Session No. 755

The Fire Prevention Plan, Another Type of Hazard Analysis

Gabriel F. Miehl
GE Transportation

Hazard analysis is a key step for the development and implementation of a comprehensive environmental, health, and safety management system. A good analysis is the first step of a proactive approach to accident prevention. Fire hazards can develop into catastrophic accidents and should be included as part of any hazard analysis. "A fire prevention plan identifies special fire hazards in the workplace and specifies procedures for controlling fire hazards through work practices and maintenance" (OSHA Fire Safety Advisor).

Fire is good, usually. Combustion supports production, either via a manufacturing aid or a repair process. The key is making sure the process is under control and that ignition sources meet fuel sources only when necessary to support the process. A fire prevention plan that contains the following elements can help ensure control:

- Identification of Fire Hazards
- Proper Handling and Storage of Hazardous Materials
- Identification and Control of Ignition Sources
- Fire Protection Equipment Necessary to Control Identified Hazards
- Housekeeping Procedures
- Equipment Maintenance to Prevent Ignition Control
- Assignment of Responsibility for Hazard Control

- Written Plans and Programs
- Training

Why Develop a Fire Prevention Plan?

There are many reasons to develop a fire prevention plan, from regulatory requirements to loss prevention. As safety professionals, the key reason to develop a fire prevention plan is that it is the right thing to do. A well developed plan will help protect people, property, and the environment.

Fire Prevention Plans are covered by 29 CFR 1910.39 "Fire Prevention Plans". Paragraph (a) states "An employer must have a fire prevention plan when an OSHA standard in this part requires one." The following OSHA standards require a Fire Prevention Plan:

Portable Fire Extinguishers, 1910.157

Ethylene Oxide, 1910.1047

Methylenedianiline - 1910.1050

10. 1,3-Butadiene - 1910.1051

Per 1910.157 (a): "Where extinguishers are provided but are not intended for employee use and the employer has an emergency action plan and a fire prevention plan that meet the requirements of 29 CFR 1910.38 and 29 CFR 1910.39 respectively, then only the requirements of paragraphs (e), inspection, maintenance, and testing, and (f), hydrostatic testing, of this section apply."

If an employer provides portable fire extinguishers that are not for employee use, the employer must comply with the Fire Prevention Plan standard.

Per OSHA's Fire Safety Advisor: "Fire Prevention involves elimination or control of condition or substances that could ignite or fuel a fire. Maintenance of a clean and orderly workplace is an essential element of fire prevention. Every employer should routinely inspect the workplace to identify fire ignition and fuel hazards and then take appropriate steps to eliminate them". The Fire Safety Advisor further states "OSHA does not require any employer to assign firefighting duties to an employee. THE EMPLOYER ALWAYS HAS THE OPTION TO ADOPT A POLICY REQUIRING COMPLETE AND IMMEDIATE EVACUATION IN THE EVENT OF FIRE. In that case the policy must be implemented by adopting a comprehensive emergency action plan and a fire prevention plan that meet OSHA criteria".

It would seem that the regulatory expectation is the implementation of a Fire Prevention Plan for worksites that do not have a fire brigade.

Per NFPA's U.S. Industrial and Manufacturing Property Structure Fires fact sheet, from 2003 to 2006, there was an annual average:

10,500 Structure Fires

12 Civilian Deaths

300 Civilian Fire Injuries

$509 Million in Direct Property Damage

This data provides an incentive in the form of corporate stewardship to develop and maintain a Fire Prevention Plan.

The Program

As a start, 29 CFR 1910.39 can be used as a reference when developing the written fire prevention plan. At a minimum, the following elements should be included:

- A list of all major fire hazards (THIS IS THE HAZARD ANALYSIS). This list should include details on:
- Proper handling and storage procedures for materials that pose a fire hazard,
- Potential ignition sources, including control measures,
- Fire protection equipment necessary to control each identified hazard;
- A housekeeping plan to control accumulation of flammable and combustible waste materials;
- Preventative maintenance procedures for heat-producing equipment to prevent ignition of potentially flammable or combustible materials used in the process;
- The name(s) or job title(s) of employees responsible for the preventative maintenance and housekeeping procedures.
- A training program that informs employees of the fire hazards in their work area and the steps that must be taken to minimize these hazards, all at the time of initial assignment.

The Hazard Analysis

OSHA defines a job hazard analysis as "a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment". In the case of the Fire Prevention Plan, the key is recognizing the fuel sources and ignition sources that could be present in the workplace, how these fuel and ignition sources can interact, and what controls are needed to prevent interaction or minimize the effects of interaction. The bulk of the time devoted to a Fire Prevention Plan should be dedicated to identification of fuel and ignition sources; therefore, as with any hazard analysis, an audit of the work area will be needed to identify fuel and ignition sources. It is important to remember that ignition sources represent heat sources while fuel sources represent ANYTHING that can burn.

