THE ASSESSMENTS OF THE FLAMMABLE LIQUID STORAGE/DISPENSING/HANDLING ROOMS AT XYZ CORPORATION

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ABSTRACT

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XYZ Corporation is a large manufacturing company headquartered in the mid-west. At its research and development facility, a comprehensive assessment of the flammable liquid storage rooms had never been conducted, nor the exact number or location of these rooms had never been ascertained. To accomplish this a comprehensive study of codes, regulations, and internal XYZ Corporation documents was conducted. This information was then utilized to create an assessment checklist of regulatory criteria required in flammable liquid storage/dispensing/handling rooms. In conduction the assessments all of the exact locations of all the rooms was identified and any situation in these rooms that was not in compliance was noted. In the fourteen lab buildings that were assessed at XYZ Corporations research and development facility, it was determined that 49 flammable liquid storage/dispensing/handling rooms were in existence and these rooms had over 450 regulatory discrepancies discovered in them.

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Chapter 1

Introduction

XYZ Corporation is a large manufacturing company, which is headquartered in the upper-Midwest with 75,000 employees worldwide. The Corporation produces a wide variety of products ranging from tape to rubber and their products are designated for both industrial and commercial use. At their main research and development facility, it has been estimated by polling the safety coordinators in every building, that they possess over 40 flammable liquid storage/dispensing/handling rooms. In an attempt to obtain the exact number of these rooms it was discovered that not only had these rooms never been identified in number or location, but a comprehensive assessment of these rooms has never been conducted. Consequently, a lack of assessment of the flammable liquid storage/dispensing/handling rooms located at XYZ Corporation poses, a significant risk to the company's employees/structures, which creates a high potential for severe loss.

Purpose

The purpose of this study was to determine the extent that effective room design, construction, and safety was exhibited by XYZ Corporation in their flammable liquid storage/dispensing/handling rooms.

Goals

There are 3 goals that this study hopes to achieve.

- Locate and identify all the flammable liquid storage/handling/dispensing rooms at XYZ Corporation.
- Create a checklist of evaluation criteria in order to conduct assessments of all of the rooms located at XYZ Corporation's research and development facility.

- Conduct assessments all of the flammable liquid storage/dispensing/handling rooms, located at XYZ Corporation's research and development facility. The assessments will identify the extent that the flammable liquid storage/dispensing/handling rooms are in compliance with pertinent codes and regulations from a building design/construction standpoint.

Background and Significance

The flammable liquid storage/dispensing/handling rooms at XYZ Corporation have never had a comprehensive assessment conducted on them. Some of the rooms at the complex have been in operation since 1957 and it is believed those are not only not up to code, but if a mishap occurred, it could cause the company severe losses. The companies safety department initially found out about this problem from an incident that occurred in one of these rooms in the fall of 2000. Upon investigating the incident it was discovered that there were no records on how many rooms were in the complex, nor the condition of these rooms. XYZ Corporation likes to think of itself as a proactive company in terms of safety. The company is concerned not only with the monitory loss that it could accrue if a severe loss occurred, but it is also concerned with providing a safe workplace for its employees and not posing a risk to the community that it is in. By locating and conducting an assessment to all of the flammable liquid storage/handling/dispensing rooms in the complex and instituting a complex wide standard on how these rooms will be maintained, the possibility for a loss will be drastically reduced.

Assumptions

The following assumptions were made in conducting this project:

1. It will be assumed that the each buildings safety coordinator will know the location of all the flammable liquid storage/dispensing/handling rooms under their control.
2. The safety coordinators will posses the knowledge of the basic functionally activities associated with all the flammable liquid storage/dispensing/handling rooms under their control.
3. It will be assumed that the different divisions who use these rooms will only conduct operations and work practices in accordance with the specific designation of the room, which are flammable liquid storage room, flammable liquid dispensing room, and flammable liquid handling room.

Limitations

The following limitations were made in conducting this project

1. Many of the flammable liquid storage/dispensing/handling rooms at XYZ Corporation's research and development facility were built before some regulations, pertaining to these rooms, were enacted.
2. The majority of the safety coordinators who are in charge of safety in each of the buildings has only had limited training in safety, and therefore may not have access to or the knowledge of the different regulatory manuals in existence.
3. XYZ Corporation decided that in conducting the assessments for these rooms, the only source for codes and regulations that will be used are the published code and rulebooks. The use of outside sources, such as what other companies have done or discovered will not be used. XYZ Cooperation

determined that they did not want people who are not employed by the Corporation to interpret the codes for them; they rely on their safety engineers to interpret the codes.

4. Because of the size of this project, it has been determined to not formally assess the quantity limitations for flammable liquids that are stored in these rooms. Once this initial assessment is conducted, a more comprehensive study will be conducted on the quantities of flammable liquids in these rooms.
5. The assessment that was conducted in these rooms is a general overview of the requirements for these rooms. At a later date XYZ Corporation is planning on conducting a comprehensive study of each general topic that this initial assessment identifies. For instance, the ventilation in every room was checked to see if it was operational, the exact amount of air being exchanged was not determined.
6. This study will only address the physical characteristics of the rooms and not storage or handling related issues.

Definitions

The following terms need to be defined:

- Flammable liquid storage/handling/dispensing rooms: These are rooms that are designed and constructed to store or use flammable liquids in. Depending on the room's use or uses, they are classified as Division 1, Class 2 or Division 1, Class 2 areas (NFC, 1997).
- In the NEC, Section 500-5(a) defines Class 1, Division 1 locations as those:

A. In which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions.

B. In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage.

C. In which breakdown of fault operation of equipment or processes might release ignitable concentrations or flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

- In the NEC, Section 500-5(b) defines Class 1, Division 2 locations as those:

A. In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, of gases will normally be confined within closed containers or closed systems from which they can escape only incase of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment.

B. In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operation of the ventilating equipment.

C. That is adjacent to a Class 1, Division 1 location and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

- Storage rooms: These are rooms that are only used for storage of flammable liquids. These rooms are classified as Division 1, Class 2 areas (Manual A, 2001).
- Handling rooms: These are rooms that are used for mixing or using different flammable liquids. Flammable liquids can also be stored and dispensed in these rooms. These rooms are classified as Division 1, Class 1 areas (Manual A, 2001).
- Dispensing rooms: These are rooms that are used for dispensing of flammable liquids from one container to another. The containers that the liquids are dispensed into are then brought out of the room and into a lab. Flammable liquids can also be stored and handled in these rooms. These rooms are classified as Division 1, Class 1 areas (Manual A, 2001).
- Red Label Rooms: This is a general term used to describe all flammable liquid storage/dispensing/handling rooms. It does not differentiate between the types of room.

- Flammable liquid: A flammable liquid is any liquid that possesses a flashpoint below 100 degrees F. All flammable liquids will be classified as Class I liquids. In OSHA 1910.106(a)(19), Class I liquids are broken down into 3 different divisions which are:

  Class IA shall include liquids having flashpoints below 73 deg. F. (22.8 deg. C.) and having a boiling point below 100 deg. F. (OSHA 1910.106(a)(19)(i)).

> Class IB shall include liquids having flashpoints below 73 deg. F. (22.8 deg. C.) and having a boiling point at or above 100 deg. F. (OSHA 1910.106(a)(19)(ii)).
>
> Class IC shall include liquids having flashpoints at or above 73 deg. F (22.8 deg. C.) and below 100 deg. F. (OSHA 1910.106(a)(19)(iii)).

Summary

XYZ Corporation's flammable liquid storage/dispensing/handling rooms pose a serious risk to loss. By meeting the goals set forth, possible shortcomings in XYZ Corporation's flammable liquid storage/dispensing/handling rooms will be identified and will then be able to be controlled.

Chapter 2

Introduction

In industry there are many possibilities to accrue a loss. The loss that many companies fear most is the loss associated with fire and explosions. In the United States, in the year 1999, over 140,000 fires occurred at business (Karter, 2000). In the same year, the companies who experienced these fires lost an estimated $499,500,000 in structural property loss alone. This figure does not account for items such as lost productively, lost inventory, insurance rate increases, workers compensation, and medical liability (Karter, 2000). Once a fire occurs it is very difficult for a business to fully recover from it, AIA of Canada has published a book on how to prevent a fire in one's business. The first step that a business needs to do in order to prevent a fire deals with the storage of flammable liquids. They recommend storing of flammable materials in approved safety cans in properly ventilated storage rooms or cabinets. These areas should be isolated from electrical sources, sparks, and other sources of ignition and be kept away from oxidizing materials (AIA Canada, 2001). This chapter will consist of a regulatory overview of the codes and regulations pertaining to red label rooms.

Electrical

Rooms that are designated Class 1, Division 1, or Class 1, Division 2, are required to follow the electrical requirements for hazardous materials (OSHA, 1997). The electrical requirements in rooms in which flammable liquids are stored or dispensed shall have the proper electrical equipment. The required electrical equipment includes:

- ¾ inch threaded conduit

- Explosion proof electrical boxes
- Explosion proof lights
- Shields that collect any piece of glass that may break off a light bulb
- Poured off seal-off fittings (OSHA, 1997)

In addition to these requirements all other electrical equipment that is in these rooms must be classified for use in Class 1, Division 1 or 2 areas (NEC, 1999). Some examples of equipment that may be in these rooms include:

- Fans
- Mixing equipment
- Speakers
- Radios
- Extension cords (NEC, 1999)

The reason that this equipment is necessary in flammable liquid storage/dispensing/handling rooms could be because if one spark from any piece of electrical equipment occurred and the room has a flammable vapor content over the lower explosive limit, a fire or explosion would likely occur.

