

PROTECTION AGAINST LIQUID DAMAGE

Table of Contents

	Page
1.0 SCOPE	2
1.1 Hazards	2
1.2 Changes	2
2.0 LOSS PREVENTION RECOMMENDATIONS	2
2.1 Construction and Location	2
2.2 Occupancy	4
2.3 Protection	4
2.4 Operation and Maintenance	6
2.5 Emergency Response	7
3.0 SUPPORT FOR RECOMMENDATIONS	8
3.1 Preplanning	9
3.2 Leak Detection and Monitoring Devices	9
4.0 REFERENCES	9
4.1 FM Global	9
APPENDIX A GLOSSARY OF TERMS	10
APPENDIX B DOCUMENT REVISION HISTORY	10
APPENDIX C PLUMBING AND MECHANICAL BLUEPRINT SYMBOLS	10

List of Figures

Fig. 2.1.1-1. MRI machine	3
Fig. 2.3-1. Leak detection under equipment	5
Fig. 2.5.2-1. Emergency Response Team Assignments	7
Fig. 2.5.3-1. Contractors and Vendors List	7
Fig. 2.5.12-1. Restoration Activity List	8

1.0 SCOPE

This data sheet provides recommendations for the prevention and mitigation of losses associated with liquid release and subsequent damage which may originate from multiple sources such as domestic waterlines and systems, drains, sewage systems, cooling and heating piping, fire protection systems, and leaky roofs and windows. This data sheet does not address flooding and storm water runoff. Refer to FM Global Loss Prevention Data Sheet 1-40, *Flood*, for information on flood assessment, prevention, and mitigation. This data sheet does not address requirements for storage or drainage of ignitable liquids, refer to FM Global Loss Prevention Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*, and Data Sheet 7-83, *Drainage Systems for Ignitable Liquids*.

1.1 Hazards

Liquid leakage can cause severe damage at locations with finished interiors such as healthcare and **education facilities**, offices, hotels, apartments, condominiums, shopping centers, and retail stores. Escaped liquids can cause considerable harm to stored raw or finished goods as well as equipment malfunction and impairment. Healthcare and education facilities with high-value medical and laboratory equipment and devices are especially susceptible to liquid damage. In all types of facilities with drywall, floor coverings, ceiling tiles, insulation, cabinetry, elevators and computer equipment, liquid damage can cause business interruption while affected areas are shut down for renovations and critical equipment is repaired or replaced.

Multiple story buildings add a level of complexity because escaped liquids often flow down to lower building levels. Basements are particularly susceptible.

Liquid damage exposure is the most frequent cause of property loss in the above-named facilities, especially in healthcare and education facilities.

1.2 Changes

April 2020. Interim revision. The following changes were made:

- A. Highlighted the need to quickly discover and stop a liquid leak in order to minimize damage and the impact on normal operations.
- B. Revised several recommendations to address the need to recommend FM Approved equipment for leak detection and backflow devices.
- C. Added new recommendations to address temperature monitoring of key spaces and providing heat to those areas with low temperature alerts.
- D. Added new recommendation to address protection of dish washing and clothes washing machines.
- E. Added new recommendation to address hot water tanks in occupancies with frequent losses.
- F. Revised liquid cart recommendation include equipping the cart with an acoustic leak listening device.
- G. Revised recommendation 2.3.1 to include specific areas where leak detection and monitoring is recommended.
- H. Revised the recommendation of valve labeling to include chilled water and steam.
- I. Revised the recommendation for the availability of drawings to include plumbing riser diagrams.

2.0 LOSS PREVENTION RECOMMENDATIONS

There are several factors to **consider** when assessing potential liquid damage risk at a non-manufacturing or non-storage facility. These factors include but are not limited to environment/building envelope, critical room exposure, presence of detection/protection devices, emergency response, inspection, testing and maintenance of equipment and piping.

