The primary goal of applying a maintenance strategy in a warehouse occupancy is to minimize or avoid the likelihood of equipment failures. Equipment failures not only result in the disruption of normal operations, but also can be a source of fire ignition if they generate heat, sparks, or flame.

Introduction

Maintenance strategies may be preventative or predictive. Preventive maintenance is a fixed schedule of planned actions aimed at keeping equipment in like-new condition so as to avoid breakdowns and failures of building, utility, or process systems. Predictive maintenance goes even further by using condition monitoring technologies to catch early failure modes and proactively repair or resolve the issue only when there is a problem and before it actually fails.

Developing, implementing, and optimizing an effective maintenance strategy will reduce or eliminate potential ignition sources that can lead to warehouse fires. As such, a comprehensive maintenance strategy, whether preventative or predictive, is a vital component of any Warehouse Fire Prevention program.

Discussion

A Warehouse Fire Prevention program is actually a collection of programs that can be separated into three categories as shown in the Warehouse Fire Prevention triangle to the right. Although a maintenance strategy may not be viewed as a typical fire prevention activity, it is an essential component of maintaining a fire safe facility. According to 2006 data from the National Fire Protection Association, leading causes of storage fires include electrical distribution systems, lighting equipment, and storage handling equipment. This data reveals the importance of an effective maintenance strategy that addresses utility syst ems as well as storage handling equipment such as industrial trucks, conveyors, and automatic storage and retrieval systems.

A warehouse maintenance strategy, like any successful program, begins with management's commitment. The program must be formalized in writing, shared with all employees, and implemented with appropriate funding and resources. Employees quickly recognize and buy into initiatives that have management's support. Supported programs will have a much greater impact than unsupported programs, which will quickly stall out and become ineffective.

Warehouse electrical maintenance

Warehouse electrical systems will range from simple to complex. Simple systems may consist of just lighting. Complex system may include motor control centers and programmable controller rooms to manage automated distribution networks comprised of conveyor and sorting systems. Regardless of complexity, electrical systems should undergo periodic inspection and testing. For

purposes of this fire prevention document, preventative inspections should apply common human's senses (sight, touch, smell, and hearing) along with infrared thermography. Additional predictive maintenance approaches can increase overall reliability and sustainability and would include vibration analysis, oil analysis, power analyzers, and motor circuit testing.

Inspections – Inspections are typically visual activities that allow the detection of unwanted conditions. Other senses can also detect issues associated with temperature or odors of electrical breakdown. Where inspection frequencies are not stated below, an appropriate frequency should be applied based upon local experience. Typical electrical inspection activities may include:

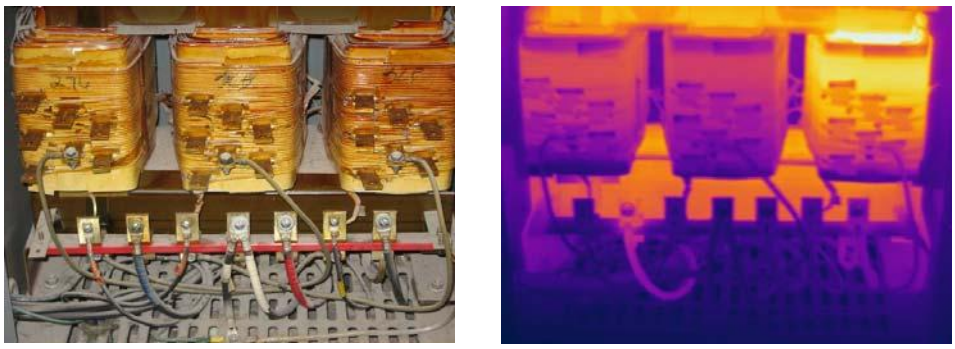
Combustible debris with dry Transformer housing
Photo source: Predictive Service

- Verifying electrical equipment is operating in a cool, dry, and clean environment
- Verifying electrical panels and equipment covers are in place
- Verifying there is a 0.9 m (3 ft) clear space around all electrical panels and other electrical equipment
- Verifying there are no visual signs of housing discoloration due to equipment overheating
- Verifying electrical extension cords are only being utilized for temporary operation and not for permanent or seasonal installations
- Weekly de-energizing of Type "S", high intensity discharge lamps in non-enclosed fixtures

Type "S" high intensity discharge lamps are subject to catastrophic failure when used for extended periods. A catastrophic failure can release hot lamp parts that can ignite nearby combustibles. Weekly off-on cycling will induce an imminent lamp failure during startup.