Fire protection

In red label rooms, a sprinkler system must be in place to provide sufficient fire protection. The fire protection system could consist of a sprinkler, water spray, foam, carbon dioxide, or any other system that has been approved by the Uniform Fire Codes (UFC, 1997). An effective sprinkler system is imperative because in case of a fire, the damage caused by the smoke and flames may be reduced.

Red label rooms are also required to have at least one portable fire extinguisher located outside of every interior door opening to any room used for the storage, dispensing, or open handling of flammable liquids (OSHA, 1997). On this requirement OSHA indicates that this fire extinguisher shall have a rating of not less than 12-B and be located not more than 10 feet from the door, while the NFPA dictates that the fire extinguisher must not have a rating of less than 20-B located not more than 10 feet from the door. The NFPA possesses a rule that is more restrictive than the OSHA rule. For this project, all rules that are more restrictive will be utilized. Another location that a business could install a fire extinguisher is inside these rooms. Although this is not a requirement, it is a good practice to do so. If a person, who has had proper fire extinguisher training, is in a room and a fire starts it would be very convenient to have an extinguisher inside the room to extinguish the fire. The requirement of the extinguisher being outside of the room may pertain to the safety of the workers. If a fire occurred in a red label room and a worker in the rooms caught on fire, the person could be extinguished outside of the rooms with one of the fire extinguishers that is located not more than 10 feet from the door. With the amounts of flammable liquids present in red label rooms, it would not be a wise idea to try to extinguish the person in a confined red label room because the risk of igniting other areas of the room and in doing so cause more harm to the person and a bigger loss for the company.

In red label rooms, adequate precautions need to be taken to prevent the ignition of flammable vapors. Sources of ignition include but are not limited to (OSHA, 1997):

- Open flames
- Lighting

- Smoking
- Cutting and welding
- Hot surfaces
- Frictional heat
- Static electricity
- Electrical
- Mechanical
- Sparks
- Spontaneous ignition from heat-producing chemical reactions
- Radiant heat (OSHA, 1997)

In flammable liquid rooms where dispensing operations take place, Class I liquids cannot be dispensed into containers unless the nozzle and container are electrically interconnected "grounding" (OSHA, 1997). This will reduce the chance of an accidental spark from occurring.

The doors entering red label rooms need to be fire doors with less than 100 square inches of glass in them. These doors also must be constructed with automatic closers. Depending on the construction of the room the fire doors must be rated appropriately. The construction requirements for doors are (UBC, 1997):

- 1 hour construction requires a ¾ hour rated door
- 2 hour construction requires a 1 hour rated door
- 4 hour construction requires a 3 hour rated door

Ventilation

Flammable liquid storage, dispensing and handling rooms need to be provided with either a gravity or a mechanical exhaust ventilation system. Such system shall be designed to provide for a complete change of air within the room at least six times per hour or 1cmf/sq. ft., whichever is greater (OSHA, 1997). However, XYZ Corporation requires that all red label rooms be equipped with a mechanical exhaust system (Manual A, 2001). The mechanical exhaust systems that are used are required to have an emergency shutoff switch that is located outside of the door and the mechanical exhaust system needs to possess an airlow switch or similar device that is interlocked to sound audible alarm upon failure of the ventilation system (Corporate Engineering Bulletin, 1998). In addition, any ventilation system installed, updated, modified, or in any other way changed after 7/98 need to have a ventilation backup encompassing one of the following options (Corporate Engineering Bulletin, 1998):

A. Provide standby or emergency power to the primary ventilation system in the event of a power loss.
B. Install a secondary “emergency” ventilation system that activates when the primary system'’ electrical power is interrupted.
C. Reducing the amounts of hazardous material to get below the code threshold levels (Corporate Engineering Bulletin, 1998).
D. Systems required to comply with the new standards must also have a manual shut off switch outside or the room being controlled.

From a ventilation back-up standpoint, standby power shall be provided in Group H, Divisions 1 and 2 Occupancies and in Group H, Division 3 Occupancies in which Class I

of II organic peroxides are stored. The standby power system shall be deigned and installed in accordance with the Electrical Code (UBC, 1997). Other ventilation requirements for red label room's state that airflow shall not be blocked by any room contents (UFC, 1997), and fire dampers need to be installed at all the applicable firewall penetrations (Manual B, 2000).

Explosion Relief

Red label rooms are required to possess deflagration relief (UBC, 1997). The purpose of this relief is to limit possible damage to the structure that these rooms are located in. Theoretically, if an explosion occurred in a red label room, the main force of the blast should be vented though the deflagration relief panels. This would limit the destructive power of the explosion. Because deflagration panels are designed to release in case of an explosion, it is necessary not to attach any thing to these panel. If shelving, rack, tools, etc. are attached to them, the force that is required to make the panels release is increased. It is also not allowed to plug any openings around theses panels (UBC, 1997). People may feel that the small openings around the panels should be plugged because they allow drafts to enter the rooms. However, practices of caulking, cementing, or taping these small openings shut can negate the usefulness of the panels.

It is recommended that all deflagration panels be tethered (XYZ Corporation Tip Sheet, 1995). A panel that is not tethered could become a projectile and a hazard for people and structures. In the past these panels were allowed to be constructed of glass, this practice is no longer allowed (UBC, 1997) because once the glass panels blew out, shards of glass would likely become projectiles and would pose a serious risk to people in the area.

Obstructions are not permitted within 50 feet from the exterior of a deflagration panel (UBC, 1997). Possible obstructions include but are not limited to trees, bushes, cars, trucks, utility poles, and picnic tables. Other areas that are not allowed within 50 feet from the exterior of a deflagration panel can include:

- Sidewalks
- Roads
- Parking lots
- Break areas

Spill Containment

Flammable liquid storage, dispensing, handling rooms shall be provided with non-combustible, liquid-tight, raised sills or ramps at least 4 inches in height, or the floor in the storage area shall be at least 4 inches below the surrounding floor. A permissible alternative to the sill or ramp is an open-grated trench inside of the room, which drains into a safe location (OSHA, 1997).

In flammable liquid storage rooms, spill control for flammable liquids is required if the room used for the storage has an individual vessel having a capacity of more than 55 gallons or when the aggregate capacity of multiple vessel exceeds 1000 gallons (UBC, 1997). Secondary containment shall be designed to contain a spill from the largest vessel, plus the design flow of fire-protection water calculated to discharge from the fire-extinguishing system over the minimum required system design area or area of the room or area in which the storage is located, whichever is smaller, for a period of 20 minutes (UBC, 1997).

In flammable liquid dispensing and handling rooms, spill control for flammable liquids is required if the flammable liquids are dispensed into vessels exceeding a 1.1 gallon capacity or used in opens systems exceeding a 5.3 gallon capacity (UBC, 1997). Secondary containment shall be designed to contain a spill form the largest vessel, plus the design flow of fire-protection water calculated to discharge from the fire-extinguishing system over the minimum required system design area or area of the room or area in which the storage is located, whichever is smaller, for a period of 20 minutes (UBC, 1997). The reasoning behind the codes requiring spill containment holding capacity not less than the largest vessel plus 20 minutes of discharge from the fire extinguishing system is to prevent any flammable liquids escaping from the room in case of a fire. Also many flammable liquids have a specific gravity less than water, meaning they will float on water. If a room used a water extinguishing system it might be possible for the flammable liquid to escape the room by floating on the water.

In red label rooms, floor debris shall not compromise the holding capacity of the containment trenches, or impede liquid flow towards the holding tanks (OSHA, 1997). If a red label rooms spill containment has been constructed properly, but has some debris on the floor blocking or covering up tank drains or trenches flammable liquids could bypass the secondary containment and escape from the room. This may cause an increased risk of fire, explosion, or the flammable liquids escaping from the room.

Signage

Depending on what the red label rooms is used for, it is required to have the correct signage on every interior door entering the room. The one exception of this rule will be discussed later. The signage required includes:

1. A visible hazard identification sign, in accordance with NFPA 704, must be placed at every entrance to locations where flammable materials are stored, dispensed, or handled. The numbers listed on the sign shall represent the most volatile or hazardous material in the room (NFPA, 1998). This written form of communication is also the only sign required on exterior doors leading into flammable liquid doors, if the door purpose is for emergency escape and fire department access (NFPA, 1998).
2. Explosion relief panels must be identified with signs, mounted on the inside of the wall that prohibit the attachment of anything that may inhibit release of such panels (Manual C, 2000). These signs are required for all red label rooms.
3. In Class 1, Division 1 areas, XYZ Corporation requires a sign that restricts radio receivers, transmitter, pagers, walkie-talkies, beeper, electrical equipment, man lifts, powered vehicles, and other potential ignition sources (GLP, 2001). These signs are required for handling and dispensing rooms.
4. Signs with the area electrical classification shall be placed at the entrance to all classified areas (Manual D, 2000). These signs are required for all red label rooms.
5. A manual shutoff control needs to be outside of the room in a position adjacent to the access door to the room or in a location approved by the chief. The switch shall be of the break-glass type and shall be labeled VENTILATION SYSTEM EMERGENCY SHUTOFF (UBC, 1997). These signs are required if the red label room has a manual ventilation system shutoff.