Potential fuel sources include:

Gasses	**Liquids**	**Solids (Cellulosic)**
o Fuels (Natural Gas, Propane, LNG, etc.)	o Solvents (Acetone, MEK, Alcohols, etc.)	o Wood (Pallets, Packaging Material)
o Sewage Gas	o Fuels (Gasoline, Diesel, etc.)	o Paper/Cardboard
o Welding Gases (Acetylene,	o Paints	o Christmas Trees

Propylene, etc.) o Production Aids (Anhydrous Ammonia, Hydrogen, etc.)	o Oils/Lubricants o Organic Peroxides o Medical (Ethylene Oxide)	(Decorations)
Fibers/Textiles o Natural Fibers (Cellulosic-Cotton, Linen, etc.) o Man Made Fibers (Nylon, Polyester, etc.)	**Plastics/Rubbers** o Foams (Styrofoam) o Films o Resins o Sheets o Natural Rubbers o Synthetic Rubbers	**Explosives/Blasting Agents** o High Explosives (TNT, nitroglycerine, etc.) o Low Explosives/Propellants (Black Powder, Solid Rocket Fuels, etc.) o Blasting Agents o Water Gels, Slurries, Emulsions
Metals o Calcium o Lithium o Magnesium o Potassium o Sodium o Zinc	**Dusts:** o Agricultural (Flour, Sugar, Coffee, etc.) o Carbonaceous (Charcoal, Coal, etc.) o Metals (Aluminum, Iron, Magnesium, etc.) o Miscellaneous (Paper) o Plastics o Drugs (Aspirin, Vitamin C)	**Structural Materials** o Wood Beams/Joists/etc. o Interior Finish o Floor Finish o Insulating Materials (Polyurethane, Polystyrene)
Other: o Oxygen Enriched Atmospheres (> 21%)		

Potential ignition sources include:

Chemical • Heat of Combustion: Fuels burned creating a heat source- ovens, torches, boilers, water heaters, matches, cigarettes, OPEN FLAMES, etc. • Spontaneous Heating: Materials that can spontaneously combust- oil soaked rags, wood chips, agricultural products (wet hay), coal, charcoal, paint and paint scrapings, and fiber products (stored before cooled-"preheated". • Heat of Decomposition: Materials that decompose when heated beyond a critical temperature- acetylene, nitrocellulose, peroxides. • Incompatible Materials: water reactive, acids/bases, etc.	Electrical • Heating Equipment (Resistance, Dielectric, Induction) • Lighting Equipment (Hot Surfaces) • Faulty/Overloaded Electrical Equipment (including overheated equipment) • Arcing • Static Electricity • Lightening • Equipment Used in Rated Atmospheres.
Mechanical • Friction Heat: Heat developed when two surface rub together- conveyor belt slipping against a pulley, metal contamination of grain or textile handling	Nuclear Heat Energy: The energy released is enough to heat steam for electrical generation.

machinery, HOT SURFACES. • Friction Sparks: Sparks developed when two surface impact- grinding operations, hammering, shoe nails on a concrete floor. • Heat of Compression: The heat released when gas is compressed- the "diesel effect". • Molten Material	

The auditor must be able to recognize potential fuel and ignition sources for the audit to be valid; therefore, the auditor must also be familiar with the processes taking place in the work environment. Research may be necessary in advance of the audit as some fuel or ignition sources are only hazardous depending on their environment. A good example of this would be electrical equipment used in flammable atmospheres. Two good sources of information would be the NFPA standards and FM Global data sheets. Both are available for viewing for free before conducting the audit.

In terms of conducting the audit of fuel and ignition sources, the auditor will need to link findings to specific locations in the facility. A facility map will be extremely useful for use during the audit along with an understanding of any facility specific procedures for location identification. Typical procedures may include the marking of building columns, catalog numbers on equipment, rack location, etc. For the actual inventory of fuel and ignition sources, the auditor could use simple pen and paper so long as the information is organized in a logical manner.

For the fuel source inventory, the following information should be gathered:

1. The location of the fuel source.
2. What the material is (specific name, type of material- paint, solvent, solid, etc.).
3. How it is stored (pile, pallet, rack, boxed, pail, drum, cylinder, pipeline).
4. The amount or volume of the material at the storage location.