Testing – Testing is an active evaluation of equipment or systems to verify condition or suitability for continued use and operation. Typical electrical testing may include:

- Infrared testing of all circuits operating at 110V or above. The scans should be comprehensive and include electrical panels, transformers, conveyor drive motors, etc. The recommended frequency will depend on the complexity of the electrical system. For warehouses with only lighting circuits, every three years may be appropriate. For facilities with a more complex electrical system, annual infrared testing would be considered appropriate
- Dielectric fluid testing for liquid insulated transformers, especially where located inside or in close proximity to a storage building. Testing should include acidity, dielectric strength, and dissolved gas analysis tests. The frequency of these tests should be annual.



Overheated dry transformer – C phase (visual and thermal images)
Photo Source: Predictive Service

Transformer Oil Analysis

Oil is one type of dielectric fluid used to cool and insulate the internal components of transformers and certain types of switches. Because it bathes every internal component, the oil contains a great deal of diagnostic information. Just as a blood test provides a doctor with a wealth of information about the health of a patient, a sample of transformer oil can tell a great deal about the condition of a transformer. This includes advanced warning of developing conditions such as tap changer arcing, overloading, partial discharge (corona), liquid overheating and break down of insulation.

The analysis is broken into two parts. 1) The oil is reviewed for contaminants and degradation of its dielectric (insulation) strength and 2) dissolved gas analysis (DGA) looks for certain gas quantities, combinations and the likely cause (see Table 1. Dissolved Gases and Probable Cause).

Oil filled transformer
Photo source: Predictive Service

Key Gases	Most Likely Causes
Hydrogen (H_2)	Partial discharge (corona)
Methane (CH_4)	Overheating
Acetylene (C_2H_2)	Arching
Ethylene (C_2H_4)	Localized overheating
Ethane (C2H5)	General overheating
Carbon monoxide (CO)	Cellulose overheating
Carbon Dioxide (CO_2)	Oil and/or cellulose overheating

Table 1. Dissolved gases and probable causes

Maintenance – Maintenance is a routine action based upon manufacturer's recommendations or best practices to maintain equipment in a serviceable state. Based upon visual reviews or thermal anomalies caused by loose connections, typical electrical maintenance may include:

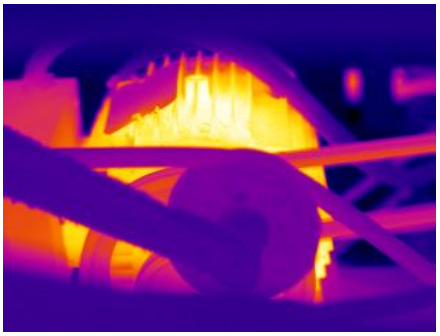
- Replacement of Type "S", high intensity discharge lamps in non-enclosed fixtures prior to reaching predicted life expectancy
- Retorquing or tightening electrical connections at transformers, circuit breakers and other equipment

Warehouse material handling preventative maintenance

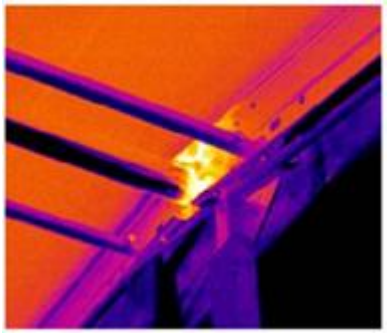
Appropriate maintenance of belts, rollers, drive motors, and other components of material handling systems will significantly reduce the likelihood of a failure or breakdown that can lead to fire. Friction from a damaged roller or overheating of a drive motor covered with dust or debris are examples of conditions that can lead to a fire.

Inspections – Inspections are typically visual activities that allow the detection of unwanted conditions. Typical material handling system inspection activities may include:

- Weekly minimum inspections of entire conveyor systems to ensure rollers, belts, drives and other components are in good condition. Any damage should be immediately reported and repaired
- Conveyor motors should be visually inspected on a weekly basis. The motors should be maintained in a cool, clean, and dry environment and in accordance with the nameplate specifications. Any adverse conditions that are discovered should be immediately corrected
- Annual infrared thermography inspections of conveyor bearings, motor drives, and gear boxes. Additional environmental and operational factors may require more frequent scanning



Infrared image of motor and pulley system
Photo Source: Predictive Service



Hot Conveyor Bearing
Photo Source: Predictive Service

Testing – Testing is an active evaluation of equipment or a system to verify condition or suitability for continued use and operation. Typical material handling system testing may include:

- Quarterly testing of interlocks or shut downs that are integrated into the conveyor system or automatic storage and retrieval system

Maintenance – Maintenance is a routine action based upon manufacturer's recommendations or best practices to maintain equipment in a serviceable state. Typical material handling system maintenance may include:

- Lubrication and service of equipment in accordance with manufacturer's specifications
- Oil analysis of critical gear boxes will help identify breakdown of gears and/or oil

Warehouse mobile equipment preventative maintenance

Most warehouses utilize various forms of mobile equipment to transport product. Whether you call them lifts, forklifts, lift trucks, clamp trucks, or industrial trucks, preventative maintenance for both the vehicle and vehicle support systems (refueling or recharging) will help to keep your facility safe from a fire. Fires involving battery-powered trucks can result from electrical short circuits, hot resistors, arcing and fused contacts, lint
accumulations, and exploding batteries. Fires involving fuel-powered trucks can result from fuel leaks, inappropriate handling of fuels, and physical damage to fuel system components.

Inspections - Inspections are typically visual activities that allow the detection of unwanted conditions. Typical mobile equipment inspections may include:

- Daily inspections including battery, controls, lift and tilt systems, brakes, and fuel system. It is also important to verify that the truck is free of lint, oil, and grease accumulations. Check with your equipment manufacturer, as most can provide support on appropriate maintenance for your specific equipment
- Daily inspections of battery-charging stations including the condition of cables, separation from combustibles, and ventilation. Ventilation is important as hydrogen gas is produced during charging of batteries (out gassing). In the right concentration, this gas can be highly explosive. If on-board chargers are provided, the vehicle should be parked in a well-ventilated area during charging

Photo Source: FEMA

Maintenance – Maintenance is a routine action based upon manufacturer's recommendations or best practices to maintain equipment in a serviceable state. Typical material handling system maintenance may include:

- Routine maintenance by trained and authorized persons per manufacturer's instructions and frequencies. Again, check with the manufacturer for your specific equipment to obtain a schedule for the appropriate service or maintenance. Service and maintenance is generally based in hours of use.

Personnel training

It is important to recognize that personnel handle, operate, and use the various utility, material handling, and mobile equipment systems present in a storage facility. Proper training of personnel will support the overall goals of a maintenance strategy. Equipment users and operators should be trained to detect off-normal or inappropriate conditions that affect equipment performance, integrity, and safety. Trouble should be reported promptly so that needed service or repairs can be completed before a hazard can lead to a fire.

Industrial material handling vehicles can contribute to property damage and fire through careless operation, improper use, or inadequately trained operators. Appropriate instructional training, including refreshers, should be provided to all operators. Safe and careful operation of mobile material handling equipment will greatly reduce the likelihood of a fire resulting from an accident.

Special hazard storage areas, such as flammable liquid or aerosol rooms, require intrinsically safe vehicles specifically rated for these areas. Appropriately rated vehicles should be provided, and vehicle operators trained to use only the suitably rated vehicles.

Conclusion

The foundation of Zurich Risk Engineering's philosophy is prevention. No loss can be smaller than the loss that is prevented, and any loss allowed to occur can grow into the worst-case disaster. To avoid the disruption of a small fire or the consequences of a major warehousing disaster, prevention is the key. By implementing and maintaining a comprehensive warehouse maintenance strategy, you have taken a big step in avoiding disaster.

References

1. Smith, CMRP, Dale P. Predictive Maintenance (PdM) Integration for Electrical Distribution Safety and Reliability. ASSE Safety 2009 Conference Proceedings, 2009.
2. Twomey, Erin R. Torch Fires in the United States. National Fire Protection Association. Quincy: NFPA, 2006.
3. NEMA LSD 25-2008 Best Practices for Metal Halide Lighting Systems, Plus Questions and Answers about Lamp Ruptures in Metal Halide Lighting Systems. Rosslyn, VA: NEMA, 2008.
4. Cote, Arthur E. Fire Protection Handbook. National Fire Protection Association. Quincy: NFPA, Nineteenth Addition.

Related documents

Zurich Services Corporation additional Risktopics:

1. Warehouse fire prevention: 2-5.001
2. Warehouse fire prevention - management of change: 2-5.003
3. Warehouse fire prevention - loss prevention: 2-5.004

Zurich Services Corporation
Risk Engineering
1400 American Lane, Schaumburg, Illinois 60196-1056
800 982 5964 www.zurichna.com

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