6. Warning signs shall be of a durable material with red lettering on a white background and shall read DANGER – FLAMMABLE LIQUIDS (UFC, 1997). These signs are required for all red label rooms.
7. A sign requires the passing of a daily shoe conductivity test before any employees can enter the room. (GLP, 2001) These signs are required for dispensing and handling rooms. Another place where a company could install one of these sign is by the shoe meter.
8. All locations that contain hazardous waste must have a sign on the doors entering these locations. The sign needs be labeled DANGER UNAUTHORIZED PERSONNEL KEEP OUT (Manual A, 2001). This sign is required in red label rooms that have hazardous waste in them
9. A sign indicating the applicable safety glass requirements shall be posted outside of red label rooms (GLP, 2001)
10. A sign indicate that a carbon dioxide fire protection systems is in place. This sign must warn people of room flooding (NFPA, 1998). This sign is only required in rooms that utilize a carbon dioxide fire protection system.

Static Control

Each person who enters an area where flammable vapors of gasses may be present shall test his or her footwear daily before the first entry into such an area. A log confirming successful testing initialed or signed by the person shall be kept adjacent to the tester (Manual A, 2001). This policy will ensure that every person entering red label rooms will have footwear that will prevent the accidental discharge of static, thus reducing the risk of an accidental explosion. If a person does not have ESD footwear,

they are required to wear grounding straps on their shoes. Once the person has tested their footwear and they have passed the test, they are required to sign a log that is required to kept adjacent to the tester (Manual A, 2001).

If the red label room has been designated a handling or a dispensing room it is required to have the proper bonding and grounding equipment installed (UBC, 1997). When dispensing is conducted in these rooms, clamps and cables need to properly ground and bond the containers. When handling is occurring the apparatus being used must also be grounded and bonded (OSHA, 1997).

Construction

Red label rooms are not allowed in the basement of a building. This rule is in place to limit possible structural damage in case of a fire or explosion and to allow the responding emergency services direct access to the room. According to OSHA, 1910.106(a)(4), a basement shall mean a story of a building or structure having one-half or more of its height below ground level and to which access for fire fighting purposes is unduly restricted. Openings to other rooms shall be constructed with non-combustible, liquid tight, raised sills or raps that are at least 4 inches in height, or the floor in the storage area shall be at least 4 inches below the surrounding floor. These rooms will also be equipped with self-closing fire doors and be liquid tight where the walls and floor meet (OSHA, 1997).

It is permissible to eliminate the requirement of a raised sill or ramp in a red label room if the room has been constructed with an open grated trench that drains into a safe location. Other regulations in red label rooms cover the types of windows allowed in

them and the type of rack construction allowed. In regards to these last two points, OSHA states:

A. Windows shall be protected as set forth in the Standard for Fire Doors and Windows, NFPA No. 80-1968, which is incorporated by reference as specified in Sec. 1910.6, for Class E or F openings.

B. Wood of least 1-inch nominal thickness may be used for shelving, racks, dunnage, scuff boards, floor overlay, and similar installations (OSHA, 1997).

Depending on the red label room's size, possible fire protection system, and the fire resistance of the structure, a maximum quantity of flammable liquids has been determined by OSHA. The actual rating and capacity limits for these rooms can be found in Table H-13, which is located OSHA 1910.106(d)(4)(ii).

Table H-13

Fire Protection Provided	Fire Resistance	Maximum Size	Total Allowable Quantities (gals./sq. ft./floor area)
Yes	2 hours	500 sq. ft.	10
No	2 hours	500 sq. ft.	5
Yes	1 hour	150 sq. ft.	4
No	1 hour	150 sq. ft.	2

In determining the different building requirements for different types of businesses, the Uniform Building Code has classified every room and structure based on their individual occupancies. These classifications will be made depending on the rooms'

character or its occupancy. The UBC has determined that the following occupancies groups will be used:

- Group A – Assembly
    - Group B – Business
    - Group E – Educational
    - Group F – Factory and Industrial
    - Group H – Hazardous
    - Group I – Institutional
    - Group M – Mercantile
    - Group R – Residential
    - Group S – Storage
    - Group U – Utility (UBC, 1997)

All of the red label rooms at XYZ Corporation are classified as a Group H occupancy. These occupancies are locations in buildings or structures or portions thereof, that involve manufacturing processing, generation, or storage of materials, which constitute a high hazard with respect to fire, explosion, or exposure (Manual C, 2000). XYZ Corporation has further broken down Group H occupancies into six different divisions. The different divisions of Group H occupancies are (Manual C, 2000):

1. H-1 occupancies have highly explosive materials such as blasting agents, black powder, organic peroxides, and unstable reactive. Such materials exceed the explosive properties of those listed in Table 3-D of the UBC.
2. H-2 Occupancies are those where combustible dust are manufactured, used or generated in such a manner that concentrations and conditions may create a fire or

explosive potential. The material quantities, normally stored in open containers or systems, exceed those listed in table 3-D of the UBC. At XYZ Cooperation, an H-2 area is one in which flammable or combustible liquids are dispensed, mixed, pumped, carted, or sprayed.

3. H-3 occupancies are those where flammable solids, other than combustible dusts are manufactured, used or generated. At XYZ Corporation, an H-3 area is one in which flammable or combustible liquids are stored in warehouses and solvent staging areas.
4. H-4 and H-5 occupancies address repair garages and aircraft hanger.
5. H-6 occupancies address fabrication and development areas, such as semiconductor manufacturing, in which hazardous production materials are used, and where the total quantity of materials exceeds that is listed in Table 3-D.
6. H-7 occupancies have quantities of health hazard materials such as corrosive, irritants sensitizes, toxic and highly toxic materials (Manual C, 2000)

Table 3-D of Section 310 of the UBC charts exempt amounts of hazardous flammable material presenting a physical hazard. An excerpt from Table 3-D, which can be found on page 24, discusses the specific storage, handling, and dispensing criteria for occupancies. This excerpt covers the classifications for red label rooms at XYZ Corporation.

Excerpt from Table 3 –D of Section 301 of the UBC

Exempt amount of hazardous flammable materials presenting a physical hazard

CONDITION		STORAGE[2]	USE[2] – CLOSED SYSTEM	USE[2]– OPEN SYSTEM
Material	Class	Liquid Gallons (lbs.)	Liquid Gallons (lbs.)	Liquid Gallons (lbs.)
Flammable Liquid[5,6,7,9]	I-A	30[10]	30	10
	I-B	60[10]	60	15
	I-C	90[10]	90	20
Combination I-A, I-B, I-C[15]		120[10]	120	30

2. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

5. For aerosols, see the Fire Code.

6. Quantities may be increased 100 percent in sprinklered buildings. When footnote 10 also applies the increase for both footnotes may be applied.

7. For storage and use of flammable and combustible liquids in Groups A, B, E, F, H, I, M, R, s and U Occupancies, see Sections 303.8, 304.8, 305.8, 306.8, 307.1.3 through 307.1.5, 308.8, 309.8, 310.12, 311.8 and 312.4.

9. Spray application of any quantity of flammable or combustible liquids shall be conducted as set forth in the fire code.

10. Quantities may be increased 100 percent when stored in approved storage cabinets, gas cabinets or exhausted enclosures as specified in the Fire Code. When the footnote 6 also applies, the increase for both footnotes may be applied.

15. Containing not more than the exempt amounts of Class I-A, Class I-B or Class I-C flammable liquids.

The construction of red label rooms where Class I, Class II, and Class III flammable liquids are stored, dispensed, or handled need to be constructed with the following requirements (UBC, 1997):

A. Red label rooms that are larger than 500 square feet in area need to have at least one exit door that is approve for fire department access (UBC, 1997).
B. Red label rooms that are larger than 200 square feet in area need to have at least 2 doors exiting the room (UBC, 1997).
C. Red label rooms shall be kept separated from other areas with a fire-restive wall of at least one hour for rooms that are smaller than 150 square feet in area and two hours for rooms that are larger than 150 square feet in area (UBC, 1997).
D. Red label rooms cannot be located in a basement of any structure or building (UBC, 1997).
E. All the shelving and racks in red label rooms need to be made out of noncombustible materials or of wood that is not less than one inch thick (UBC, 1997).

Red label rooms are required to have self-closing fire doors (OSHA, 1997). This is to ensure that if a fire occurred in one of these rooms, the fire could not spread through an open door. If this was not a requirement for red label rooms, it is possible that the fire rated doors required for these rooms would be negated.

Any penetration through one of the firewalls in red label rooms needs to be firestopped (UBC, 1997). A penetration through a fire-wall could lead to any possible fire spreading outside of the red label room, also a penetration could hinder the efficiency of the blowout panels because some of the force of the explosion could be directed

through the penetrations and into other areas of the building, thus reducing the total effectiveness of the blowout panels.

Security

Red label rooms need to be secured against unauthorized entry. These areas also need to be secured to protect both the facility and the general publics safety (UFC, 1997). A person who has been properly trained to operate in red label rooms poses a smaller risk to themselves, the facility and the general public, than a person who enters a red label rooms without the proper training. By securing red label rooms against unauthorized entry, XYZ Cooperation could drastically reduce the chance of a loss.

Ignition Control

In flammable liquid storage/dispensing/handling rooms all spark and ignition sources need to be controlled (OSHA, 1997). With all spark and ignition sources controlled the possibility of a fire and explosion may be drastically reduced. Possible ignition sources can include:

- Heating systems
    - Only approve heating systems are allowed in red label rooms (UFC, 1997). A heating system allows ambient air from other locations to be vented into red label rooms may be a possible heating solution in red label rooms. This type of system would not cause any hot surfaces in these restrictive areas.
- Sparking tools

- Only non-sparking tools are allowed in red label rooms. These tools can be made out of metals, such as beryllium, or plastic composites (Guide to Lab Practices, 2001).