2.1 Construction and Location

2.1.1 Do not construct or locate critical rooms below grade or in basements. Critical rooms include the following:

- Telephone and data transmission rooms

- Electrical and alarm system rooms
- Data rooms containing mainframes and servers
- Rooms containing high-value items such as **research freezers, MRI machines, CT scan machines, ultrasound equipment, medical device/implant storage, and other items with high operational impact.** (See Figure 2.1.1-1.)
- Diagnostic equipment rooms
- Pharmacy
- Sterile environments and clean rooms
- Medical records



Fig. 2.1.1-1. MRI machine

2.1.2 Provide adequate heating and weather sealing to prevent cold air penetration via doors, windows, and other unsealed gaps, especially in out-of-the-way areas susceptible to freezing, such as stairwells, above ceilings, and other concealed spaces, particularly for areas that have exterior walls. For more detailed recommendations, refer to Data Sheet 9-18/17-18, *Prevention of Freeze-Ups*.

2.1.3 Do not place high-value equipment or critical rooms directly below floors and occupancies in which liquid spills may occur, such as residential area bathrooms, kitchens, and other domestic water sources, cafeterias, restrooms, and mechanical rooms.

2.1.4 Route steam lines around rooms with critical equipment.

2.1.5 Route domestic and chilled waterlines around rooms with critical equipment.

2.1.6 Do not locate roof drain piping above or through rooms containing high-value equipment or contents designated as critical.

2.1.7 Seal perimeter walls and ceilings of critical rooms to reduce the likelihood of spills or leaks in adjacent areas from entering. Use water-resistant materials for the first 1 ft (0.3 m) of the wall and seal the wall and floor intersection with a water-resistant material. Seal pipe, electrical, and other penetrations through walls and ceilings to prevent water and liquid intrusion; use FM Approved fire-resistant and water-tight materials. Refer to Data Sheet 1-3, *High-Rise Buildings*.

2.1.8 Use FM Approved roofing systems designed for local wind speeds and hail exposure. Refer to Data Sheets 1-28, *Wind Design*; 1-29, *Roof Deck Securement and Above-Deck Roof Components*; and 1-34, *Hail Damage*, for design criteria.

2.1.9 Conduct wind uplift tests on newly adhered roofing systems after installation to ensure proper installation. Test procedures are outlined in Data Sheet 1-52, *Field Verification of Roof Uplift Resistance*.

2.1.10 Size roof drains for local maximum rainfall intensity and provide secondary emergency drainage. Refer to Data Sheet 1-54, *Roof Loads for New Construction*, for design criteria.

2.1.11 Equip fire protection systems, including piping, fire pumps, and pump controllers, in recognized seismic areas to meet earthquake protection requirements per Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*.

2.1.12 Install **FM Approved** backflow prevention where the potential for backflow flooding into buildings exists via sewer lines where urban street flooding **occurs** and street runoff is routed to **combined** sanitary sewers.

2.1.13 Design the site to direct rainwater, roof drainage, and storm water drainage away buildings. Refer to Data Sheet 1-40 *Flood*, for design criteria.

2.1.14 Provide exterior doors and windows with seals or **weather stripping to prevent rain or snow from entering the building**.

2.2 Occupancy

2.2.1 Arrange domestic and chilled water lines during new construction or renovations as follows:

- A. In rooms containing high-value **or** critical equipment, use piping systems that have been welded, brazed, or soldered. Do not use threaded, flanged, gasketed, or compression fittings.
- B. Provide each floor with a common supply line with a well-marked, easily accessible shutoff valve. Avoid multiple interconnections. Use polytetrafluoroethylene (PTFE) lined quarter-turn valves for floor shutoffs.
- C. Do not create connections of dissimilar metals.

2.2.2 Where items particularly susceptible to liquid damage are already located in basement areas of existing buildings, do **one** of the following:

- A. Remove stock from the below-grade area.
- B. Raise stock above the anticipated water level.

Where practical, provide racks, skids, or pallets at least 4 in. (100 mm) high for storage of valuable stock or equipment susceptible to **liquid** damage, particularly those that would topple or collapse if wet by a few inches of **liquid**.

2.2.3 In upper stories, flash building walls to floors. Keep storage racks at least 4 to 6 in. (100 to 150 mm) away from building walls. If a metal screen or similar device is attached to the back of the racks to prevent storage from being pushed against the wall, the distance may be reduced to 2 in. (50 mm).

2.2.4 Provide a liquid damage control cart near critical rooms and stock it with emergency pipe repair supplies, **an acoustic leak listening device to help identify exactly where the leak is located**, and equipment to contain and dry-up escaped liquid.

2.2.5 In residential buildings or facilities such as hotels, hospitals, and dormitories where occupants are not necessarily familiar with the operation of automatic sprinklers, provide labeling to indicate a warning to avoid contact with sprinklers.