Example Chart

	Storage Location	**Material**	**Amount/Volume**
1	B6-Bay A Col 4, "HAZMAT" Room	Oxygen	4 X HP250 Cylinders
2	B6-Bay F Col 4, Receiving Dock	Isopropyl Alcohol	4 X 5 Gallon Pails on a Pallet
3	B6 Bay F Col 1, Receiving Dock	Idle Wood Pallets (36" X 36")	3 X 8' Stacks

For the ignition source inventory, the following information should be gathered:

1. The location of the ignition source.
2. The type of ignition source (hot surface, static electricity, arcing, etc.).

3. The cause of the ignition source (steam pipes, ovens, grinders, electrical equipment, etc.).

Example Chart

	Ignition Source Location	Ignition Source	Cause
1	B6-Bay A Col 4, "HAZMAT" Room	Hot Surface	Steam Pipes at Ceiling
2	B6-Bay F Col 4, Receiving Dock	Hot Surfaces/Overheating/Arcing	Electrical Transformers
3	B6 Bay F Col 1, Receiving Dock	Hot Surfaces/Sparking	Bench Grinder

The next step in the hazard analysis is the identification of controls to prevent ignition of fuel sources. Each fuel and ignition source should have at least one associated control. These controls may be present, in which case a housekeeping or preventative maintenance program needs to be present, or may not, in which case a corrective action will need to be initiated in order to provide adequate protection. Controls may be identified and evaluated during the audit if the auditor has the knowledge and experience to do so. Fuel and ignition source controls often follow this hierarchy:

Ignition Prevention

Control Ignition Sources ***OR***	Control Interaction Between Ignition and Fuel Sources ***OR***	Control Fuel Sources
• Eliminate Ignition Sources ***OR*** • Control Heat Transfer to Fuel Sources	• Control Heat Transfer to Fuel Sources: 1. Separation ***OR*** 2. Barriers ***AND*** • Control Heat Transfer Process to Fuel Sources: 1. Convection ***AND*** 2. Conduction ***AND*** 3. Radiation ***AND*** • Control (Contain) Fuel Sources 1. Barriers ***OR*** 2. Separation	• Eliminate Fuel Sources ***OR*** • Control Ability of Fuel to Ignite 1. Control Fuel Properties ***OR*** 2. Control the Storage Environment
Examples: • Indirect heating sources (steam versus direct fire) • Torch Heating to Induction Heating • Temperature Controls	Examples: • Spark Catchers • Double Wall Metal Piping • Guarding by Location • Air/Fuel/Pressure Safety Interlocks	Examples: • Material Substitution (Water Base vs. Solvent Base Parts Washers) • Fire Resistive Air Filters • Inerting Atmospheres

	• Chimney Cleaning • Ventilation Interlocks • Hot Work Permit Programs	

(NFPA Fire Protection Handbook 1-38)

Management "controls" can also be used, such as fire suppression systems (sprinklers, portable fire extinguishers, and fixed agent systems), fire detection systems, and fire resistive construction.

A controls column can be added to both the fuel source and ignition source charts.

Example Chart

	Storage Location	Material	…	Control
1	B6-Bay A Col 4, "HAZMAT" Room	Oxygen		• Protected by a rated fire wall.
2	B6-Bay F Col 4, Receiving Dock	Isopropyl Alcohol		• No cell phone/radio use area. • Protected by a foam fire suppression system.
3	B6 Bay F Col 1, Receiving Dock	Idle Wood Pallets (36" X 36")		• Storage height limited to 8' stacks, maximum of 4 stacks. • Protected by an automatic sprinkler system.

	Ignition Source Location	Ignition Source	Cause	Control
1	B6-Bay A Col 4, "HAZMAT" Room	Hot Surface	Steam Pipes at Ceiling	• Steam pipes are fully insulated and located at ceiling level to prevent contact with material.
2	B6-Bay F Col 4, Receiving Dock	Hot Surfaces/ Overheating/ Arcing	Electrical Transformers	• PM Program involving regular thermographic imaging and oil analysis. • Transformer located in fenced area. • Regular housekeeping of the area surrounding the transformer.
3	B6 Bay F Col 1, Receiving Dock	Hot Surfaces/ Sparking	Bench Grinder	• Grinder located in an "approved" hot work maintenance location. • Grinder located behind weld curtains.

Once controls have been identified, a system must be in place to maintain the controls.

Housekeeping and Equipment Maintenance Programs

Housekeeping is defined by the Encarta World English Dictionary as “management of property and equipment: the management and upkeep of equipment and property for a business or other organization”. For the purposes of fire prevention, housekeeping is the minimization of fuel sources.

The goals of a housekeeping program include:

- Minimize locations where a fire can start.
- Minimize the potential for fire to spread.
- Minimize the potential for dust explosions.
- Minimize accumulations of spilled materials.
- Minimize the potential for spontaneous combustion.