An Open-flame and Spark Hazard Permit shall be used for all work producing sparks, heat, and open flames in red label rooms. In order to the permit to be approved all flammable liquids must be removed from the area where the work will be performed (Manual A, 2001).

Egress

Lighted exits need to be maintained in red label rooms (OSHA, 1997). If an exit light is burned out, it may be impossible for a person in the room to find a safe means of egress from the room if a mishap occurred. In addition, all egress isles must be at least three feet wide and be kept free of obstructions (OSHA, 1997). In every storage room there shall be maintained one clear aisle at least 3 feet wide between shelves and if the room contains any storage racks; a four-foot aisle must be present between racks (NFPA, 1998). The exit doors in red label rooms must be operational and cannot be blocked by any object in the room that would reduce or restrict their function (NFPA, 1998).

Housekeeping must be maintained to keep red label rooms clear of miscellaneous combustibles, trip hazards, and unnecessary storage (OSHA, 1997). If proper housekeeping is not conducted in a red label room, the possibility for a loss may increase because if the room is full of unnecessary combustibles, any fire that could occur may be intensified because of the excess fuel in the room.

Eyewash/Emergency Showers

In rooms where flammable liquids are dispensed or handled, an eyewash/emergency shower is required to be within 50 feet any door exiting the room. These stations must also not be more that two doors away (ANSI, 2001). It is imperative to have eyewash/emergency shower stations located near room where dispensing and handling of flammable liquids occurs because if a person was accidentally splashed by one of the flammable chemicals in the room, it is necessary to wash off the chemical before any permanent damage may be done.

Miscellaneous

Any container over 30-gallon capacity cannot be stacked on upon the other (OSHA, 1997). This policy could reduce the chance of an accidental injury to a person and the possibly of an accidental spill because if the containers are not stacked they are less likely to tip over. Furthermore, any drums elevated within racks needs to meet the applicable rules governing both the use of non-combustible racks (UBC, 1997), and shelf storage (UFC, 1997).

Materials that are water reactive should not be stored in flammable liquid storage/dispensing/handling rooms (OSHA, 1997). Also, if any incompatible hazardous materials are in a red label room, they need to be kept in a separate area, which is a minimum of 20 feet away from any flammable or combustible liquids in the room (UFC, 1997).

Because of the risk of fire in red label rooms, storing or transferring Class I liquids is prohibited in any exit access (NFC, 1997). If a fire occurred in a red label room and the fire was centralized in the area in front of an exit, it may be impossible for a

person to safely exit the room. This situation could cause a person seriously injured or they could even become a fatality.

Summary

The thirteen broad areas of concern pertaining to red label rooms include electrical, fire protection, ventilation explosion relief, spill containment, signage static control, construction, security, ignition control, egress, eyewash/emergency showers, and miscellaneous. In researching these different areas pertaining to red label rooms it is possible to design a checklist in order to assess these rooms at XYZ Corporation. This checklist will then be used as a guide to conduct a methodical assessment of all the flammable liquid storage/dispensing/handling rooms at XYZ Corporation.

Chapter 3

A thorough review of codes, regulations, and internal XYZ Corporation documents, was conducted to ascertain the requirements for flammable liquid storage/dispensing/handling rooms. These requirements were summarized and then formatted into a checklist. This checklist was then used as a tool in assessing the red label rooms. This process will allow the goals set forth in Chapter 1 to be achieved. The goals from Chapter 1 are:

- Locate and identify all the flammable liquid storage/handling/dispensing rooms at XYZ Corporation.
- Create a checklist of evaluation criteria in order to conduct assessments of all of the rooms located at XYZ Corporation's research and development facility.
- Conduct assessments all of the flammable liquid storage/dispensing/handling rooms, located at XYZ Corporation's research and development facility. The assessments will identify the extent that the flammable liquid storage/dispensing/handling rooms are in compliance with pertinent codes and regulations from a building design/construction standpoint.

In order to assist all of the assessments of the red label rooms at XYZ Corporation, the pertinent codes, regulations, and internal directives were consolidated into 13 main areas of concern, which are:

- Electrical
- Fire Protection
- Ventilation

- Explosion Relief
- Spill Containment
- Signage
- Static Control
- Construction
- Security
- Ignition Control
- Egress
- Eyewash/Emergency Showers
- Miscellaneous

The main points then had applicable codes, regulations, and internal directives applied to them. The thirteen main areas of concern with codes, regulations, and internal directives applied to them are:

Electrical - Rooms in which flammable liquids are stored or dispensed shall have the proper electrical equipment. General things to look for include explosion-proof boxes and panelboards, threaded rigid conduit, explosion proof lights, poured seal-off fittings, etc.

Fire Protection - A fixed fire protection system shall be provided per code. At least one portable fire extinguisher shall be located outside of, but not more than 10' from, any door opening into a flammable liquid storage room.

Ventilation - Every flammable storage, dispensing and handling room shall have an exhaust ventilation system which provides a minimum of 6

air changes per hour or 1 cfm/sq. ft., whichever is greater. If the ventilation system has been installed, updated or modified after 7/98, the ventilation system electrical source needs emergency power backup. Fire dampers shall be installed at applicable firewall penetrations. Airflow shall not be blocked by any room contents.

Explosion Relief – Deflagration relief shall be provided in accordance with applicable codes. Except for engineered bunker walls, obstructions are not permitted within 50' from the exterior of a blow-out wall. Panel tethering is recommended.

Spill Containment - Flammable liquid storage, dispensing and handling rooms shall be provided with a means of secondary containment to keep spilled products within the room. Spill containment shall be sized to handle a spill from the largest container, plus 20 minutes of sprinkler discharge water. Floor debris shall not compromise the holding capacity of containment trenches, or impede liquid flow towards holding tanks.

Signage - Flammable liquid storage rooms shall have a sign reading DANGER – FLAMMABLE LIQUIDS, a sign stating the electrical classification, and a hazard diamond sign (NFPA 704), placed at their entrances. In Class 1 Division 1 areas (open handling), a sign restricting electronic devices such as cell phones, pagers, walkie-talkies, electrical equipment, photographic equipment, and all other potential ignition sources is required. Explosion relief panels shall be identified to prohibit impediments to their ability to "blow out." A sign indicating applicable

safety glass requirements shall be posted as necessary. Rooms having room-flood carbon dioxide systems shall be so signed.

Static Control - People entering flammable liquid dispensing and open handling rooms shall test their shoe conductivity daily. A sign-in log confirming successful testing shall be kept adjacent to the tester. While dispensing, clamps and cables shall be used to properly ground/bond containers and apparatus being used.

Construction - Flammable liquid storage, dispensing and handling rooms for Class I liquids shall not be located in a basement. Rooms in excess of 200 sq. ft. shall have at least two approved exit doors. Rooms in excess of 500 sq. ft. shall have at least one exterior door approved for fire department access. Holes in walls shall be firestopped. Doors shall be self-closing.

Security - Unauthorized access to flammable dispensing and storage rooms shall be prohibited.

Ignition Control - All spark and ignition sources shall be controlled in flammable liquid dispensing, handling and storage rooms. Non-sparking tools are required in open dispensing and handling rooms. Only approved heating systems are allowed. An Open-flame and Spark Hazard Permit shall be used for all work producing sparks, heat, open-flames and other ignition sources.

Egress - Exit doors, aisles and lights shall be installed and maintained per code. Housekeeping shall be maintained to keep rooms clear of miscellaneous combustibles, trip hazards, and unnecessary storage.

Eyewash/Emergency Showers - Installed and maintained, with travel distance/time not greater than 50'/10 seconds away from flammable liquid dispensing/handling rooms.

Miscellaneous - Flammable liquids shall be separated from incompatible materials, such as corrosives. Containers over 30-gallon capacity shall not be directly stacked upon one another. Drums elevated within racks shall meet the applicable rules for in-rack fire protection and exit aisles.

After the critical areas of concern were identified, a checklist was then derived from the applicable codes, regulations, and internal directives. This checklist is located on pages 38 and 39 of Chapter 3. Upon completion of the checklist, the flammable liquid storage/dispensing/handling rooms at XYZ Corporation could begin to be assessed.

XYZ Corporations have twenty-nine buildings at their research and development facility. Of these buildings, only fourteen of them have labs in them, thus a possibility of a red label room. The fourteen buildings have seven different safety coordinators in charge of them. These safety coordinators possessed the knowledge of where these rooms were located. It was determined that the first rooms that would be assessed would be in the lowest number building, which is 201, and continue assessing buildings in order until all fourteen buildings had been assessed. The rooms identified in these building will be assigned a number starting at number 201 and counting upwards until the highest number is the last room assessed.

In order to accomplish the methodical assessments of the red label rooms in these buildings, the safety coordinator who was in charge of building 201, was contacted and a time was set up to assess the rooms under their control. At the coordinated time, the author of this paper would meet the safety coordinator at their buildings entrance and be escorted to the rooms under their control. Once in a red label room, an assessment would begin.

An assessment would consist of examining all the criteria set forth on the checklist, as well as talking to the safety coordinator about any concerns that they may have pertaining to the room, in addition, all past know safety violations are discussed. While conducting the assessment, any unusual or unexpected situation is noted on the checklist and the situation is then looked up in the reference material to see if it is a violation or not. Items noted in this category included ductless air intake vents taped over, acrylic acid located in the room, and exit signs that are not lit. The assessments continued until all of the red label rooms were located and assessed. Once completed the process would be conducted at the next building until all nineteen building's red label rooms were assessed.