2.2.6 Locate main emergency power equipment and associated electrical equipment outside areas susceptible to **liquid** damage.

2.3 Protection

2.3.1 Provide **FM Approved** leak detection with monitoring that alarms to a constantly attended location for the following:

- A. High-value equipment areas, **including the following**:
 - **Telephone and data transmission rooms**
 - **Electrical and alarm system rooms**

- Rooms containing high-value items such as research freezers, MRI machines, CT scan machines, ultrasound equipment, medical device/implant storage, and other items with high operational impact (see Figure 2.1.1-1)
- Diagnostic equipment rooms
- Pharmacy
- Sterile environments

B. Under raised floors of **data centers, computer rooms and mainframes and servers**. Refer to Data Sheet 5-32, *Data Centers and Related Facilities*.

C. Critical rooms (those needed for continued business operation), located in below-grade areas with liquid piping running through them.(See Figure 2.3-1.)

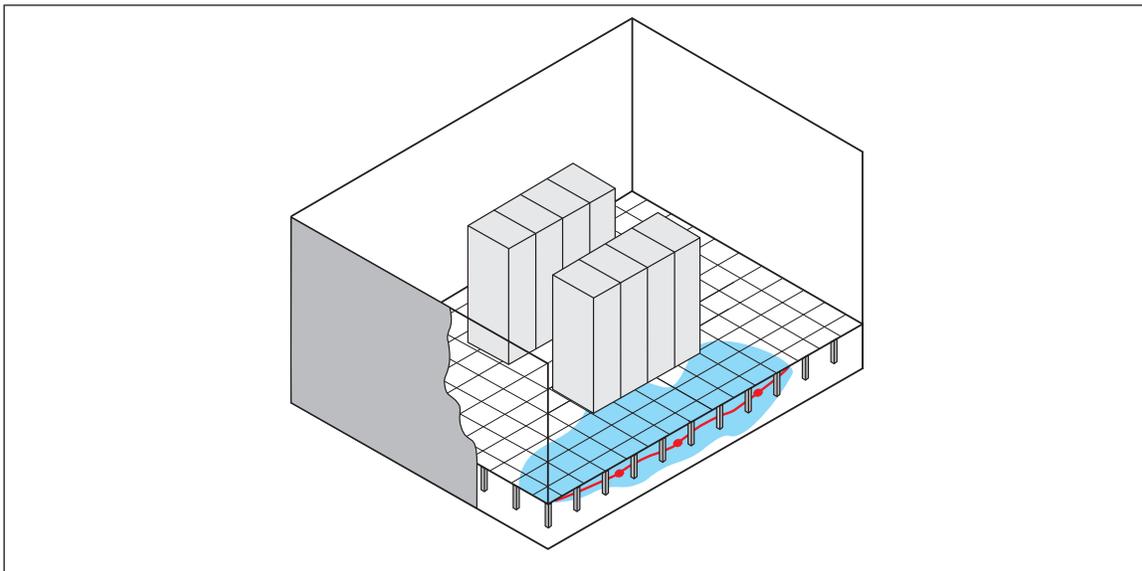


Fig. 2.3-1. Leak detection under equipment

2.3.2 Provide **FM Approved** leak detection with **monitoring** that alarms to a constantly attended location for areas where domestic water and fire protection services enter the building and are adjacent to or above critical areas. Provide a method to collect the water, such as curbing or trenches, to ensure the leak detection device will activate promptly.

2.3.3 In geographic areas subject to freezing temperatures, provide temperature monitoring of attic spaces, concealed spaces, stairwells, and vestibules that contain water and liquid lines, including fire sprinkler lines. Arrange for signals to be sent to a monitoring station or constantly attended location when temperatures fall below 40°F (4°C).

2.3.4 Where domestic and chilled waterlines are directly above high-value equipment, provide lines with secondary containment, such as concentric piping. Arrange secondary containment to drain to a safe location and provide **FM Approved** leak detection with **monitoring** at the draining point.

2.3.5 Provide **FM Approved** sump pumps near points of water ingress or collection (i.e., low points or around open floor drains near backflow prevention valves). Use pumps that are minimum 50 gpm (189 L/m) and connected to an appropriately sized power supply with a connection to emergency power. Provide high water-level alarms monitored at a constantly attended location.