Typical areas of concern for housekeeping include:

- Floors/Horizontal Surfaces: Minimize buildup of wood, textile, agricultural product (flour, sugar, etc.) or cardboard/paper debris, combustible dusts, drip pans containing greases/oils/solvents, oily rags, leaves, etc.
- Waste Receptacles: Use of receptacles appropriate to the waste with receptacles emptied daily before the end of each shift.
- Spill Response: Immediate containment and clean-up of spilled combustible or flammable liquids.
- Storage: Confinement of flammable and combustible materials and oxidizers to appropriate storage cabinets or areas in acceptable amounts.
- Combustible Dusts: Per NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, combustible dust accumulations should not exceed a depth of 1/32”.
- Vents/Ducts: Regular cleaning of duct work where the buildup of oils, greases, or other combustible materials is possible.

Preventative Maintenance is defined by Webster’s Dictionary as “To bring down a machine for inspection or test purposes.” The goal of an equipment maintenance program is to ensure that a piece of equipment does not become a potential ignition source. Equipment maintenance programs are often process specific; therefore, knowledge of the process hazards are critical to developing the maintenance program.

Typical areas of equipment maintenance areas include:

- Spray Application: Equipment bonding and grounding to prevent electrostatic ignition; Hose connections to prevent accidental release of materials.

- Conveyor Systems: Equipment bonding and grounding to prevent electrostatic ignition; Regular bearing maintenance to prevent mechanical failure leading to overheating.
- Ovens/Heaters: Regular functional checks of supervisory control systems, including ventilation controls, fuel supervisory controls, temperature controllers, etc.
- Boilers: Regular functional checks of supervisory control systems, internal inspections per state requirements.
- Electrical Systems: Insulation on flexible cords and cord and conduit connections.
- Safety Devices: Regular checks of emergency shutdown systems, ventilation interlocks, relief valves, vent lines, etc.

As with any program, authority and responsibility must be assigned for housekeeping and equipment maintenance tasks. This assignment should be made by upper management with regular audits conducted to ensure compliance with the program. For equipment maintenance tasks, the use of a work order system will assist by making regular reminders for equipment maintenance and to track completed tasks.

Training

The purpose of the training program under the Fire Prevention Plan is to inform employees of the fire hazards in their work area and the steps that must be taken to minimize these hazards. This training is developed directly from the hazard analysis, and is similar to the training developed through job hazard analysis or PPE analysis. The frequency of this training should be at initial assignment; however, changes in workplace hazards or a failure in the program should initiate retraining.

As with the housekeeping and equipment maintenance programs, training is also often process specific; therefore, knowledge of the process hazards is critical to developing the training program. A specific example of process specific training would be the start-up procedures for a natural gas fired oven. Employees tasked with operating the oven must be instructed on proper start-up and shut down procedures and how these procedures prevent build-up and ignition of fuel-air mixture. These procedures often include a pre-ignition purge process and steps to take should oven ignition not be successful on the first attempt.

Conclusion

A Fire Prevention Plan is a key part of preventing fires in the workplace; however, knowledge of process specific hazards is critical to understanding fire hazards and developing housekeeping, equipment maintenance, and training programs relating to the Fire Prevention Plan.

Bibliography

Encarta® World English Dictionary[North American Edition] © & (P) 2009 Microsoft Corporation http://www.bing.com/Dictionary/search?q=define+housekeeping&FORM=DTPDIA&qpvt=housekeeping%2c+definition. WEB. 2-1-2011

fmglobal.com. http://www.fmglobal.com/fmglobalregistration/Vshared/FMDS0700.pdf .WEB. 2-1-2011

ILO.org.http://www.ilo.org/safework_bookshelf/english?content&nd=857170508 .WEB. 2-1-2011

NFPA.org. http://www.nfpa.org/assets/files/PDF/IndustrialFactSheet.pdf .web. 2-1-2011

OSHA.gov. 29 CFR 1910.157 http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9811 .WEB. 2-1-2011

OSHA.gov. 29 CFR 1910.39 http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12887 .WEB. 2-1-2011

OSHA.gov. OSHA CPL_2-1_037. http://www.osha.gov/dts/osta/oshasoft/softfirex.html .WEB.2-1-2011

OSHA.gov. OSHA Publication 3071-Job Hazard Analysis.http://www.osha.gov/Publications/osha3071.html .WEB. 2-1-2011

OSHA.gov.OSHA Fire Safety Advisor. http://www.osha.gov/dts/osta/oshasoft/softfirex.html .WEB. 2-1-2011

webster-dictionary.org. http://www.webster-dictionary.org/definition/preventive%20maintenance .WEB. 2-1-2011