Summary

The assessments were carried out in a very methodical manner. Every applicable building was entered and examined for red labels rooms and every red label room located had its room number recorded, assigned number in order to count the rooms, and were assessed with the help of a checklist and the reference of the executive summary.

The methodology described in this chapter will allow the successful assessment of all of the flammable liquid storage rooms at XYZ Corporation. Any possible shortcoming in these rooms will be identified and then controlled.

Checklist for Flammable Liquid Storage, Dispensing and Open Handling Rooms at XYZ Corporation

Center Building:_____ Room Number:_____ Date:_____

Electrical

Classified wiring, boxes, switches etc.	Yes	No	Unk.
Sealed lighting	Yes	No	Unk.

Fire Protection

What kind of sprinkler system	H_2O	Lite H_2O
Portable fire extinguisher 10' from door	Yes No	Unk.

Ventilation

Exhaust Ventilation system in operation	Yes	No	Unk.
Backup/standby power	Yes	No	Unk.

(Required for systems revamped or installed after 7/98)

Spill Containment

Spill containment – tanks, trenches, curbed	Yes	No	Unk.

Signage

Hazard identification, NFPA diamond	Yes	No	Unk.
Explosion relief panels signed	Yes	No	Unk.
Spark restriction sign	Yes	No	Unk.

(Restricting portable electronics and other ignition sources)

Electrical classification sign	Yes	No	Unk.
"Ventilation System Emergency Shutoff"	Yes	No	Unk.
"Danger – Flammable Liquids"	Yes	No	Unk.
"Danger – Unauthorized Personnel Keep Out"	Yes	No	Unk.

(Required if flammable waste is in the room)

Static Control

Shoe meter available	Yes	No	Unk.

(Required for open handling and dispensing rooms)

Shoe log	Yes	No	Unk.

(If a shoe meter is required)

Bonding/grounding devices available	Yes	No	Unk.

(Required in rooms where dispensing takes place)

Construction

Approximate Sq. footage _____

Number of exits _____

Exterior exit door available Yes No Unk.

(Required in rooms greater than 500 square feet)

Blowout panels Yes No Unk.

Blowout panels tethered Yes No Unk.

50’ clearance for panel relief Yes No Unk.

Type of room Store. Disp. Hand.

Security

Access secured against unauthorized entry Yes No Unk.

Ignition Control Measures

Require open-flame / spark hazard permit Yes No Unk.

(No open flames, spark producers, hot surfaces, etc.)

Non-spark tools available Yes No Unk.

Egress

One clear aisle of egress 3’ wide maintained Yes No Unk.

Racks 4’ apart Yes No Unk.

Good housekeeping Yes No Unk.

Miscellaneous

Containers over 30 gallons are not stacked Yes No Unk.

Holes in firewalls are firestopped Yes No Unk.

Eyewash stations per manual 80 Yes No Unk.

No Flammable Hazardous Waste Yes No Unk.

Other

_____

_____

_____

_____

_____

_____

_____

_____

Chapter 4

Introduction

XYZ Corporations have twenty-nine buildings at their research and development facility. Of these buildings, only fourteen of them have labs in them, and thus creating a possibility of a red label room. A methodical assessment of all the red label rooms was conducted each of these buildings. All of the exact locations of the flammable liquid storage/dispensing/handling rooms were identified and any deficiency found in these rooms were noted.

Data Collected

Using the methodology that was described in Chapter 3, a methodical assessment of all the fourteen buildings was conducted. In order to conduct these assessments, every particular safety coordinator responsible each specific lab building was contacted and a time was set up to enter and then look for every red label room in each specific building. Once every red label room had been identified, an assessment of the room was conducted. This assessment utilized the checklist, which can be found on pages 38 and 39 of this paper. While conducting these assessments, any deficiency that was found was noted on the checklist and a spreadsheet was created in order to keep track of all the items found. The data collected in the accomplishment of all of the assessments of the red label rooms at XYZ Corporation is located on pages 40 thru 49 of this paper. Following is a summary of the information gathered in the assessments:

Room Count	Building Number	Room Number	Electrical	Classified wiring, boxes etc.	Sealed lighting	Fire Protection	What kind of sprinkler system	Portable fire extinguisher 10' from door	Ventilation	Exhaust Ventilation system in operation
1	201	N178		yes	yes		H2O	yes		yes
2	207	W178		yes	yes		H2O	no		yes
3	208	N102		yes	yes		LITE H2O	no		yes
4	208	WW113		yes	yes		LITE H2O	yes		no
5	209	N166B		yes	yes		H2O	yes		yes
6	209	N244A		yes	yes		H2O	yes		yes
7	209	S127A		yes	yes		LITE H2O	yes		yes
8	209	S227		yes	yes		H2O	no		yes
9	209	W294A		yes	yes		H2O	yes		yes
10	218	CC119		yes	yes		LITE H2O	yes		yes
11	219	EB155		yes	yes		CO2	yes		yes
12	219	EB161		yes	yes		LITE H2O	no		yes
13	219	EB165		yes	yes		H2O	yes		yes
14	219	EC187		yes	yes		H2O	yes		yes
15	230	D110D		yes	yes		CO2	yes		yes
16	230	D38A		yes	yes		CO2	yes		yes
17	230	S201A		yes	yes		CO2	yes		yes
18	230	S69A		yes	yes		CO2	no		yes
19	235	B280		no	yes		H2O	no		yes
20	235	D162C		yes	yes		LITE H2O	yes		yes
21	235	F64H		yes	yes		LITE H2O	yes		yes
22	236	144C		yes	yes		LITE H2O	yes		no
23	236	N04		yes	yes		LITE H2O	yes		yes
24	236	N104A		yes	yes		LITE H2O	no		yes
25	236	N-14		yes	yes		LITE H2O	yes		yes
26	236	N20		yes	yes		LITE H2O	yes		yes
27	236	N-30/38		yes	yes		LITE H2O	yes		yes
28	236	N30A		yes	yes		LITE H2O	yes		yes
29	236	S162		yes	yes		LITE H2O	yes		yes
30	236	S168C		yes	yes		LITE H2O	no		yes
31	240	124		yes	yes		LITE H2O	yes		no
32	250	E124		yes	yes		LITE H2O	yes		yes
33	250	E124.1		yes	yes		LITE H2O	yes		yes
34	250	E126.1		yes	yes		H2O	yes		yes
35	250	E316		yes	yes		LITE H2O	yes		yes
36	252	DB101B		yes	yes		H2O	no		yes
37	252	DB101C		yes	yes		LITE H2O	no		yes
38	252	DC110		yes	yes		LITE H2O	yes		yes
39	250	DB168		yes	yes		LITE H2O	yes		yes
40	260	A157		no	no		LITE H2O	no		no
41	260	A157B		no	no		LITE H2O	no		no
42	260	B177		yes	yes		H2O	no		yes
43	270	ND120		no	yes		LITE H2O	yes		yes
44	270	ND140		yes	yes		LITE H2O	yes		yes
45	270	ND150		yes	yes		LITE H2O	yes		yes
46	270	ND160		yes	yes		H2O	yes		yes
47	270	SC271		yes	yes		H2O	yes		yes
48	270	SC371		yes	yes		H2O	yes		yes
49	270	SC471		yes	yes		H2O	yes		yes
Number of Findings				4	2			13		5

Room Count	Building Number	Room Number	Explosion Relief	Blow out panels	Blow out panels tethered	Clearance for panel relief	Spill Containment	Spill containment- tanks, trenches curbed
1	201	N178		yes	yes	yes		yes
2	207	W178		yes	no	yes		yes
3	208	N102		yes	yes	yes		yes
4	208	WW113		no	n/a	n/a		no
5	209	N166B		yes	no	yes		yes
6	209	N244A		yes	yes	yes		yes
7	209	S127A		yes	yes	yes		yes
8	209	S227		yes	yes	yes		yes
9	209	W294A		yes	yes	yes		yes
10	218	CC119		yes	yes	yes		yes
11	219	EB155		yes	yes	no		yes
12	219	EB161		no	n/a	n/a		yes
13	219	EB165		yes	no	no		yes
14	219	EC187		no	n/a	no		yes
15	230	D110D		yes	yes	yes		yes
16	230	D38A		yes	no	yes		yes
17	230	S201A		yes	yes	yes		yes
18	230	S69A		yes	no	yes		yes
19	235	B280		yes	no	yes		yes
20	235	D162C		yes	yes	yes		yes
21	235	F64H		yes	no	no		yes
22	236	144C		yes	no	yes		yes
23	236	N04		yes	no	yes		yes
24	236	N104A		yes	yes	yes		yes
25	236	N-14		yes	yes	yes		yes
26	236	N20		yes	no	yes		yes
27	236	N-30/38		yes	yes	yes		yes
28	236	N30A		yes	yes	yes		yes
29	236	S162		yes	yes	yes		no
30	236	S168C		yes	yes	no		yes
31	240	124		yes	no	no		yes
32	250	E124		yes	yes	no		yes
33	250	E124.1		yes	yes	no		yes
34	250	E126.1		yes	yes	no		yes
35	250	E316		yes	yes	yes		yes
36	252	DB101B		yes	yes	no		yes
37	252	DB101C		yes	yes	no		yes
38	252	DC110		yes	yes	yes		yes
39	250	DB168		yes	no	no		yes
40	260	A157		yes	no	no		no
41	260	A157B		yes	no	no		no
42	260	B177		yes	yes	yes		yes
43	270	ND120		yes	yes	yes		no
44	270	ND140		yes	yes	yes		no
45	270	ND150		unk.	unk.	unk.		yes
46	270	ND160		yes	yes	yes		yes
47	270	SC271		yes	yes	yes		yes
48	270	SC371		yes	yes	yes		yes
49	270	SC471		yes	yes	yes		yes
Number of Findings				3	14	14		6