2.3.6 Air test new sprinkler systems in critical rooms and areas containing high-value equipment at low pressure prior to hydrostatic testing.

2.3.7 Provide dishwashing and clothes washing machines with braided stainless steel fill hoses and collection pans that drain to a safe location. Provide units located in apartments, condominiums, hotels, and offices with **FM Approved** leak detection monitored at a constantly attended location.

2.3.8 Provide hot water heaters with water collection pans that drain to a safe location. In residential apartments, condominium units, hotels, and offices, provide FM Approved leak detection with monitoring.

2.4 Operation and Maintenance

Adopt a robust preventive maintenance program to minimize liquid damage exposure and help prevent long-term shutdown to a facility.

2.4.1 Shut down and remove dead-ended, unused, but charged waterline piping when doing renovations.

2.4.2 Inspect the exterior seals of window frames, sliding doors, and HVAC units **annually**, and repair deteriorated seals.

2.4.3 Inspect roofing systems quarterly **and after hailstorms, windstorms, and other severe weather events**. The inspection should look for the following:

- Roof drains free and clear of debris
- Roof covering and seams in good condition
- Loose debris and materials that could cause roof damage (screws and nails) or that could obstruct roof drains removed
- Flashing properly attached
- Mechanical equipment securely fastened
- **Skylights, roof hatches, and vents are in good condition**

2.4.4 Inspect the liquid damage control cart quarterly and ensure supplies are replenished.

2.4.5 Clean main sewer lines using a pressurized water system **quarterly** if there is a history of clogged main sewer lines.

2.4.6 Test sump pumps quarterly.

2.4.7 Check the condition of water heaters quarterly.

2.4.8 Check water pumps for excessive vibration **quarterly**.

2.4.9 Test leak detection, flow alarms, **and monitoring** quarterly.

2.4.10 If connections of dissimilar metals cannot be avoided/removed, develop a list of their locations and inspect them for signs of corrosion quarterly.

2.4.11 Inspect HVAC condensate drains monthly.

2.4.12 Visually inspect and clear inlets and catch basins if storm drains are present **monthly**.

2.4.13 Ahead of freezing temperatures, winterize the facility as follows:

- A. Ensure the heating systems are maintained and working.
- B. Confirm appropriate heat is provided for sprinkler, chilled, and domestic water systems. Consider the following areas:
 1. Tops and bottoms of stairwells where exterior doors are present
 2. Atriums and porticos (especially above suspended ceilings)
 3. Near loading dock doors
 4. Near large air intakes or exhaust ports
 5. Diesel generator rooms
 6. Fire pump and sprinkler riser rooms
 7. Trailers and temporary housing/office structures
 8. Penthouses
- C. Inspect and confirm good condition of non-freeze and dry-pipe sprinkler systems:
 1. **Drain all low points.**
 2. **Verify adequate air pressure is being maintained.**
 3. **Verify adequate antifreeze charge in non-freeze systems.**

2.4.14 Inspect and exercise domestic and chilled water control valves **annually** to verify good working order of the valves.

2.5 Emergency Response

Effective loss prevention measures to minimize **liquid** leakage and subsequent damage include establishing and maintaining an emergency response plan that outlines actions to be taken during and after a water damage event occurs. With proper planning, both property damage and business interruption may be reduced following a liquid damage loss.

2.5.1 Develop and maintain a response plan for **liquid** leakage exposure and include the following components:

- Pre-planning
- Mitigation
- Recovery

2.5.2 Include in the response plan the names of individuals (and alternates) who are responsible for designated activities as well as having the authority to activate, implement, revise, and enforce the response plan for each shift of operation. See Table 2.5.2-1 for an example of emergency response assignment designations.

Fig. 2.5.2-1. Emergency Response Team Assignments

Role	Employee	Office phone number	Mobile number	Home phone number
Team leader/facilities				
Alternate leader/ manager				
Response coordinator or building engineer				
Alternate response				
Maintenance personnel				
Security				
Insurance claims coordinator				

2.5.3 Identify and establish written contracts with key vendors and contractors able to provide critical backup equipment, emergency power, or cleanup services during or after a water damage event (see Table 2.5.3-1). Consider their response time, geographical location, and staffing.