Room Count	Building Number	Room Number	Signage	Doors requiring signage	Hazard identification, NFPA diamond	Explosion relief panels signed	Spark restriction sign	Electrical classification sign	"Ventilation System Emergency Shutoff"	"Danger - Flammable Liquids"	"Danger - Unauthorized Personnel Keep Out"
1	201	N178		1	no	no	no	no	n/a	no	yes
2	207	W178		1	no	no	no	no	n/a	yes	no
3	208	N102		1	no	no	no	no	no	no	no
4	208	WW113		3	no	n/a	no	no	n/a	no	no
5	209	N166B		1	no	no	no	no	n/a	no	n/a
6	209	N244A		2	no	no	no	no	n/a	yes	n/a
7	209	S127A		2	yes	no	no	no	n/a	no	yes
8	209	S227		2	no	no	no	no	n/a	no	n/a
9	209	W294A		2	no	no	no	no	n/a	yes	n/a
10	218	CC119		4	no	no	no	yes	n/a	no	yes
11	219	EB155		4	no	no	no	yes	n/a	no	no
12	219	EB161		1	no	no	no	yes	n/a	no	n/a
13	219	EB165		2	no	no	no	no	n/a	no	yes
14	219	EC187		1	no	n/a	no	yes	n/a	no	yes
15	230	D110D		2	no	no	no	no	no	no	yes
16	230	D38A		2	no	no	yes	no	n/a	no	n/a
17	230	S201A		2	yes	no	no	no	n/a	no	n/a
18	230	S69A		2	no	no	no	no	no	yes	n/a
19	235	B280		2	no	no	no	no	n/a	yes	n/a
20	235	D162C		2	no	no	no	no	n/a	yes	n/a
21	235	F64H		1	no	no	no	no	n/a	no	yes
22	236	144C		2	no	no	no	no	n/a	no	yes
23	236	N04		2	no	no	no	no	no	no	yes
24	236	N104A		1	no	no	no	no	no	yes	yes
25	236	N-14		1	no	no	no	no	no	no	n/a
26	236	N20		4	no	no	no	no	no	no	no
27	236	N-30/38		2	no	no	no	no	no	no	yes
28	236	N30A		3	no	no	no	no	no	no	yes
29	236	S162		2	no	no	no	no	n/a	no	yes
30	236	S168C		1	no	no	no	no	n/a	no	n/a
31	240	124		2	no	no	no	no	n/a	no	n/a
32	250	E124		1	no	no	no	no	no	yes	n/a
33	250	E124.1		1	no	no	no	no	no	yes	no
34	250	E126.1		1	no	no	no	no	no	no	n/a
35	250	E316		2	no	no	no	no	no	yes	n/a
36	252	DB101B		1	no	no	no	no	no	no	n/a
37	252	DB101C		1	no	no	yes	no	no	no	n/a
38	252	DC110		2	yes	no	no	no	no	no	n/a
39	250	DB168		1	no	no	no	no	n/a	no	yes
40	260	A157		1	no	no	no	no	no	no	n/a
41	260	A157B		1	no	no	no	no	no	no	n/a
42	260	B177		2	no	no	no	no	n/a	no	no
43	270	ND120		1	no	no	no	no	n/a	no	n/a
44	270	ND140		1	no	no	no	no	n/a	no	n/a
45	270	ND150		1	no	no	no	no	n/a	no	n/a
46	270	ND160		1	no	no	no	no	n/a	yes	yes
47	270	SC271		1	no	no	no	no	n/a	no	n/a
48	270	SC371		1	no	no	no	no	n/a	no	n/a
49	270	SC471		1	no	no	no	no	n/a	no	n/a
Number of Findings				81	73	47	53	71	18	64	16

Room Count	Building Number	Room Number	Static Control	Shoe meter Available	Shoe log	Bonding/grounding devices available
1	201	N178		no	no	no
2	207	W178		no	no	no
3	208	N102		yes	yes	yes
4	208	WW113		yes	yes	yes
5	209	N166B		no	no	yes
6	209	N244A		no	no	yes
7	209	S127A		yes	yes	yes
8	209	S227		no	no	yes
9	209	W294A		no	no	yes
10	218	CC119		yes	yes	yes
11	219	EB155		yes	yes	yes
12	219	EB161		yes	yes	yes
13	219	EB165		no	no	no
14	219	EC187		yes	yes	yes
15	230	D110D		yes	no	yes
16	230	D38A		no	no	no
17	230	S201A		no	no	yes
18	230	S69A		no	no	no
19	235	B280		yes	no	yes
20	235	D162C		no	no	yes
21	235	F64H		yes	yes	no
22	236	144C		yes	yes	yes
23	236	N04		yes	yes	yes
24	236	N104A		yes	yes	yes
25	236	N-14		yes	yes	yes
26	236	N20		yes	yes	yes
27	236	N-30/38		yes	yes	no
28	236	N30A		yes	yes	yes
29	236	S162		yes	yes	yes
30	236	S168C		yes	no	yes
31	240	124		no	no	
32	250	E124		no	no	no
33	250	E124.1		no	no	yes
34	250	E126.1		no	no	no
35	250	E316		no	no	no
36	252	DB101B		no	no	no
37	252	DB101C		no	no	no
38	252	DC110		yes	yes	yes
39	250	DB168		no	no	no
40	260	A157		no	no	no
41	260	A157B		no	no	no
42	260	B177		yes	no	yes
43	270	ND120		yes	no	yes
44	270	ND140		yes	no	no
45	270	ND150		yes	no	no
46	270	ND160		yes	no	no
47	270	SC271		no	no	no
48	270	SC371		no	no	no
49	270	SC471		no	no	no
Number of Findings				13	15	6

Room Count	Building Number	Room Number	Construction	Approximate Square footage	Number of exits	Exterior exit door available	rooms larger than 500 square feet without exterior doo	Rooms larger than 200 ft^2 without at least 2 exits	Type of room
1	201	N178		800	2	yes			store
2	207	W178		200	1	no			store, disp
3	208	N102		1000	2	yes			store
4	208	WW113		40	3	no			disp
5	209	N166B		150	1	no			store, disp
6	209	N244A		400	2	no			store, disp
7	209	S127A		144	2	no			store, disp
8	209	S227		300	2	no			store, disp
9	209	W294A		400	2	no			store, disp
10	218	CC119		200	4	no			disp
11	219	EB155		3600	5	yes			disp, hand
12	219	EB161		1000	2	yes			store
13	219	EB165		500	3	yes			store
14	219	EC187		144	2	yes			store, disp
15	230	D110D		175	2	no			store, disp
16	230	D38A		525	2	no	1		store
17	230	S201A		215	2	no			store, disp
18	230	S69A		100	2	no			store, disp
19	235	B280		420	2	no			store
20	235	D162C		288	2	no			store
21	235	F64H		80	1	no			store, disp
22	236	144C		266	2	no			store
23	236	N04		3250	2	no	1		store, disp
24	236	N104A		500	2	yes			store
25	236	N-14		900	2	yes			store, disp, hand
26	236	N20		1200	4	no	1		store, disp, hand
27	236	N-30/38		800	3	yes			store
28	236	N30A		900	4	yes			store, disp, hand
29	236	S162		900	2	no	1		store, disp
30	236	S168C		100	1	no			store, disp
31	240	124		200	2	no			store, disp
32	250	E124		750	2	yes			store
33	250	E124.1		96	1	no			store, disp, hand
34	250	E126.1		175	1	no			store
35	250	E316		360	2	no			store, disp, hand
36	252	DB101B		1600	2	yes			store
37	252	DB101C		100	1	no			disp
38	252	DC110		250	2	no			store, disp
39	250	DB168		320	2	yes			store, disp
40	260	A157		150	1	no			store
41	260	A157B		150	1	no			disp
42	260	B177		2160	2	no	1		store, disp
43	270	ND120		1200	2	yes			store
44	270	ND140		600	2	yes			store
45	270	ND150		300	2	yes			store
46	270	ND160		170	1	no			store
47	270	SC271		150	1	no			store
48	270	SC371		150	1	no			store
49	270	SC471		150	1	no			store
Number of Findings							5	0	

Room Count	Building Number	Room Number	Security	Access secured against unauthorized entry	Ignition Control Measures	Require open-flame / spark hazard permit	Non-spark tools available
1	201	N178		yes		yes	yes
2	207	W178		yes		yes	no
3	208	N102		yes		yes	yes
4	208	WW113		yes		yes	yes
5	209	N166B		yes		yes	yes
6	209	N244A		yes		yes	no
7	209	S127A		yes		yes	yes
8	209	S227		yes		yes	yes
9	209	W294A		yes		yes	no
10	218	CC119		yes		yes	no
11	219	EB155		yes		yes	yes
12	219	EB161		yes		yes	yes
13	219	EB165		yes		yes	yes
14	219	EC187		yes		yes	yes
15	230	D110D		yes		yes	no
16	230	D38A		yes		yes	yes
17	230	S201A		yes		yes	yes
18	230	S69A		yes		yes	yes
19	235	B280		yes		yes	yes
20	235	D162C		yes		no	no
21	235	F64H		yes		yes	yes
22	236	144C		yes		yes	yes
23	236	N04		yes		yes	no
24	236	N104A		yes		yes	yes
25	236	N-14		yes		yes	yes
26	236	N20		yes		yes	yes
27	236	N-30/38		yes		yes	yes
28	236	N30A		yes		yes	yes
29	236	S162		yes		yes	yes
30	236	S168C		yes		yes	yes
31	240	124		yes		yes	no
32	250	E124		yes		yes	yes
33	250	E124.1		yes		yes	yes
34	250	E126.1		yes		yes	yes
35	250	E316		yes		yes	yes
36	252	DB101B		yes		yes	yes
37	252	DB101C		yes		yes	yes
38	252	DC110		yes		yes	yes
39	250	DB168		yes		yes	yes
40	260	A157		yes		no	no
41	260	A157B		yes		no	no
42	260	B177		yes		yes	yes
43	270	ND120		yes		yes	yes
44	270	ND140		yes		yes	no
45	270	ND150		yes		yes	no
46	270	ND160		yes		yes	yes
47	270	SC271		yes		yes	yes
48	270	SC371		yes		yes	yes
49	270	SC471		yes		yes	yes
Number of Findings				0		3	8

Room Count	Building Number	Room Number	Egress	One clear aisle of egress 3' wide maintained	Racks 4' apart	Good housekeeping	Eyewash /Emergency Showers	Eyewash stations per manual 80
1	201	N178		yes	yes	yes		yes
2	207	W178		yes	yes	yes		no
3	208	N102		yes	yes	yes		no
4	208	WW113		yes	yes	yes		yes
5	209	N166B		no	yes	yes		yes
6	209	N244A		yes	yes	n		yes
7	209	S127A		yes	no	yes		no
8	209	S227		yes	no	yes		yes
9	209	W294A		yes	yes	yes		yes
10	218	CC119		yes	yes	yes		yes
11	219	EB155		yes	yes	yes		yes
12	219	EB161		yes	yes	yes		yes
13	219	EB165		yes	yes	yes		yes
14	219	EC187		yes	yes	yes		yes
15	230	D110D		yes	yes	yes		no
16	230	D38A		yes	no	yes		no
17	230	S201A		yes	yes	yes		no
18	230	S69A		yes	yes	yes		no
19	235	B280		yes	no	no		yes
20	235	D162C		yes	yes	yes		yes
21	235	F64H		yes	no	yes		yes
22	236	144C		yes	yes	yes		yes
23	236	N04		yes	yes	yes		yes
24	236	N104A		yes	yes	yes		yes
25	236	N-14		yes	yes	yes		yes
26	236	N20		yes	yes	yes		yes
27	236	N-30/38		yes	yes	yes		yes
28	236	N30A		yes	yes	yes		yes
29	236	S162		yes	yes	yes		yes
30	236	S168C		yes	yes	yes		no
31	240	124		yes	yes	yes		no
32	250	E124		no	no	n		yes
33	250	E124.1		yes	yes	yes		yes
34	250	E126.1		no	no	yes		yes
35	250	E316		yes	no	yes		no
36	252	DB101B		yes	yes	yes		no
37	252	DB101C		yes	yes	yes		no
38	252	DC110		yes	yes	yes		yes
39	250	DB168		yes	yes	yes		yes
40	260	A157		no	no	no		yes
41	260	A157B		no	no	no		yes
42	260	B177		no	yes	no		yes
43	270	ND120		yes	yes	no		yes
44	270	ND140		yes	yes	yes		yes
45	270	ND150		yes	no	yes		yes
46	270	ND160		yes	no	yes		yes
47	270	SC271		yes	yes	yes		yes
48	270	SC371		yes	yes	no		yes
49	270	SC471		yes	yes	yes		yes
Number of Findings				6	12	6		12

Room Count	Building Number	Room Number	Miscellaneous	Containers over 30 gallons are not stacked	Holes in firewalls are firestopped	No Flammable Hazardous Waste
1	201	N178		yes	yes	no
2	207	W178		yes	no	yes
3	208	N102		yes	yes	no
4	208	WW113		yes	yes	yes
5	209	N166B		yes	yes	yes
6	209	N244A		yes	no	yes
7	209	S127A		yes	yes	no
8	209	S227		yes	no	yes
9	209	W294A		yes	yes	yes
10	218	CC119		yes	yes	no
11	219	EB155		yes	yes	no
12	219	EB161		yes	no	yes
13	219	EB165		yes	yes	yes
14	219	EC187		yes	no	no
15	230	D110D		yes	no	no
16	230	D38A		yes	yes	yes
17	230	S201A		yes	no	yes
18	230	S69A		yes	no	yes
19	235	B280		yes	no	yes
20	235	D162C		yes	no	yes
21	235	F64H		yes	yes	no
22	236	144C		yes	yes	no
23	236	N04		yes	yes	no
24	236	N104A		yes	yes	no
25	236	N-14		yes	yes	yes
26	236	N20		yes	yes	no
27	236	N-30/38		yes	yes	no
28	236	N30A		yes	yes	no
29	236	S162		yes	yes	no
30	236	S168C		yes	yes	yes
31	240	124		yes	yes	yes
32	250	E124		yes	yes	yes
33	250	E124.1		yes	yes	no
34	250	E126.1		yes	yes	yes
35	250	E316		yes	yes	yes
36	252	DB101B		yes	no	yes
37	252	DB101C		yes	no	yes
38	252	DC110		yes	no	yes
39	250	DB168		yes	yes	no
40	260	A157		yes	no	yes
41	260	A157B		yes	no	yes
42	260	B177		yes	yes	no
43	270	ND120		yes	yes	yes
44	270	ND140		yes	yes	yes
45	270	ND150		yes	unk.	yes
46	270	ND160		yes	no	no
47	270	SC271		yes	no	yes
48	270	SC371		yes	yes	yes
49	270	SC471		yes	no	yes
Number of Findings				0	18	19

Room Count	Building Number	Room Number	Other hazardous room conditions
1	201	N178	1. A 2'x3' vent entering the hallway is not to code.
2	207	W178	1. There are no grounding bar in this room.
3	208	N102	
4	208	WW113	
5	209	N166B	
6	209	N244A	
7	209	S127A	
8	209	S227	1. The roof leaks.
9	209	W294A	1. The blow out panels are tied down.
10	218	CC119	
11	219	EB155	
12	219	EB161	
13	219	EB165	
14	219	EC187	1. A plastic bag is covering the fire extinguisher.
15	230	D110D	1. The ventilation ON/OFF switch is bolted in the ON position.
16	230	D38A	1. A damper in the wall is broken, it is locked in the shut position.
17	230	S201A	1. A small crate is used as a step stool.
18	230	S69A	1. There are maps covering one of the doors entering this room.
19	235	B280	1. The speaker in the room may not be to code.
20	235	D162C	1. The room is used to store gas powered machines. 2. The blowout panels appear to be caulked shut.
21	235	F64H	1. The blowout panels are cemented shut. 2. There are no grounding wires connected to a grounding bar.
22	236	144C	
23	236	N04	
24	236	N104A	
25	236	N-14	
26	236	N20	
27	236	N-30/38	
28	236	N30A	1. The ventilation hood is misaligned over the mixer.
29	236	S162	1. The spill containment by one of the doors is covered up.
30	236	S168C	
31	240	124	1. There is exposed electrical wires. 2. The tape on the vent needs to be removed.
32	250	E124	
33	250	E124.1	
34	250	E126.1	
35	250	E316	1. There are no wires for grounding in this room.
36	252	DB101B	1. The exit light is out.
37	252	DB101C	1. The wrong clamps are being used for grounding.
38	252	DC110	1. The ventilation ON/OFF switch is secured with a bolt in the ON position
39	250	DB168	
40	260	A157	1. Sheet rock is attached to the blow out panels. 2. This room is under construction.
41	260	A157B	1. Sheet rock is attached to the blow out panels. 2. This room is under construction.
42	260	B177	1. The shoe meter is not working.
43	270	ND120	1. The pharmaceuticals area is full of trash. 2. One door lacks proper spill control.
44	270	ND140	
45	270	ND150	1. The room is used for general storage but still has flammable liquids in it.
46	270	ND160	1. Brackets affixed to the wall appear to have firewall penetrations behind them.
47	270	SC271	1. Cracks in the wall need to be firestopped.
48	270	SC371	
49	270	SC471	
Number of Findings			

Summary

In collecting the data from the assessments of the red label rooms at XYZ Corporation's research and development center, it has been determined that there are numerous deficiencies in these areas. In addition to all the deficiencies that were uncovered, the exact number and locations of all the flammable liquid storage/dispensing/handling rooms at XYZ Corporation has finally been determined.

Chapter 5

Introduction

In completing this study, it has been determined that XYZ Corporation possesses many deficiencies in their flammable liquid storage/handling/dispensing rooms. This was performed by examining all the pertinent codes, regulations and internal directives relating to flammable liquid storage/dispensing/handling rooms. As a result of this study, XYZ Corporation now has the knowledge of these shortcomings and this makes it possible to control them and thus reduce the chance of a loss

Discussion

A systematic and methodical search was conducted in order to locate and identify all the flammable liquid storage/handling/dispensing rooms at XYZ Corporation. In the fourteen buildings at the research and development facility total of 49 red label rooms were identify and documented. The room numbers for these rooms can be found in Chapter 4, page 41, and the number of rooms per building can be located on the next page in Table A.

Table A

Building Number	Number of Rooms
201	1
207	1
208	2
209	5
218	1
219	4
230	4
235	3
236	9
240	1
250	4
252	4
260	3
270	7

A checklist of evaluation criteria was created in order to conduct assessments of all 49 flammable liquid storage/dispensing/handling rooms at XYZ Corporations research and development center. The checklist that was utilized in accomplishing all of these assessments can be located in Chapter 3, pages 38 and 39. The development of this checklist implemented pertinent codes, regulations, and internal XYZ Corporations directives. This information gathered was then consolidated into 13 main areas of concern, which are:

- Electrical
- Fire Protection
- Ventilation
- Explosion Relief
- Spill Containment
- Signage
- Static Control

- Construction
- Security
- Ignition Control
- Egress
- Eyewash/Emergency Showers
- Miscellaneous

The assessments conducted identified the extent that the flammable liquid storage/dispensing/handling rooms, at XYZ Corporation, are in compliance with pertinent codes and regulations from a building design/construction standpoint. In examining the data collected from these rooms, it has been discovered that every one of the 49 red label rooms at XYZ Corporation's research and development facility was out of compliance in some manner or another. This study categorized the pertinent codes, regulation, and internal documents into thirteen broad areas of risk. Following are the conclusions, which can be drawn from the room assessments:

1. Rooms in which flammable liquids are stored or dispensed need to have the proper electrical equipment. This equipment includes explosion-proof boxes and panelboards, threaded rigid conduit, explosion proof lights, poured seal-off fittings, etc. Of the 49 red label rooms assessed, it has been determined that 2 of the rooms did not have the type of lighting and 4 of the rooms did not poses electrical wiring that was up to code. However, 96% of these rooms had the proper type of lighting in them and almost 92% of them had the proper electrical wiring

2. In red label rooms a fire protection system needs to be present. These fire protection systems are permanently installed in the room and when automatically tripped, they discharge water, foam, or carbon dioxide into the room. All the red label rooms at XYZ Corporation have fire protection systems that are up to code. In addition to the fire protection system, these areas are required to have at least one portable fire extinguisher located outside of, but not more than 10' from any door opening into a flammable liquid storage room. Thirteen of the rooms at this facility did not meet this requirement.
3. Every flammable liquid storage/dispensing/handling room needs to have an exhaust ventilation system which provides a minimum of 6 air changes per hour or 1 cfm/sq. ft., whichever is greater. In conducting the assessments of these rooms, it was discovered that over 10% of these rooms had ventilation systems that were not operational. All of the red label rooms did have the required backup/standby power that is required and the airflow was not blocked in such rooms by anything located in these areas.
4. Explosion relief shall be provided in accordance with applicable codes. It was discovered that 3 of the 49 rooms did not possess any deflagration relief, but since these three rooms limited the amounts of flammable liquids allowed in them, the applicable codes and regulations were not violated. It was also discovered that over 28% of the deflagration panels in the red label rooms where not tethered and the same amount of these rooms had obstructions within 50' from the exterior of their blow-out walls.

5. Flammable liquid storage, dispensing and handling rooms are required to be provided with a means of secondary containment to keep spilled products within the room. Of the 49 rooms assessed, 6 or these rooms did not have adequate spill containment. Four of these rooms had been built with adequate spill containment, but this was negated by attaching metal plates over the trenches and drains. This was done in order to prevent the possibility of a chemical cart's wheel becoming stuck in the openings of the grating covering the trenches and drains.
6. In assessing all of the red label rooms at XYZ Corporation's research and development facility, 100% of these rooms had incorrect signage on their entrances in reference to the pertinent codes, regulations, and internal documents. The only sign that was displayed accurately at all locations pertained to the rooms having carbon dioxide fire protection systems. Every one of these rooms had the correct signage warning about carbon dioxide room flooding in the event of a fire.
7. People entering flammable liquid dispensing and open handling rooms need to have a shoe conductivity meter available to them so they can test their shoes conductivity prior to entry. A sign-in log confirming successful testing needs to be kept adjacent to the tester. Over 25% of these rooms did not have a shoe meter or a sign-in log. The assessments have also reveled that 6 rooms do not possess the proper bonding and grounding equipment.
8. Flammable liquid storage, dispensing and handling rooms for Class I liquids shall not be located in a basement. At XYZ Corporation's research and development facility, none of the red label rooms are located in the basement of any building. The Corporation is also in compliance by not having any room in excess of 200

sq. ft. without at least two approved exit doors. However, it does have 5 rooms in excess of 500 sq. ft. without at least one exterior door approved for fire department access. It has also been determined that almost 37% of the red label rooms have holes in walls that need to be firestopped.

9. At the research and development center, XYZ Corporation has every one of the red label rooms secured against unauthorized access. This is performed by restricting access to these areas by providing badges to the personnel who need to enter such areas.
10. All spark and ignition sources need to be controlled in flammable liquid dispensing, handling and storage rooms and non-sparking tools are required in such locations. Of all of these rooms, eight of them did not have the proper non-sparking tools in them. In discussions with the Safety Coordinators in charge of these rooms, it was discovered that no system was in place to apply and then receive an Open-flame and Spark Hazard Permit in three of the red label rooms.
11. A requirement for red label rooms states that one clear aisle of egress a minimum of three feet wide must be maintained. In 6 of the 49 red label rooms assessed, this requirement was not met. Housekeeping was a problem in 12% of the red label rooms and in this group there were rooms that had miscellaneous combustibles, trip hazards, and unnecessary storage in them. The exit signs in one flammable liquid storage room were not operational because the light bulbs were burnt out.
12. Eyewash/emergency showers were not installed and maintained in almost 25% of the flammable liquid storage/dispensing/handling rooms. Of the affected rooms,

all of them had eyewash/emergency shower in their general area but not within the required travel distance/time of not greater than 50 feet or 10 seconds away.

13. Flammable liquids at XYZ Corporation were separated from incompatible materials, such as corrosives, and no containers over 30-gallon capacity were directly stacked upon one another or elevated within racks.

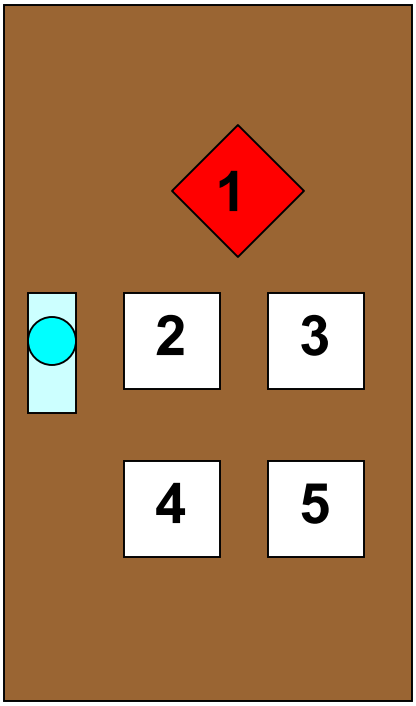
Recommendations for process improvement

This study turned up over 450 deficiencies in XYZ Corporations research and development facilities flammable liquid storage/handling/dispensing rooms. The corporation needs to correct these deficiencies to reduce the chance for loss. Of all of these deficiencies, the author of this paper believes that the deficiencies that pose the greatest chance of loss pertain to the ventilation systems. As stated earlier in this chapter, over 10% of the red label rooms did not have operational ventilation systems. Without the adequate air exchange, the possibility of flammable vapors existing above the LEL in these rooms is dramatically increased, thus making the chance of a loss substantial.

The biggest area of non-compliance pertained to the proper signage affiliated with red label rooms. XYZ Corporation should order the signage that is required in these locations and design a standardized method of displaying it on all the affected doors and locations. One possible solution is shown in figure 1.

Figure 1.

Signage display method for flammable liquid storage rooms



1. NFPA Diamond
2. Danger Flammable Liquids
3. Electrical Classification
4. Danger Unauthorized Personnel – Keep Out
5. Danger – Carbon Dioxide Room Flooding

Once XYZ Corporation has made the repairs on the non-operational ventilation systems and installed the correct signage, a systematic correction of all of the deficiencies should be conducted. The correction of the remaining deficiencies should be in the following order

1. Electrical
2. Fire Protection

3. Explosion Relief
4. Spill Containment
5. Static Control
6. Construction
7. Security
8. Ignition Control
9. Egress
10. Eyewash/Emergency Showers
11. Miscellaneous

This study provides a lot of raw information to XYZ Corporation, but not a means of tracking the information. A tool could be developed in order to track the progress of the corrective actions needed in each on of these rooms. This tool along with this study could be incorporated in Manual A and be referenced to in the future in order to reassess red label rooms.

Recommendations for further study

Because of the size of this project, an in-depth study of all the different facets of flammable liquid storage rooms could not be accomplished. In the future, many different studies could be developed or grow out from this study. Two recommendations for further study/research are:

1. This study did not pay much attention to the types and amounts of flammable liquids in each red label room. Limitations on the amounts the different classes of flammable liquids allowed in rooms of a certain size exist.

2. This study did not examine any work practices in flammable liquid storage/dispensing/handling rooms. XYX Corporation may want to conduct a study of these practices in order to ascertain the level of safety exhibited by their employees who work in these locations

Conclusion

Prior to this study, the flammable liquid storage/dispensing/handling rooms at XYZ Corporation's research and development facility had never been assessed, nor had the exact number of rooms or their location been recorded. In order to accomplish this, a comprehensive study of pertinent codes, regulations, and internal XYZ Corporation directives was conducted. This study provided the background to create a checklist of regulatory criteria that was used during the assessments of the red label rooms. In order to ascertain the exact location and number of red label rooms, a methodical search was performed in the 14 buildings at the facility, which contain labs. In the conduction in the assessment of 49 flammable liquid storage/dispensing/handling rooms at XYZ Corporation's research and development facility, 497 findings were discovered.

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