Fig. 2.5.3-1. Contractors and Vendors List

Contractors/Vendors	Phone Number	Website or Email

2.5.4 Identify and label all domestic water, **chilled water services, steam** and fire protection system valves within a building and by floor. These should include the following:

- Main building valves
- Main valves for each floor
- Control valves for critical areas

Keep a list of these valves in the facilities, engineering, maintenance, and/or security offices. **The valve list should contain a valve number, description of the valve (size and type), description of where the valve is located, the area the valve services and shutoff instructions.**

2.5.5 Label supply lines for chilled water services indicating the direction of water flow.

2.5.6 Obtain a **plumbing riser diagram** or develop simplified drawings of all domestic, chilled, steam, and fire protection water systems that show layout of the pipes, pumps, and controlling valves. Keep copies of these drawings in accessible areas such as the engineering, facilities, and/or security offices of the building.

2.5.7 Lock all fire protection valves in the open position to prevent unauthorized tampering. Maintain strict key control so only authorized and trained personnel can impair fire protection in case of a leak.

2.5.8 Instruct designated personnel to immediately contact the fire service upon activation of a waterflow alarm on a fire protection system, and then investigate the area. If there is no fire and the water leakage involves the fire protection system, use the FM Global Red Tag Permit System to manage the impairment.

2.5.9 Instruct personnel to close the shut-off valve to a leaking or burst pipe upon activation of a waterflow alarm on a domestic water system or from a leak detection device.

2.5.10 Instruct personnel to investigate and provide additional heat to the area upon activation of a low-temperature alarm.

2.5.11 For leaks involving the building structure (e.g., roof drains, windows), take immediate steps to divert the water, contain the spillage, and block additional water from entering the building. Make temporary repairs to minimize water damage to the affected area. Once the leak has been isolated and stopped, initiate cleanup and restoration activities.

2.5.12 To facilitate prompt salvage and restoration of operations, prioritize the following restoration activities (see Table 2.5.3-1):

- A. Contact the list of contractors and vendors necessary for cleanup and restoration of the site.
- B. Identify any damaged building equipment that will require replacement for needed building or area operation, such as electrical, HVAC, plumbing, etc.
- C. Initiate **liquid** removal using pumps, wet vacuums, squeegees, etc.
- D. Initiate de-humidification equipment and fans to reduce the possibility of mold growth.
- E. Implement a contingency plan for extensively damaged areas that may require relocation of operations, and document procedures on how production will be made up at other facilities.
- F. Remove wallboard or provide access panels to facilitate air movement within gypsum board, plaster, or wooden walls.
- G. Initiate drying, cleaning, and application of rust-preventive coatings to mechanical and electrical equipment.
- H. Relocate salvageable and undamaged stock and supplies to a safe area.

Fig. 2.5.12-1. Restoration Activity List

<i>Building and Equipment</i>	<i>Restoration Activity</i>

2.5.13 Review and practice the emergency response plan annually. In addition, review the plan after an event to identify areas for improvement.

3.0 SUPPORT FOR RECOMMENDATIONS

Efforts for loss prevention and mitigation of a liquid damage loss vary depending on the occupancy of the building or facility. For non-manufacturing and nonstorage facilities **such as healthcare and education facilities, offices, hotels, apartment/condominiums, shopping centers and retail stores**, and data centers, the focus should be on critical rooms that contain diagnostic equipment, pharmacies, research laboratories, highly sensitive operating equipment and building finishes (ceilings, floors, walls). For manufacturing and warehousing facilities, the focus should be on high-value contents, raw or finished storage, machinery or equipment with motors, and electronics susceptible to **liquid** damage. The key is to quickly dry out the building once leaks have stopped and promptly start repairs.

3.1 Preplanning

Actions taken before a liquid damage event happens can significantly reduce the magnitude of the property damage and minimize business interruption, especially in healthcare facilities. For quick response to a leak, keeping a mobile **liquid damage** cart in multiple locations of your facility can be useful during the first hours of an event. Below is a sample list of tools and materials to have on hand to absorb and/or contain spills:

- Plastic tarps
- **Acoustic leak listening device**
- Wet/dry vacuums
- Portable sump pumps and hoses
- Dehumidifiers
- Fans
- Pipe leak diverters
- Containment socks, flood sacks
- Latex gloves
- Caution tape
- Duct tape
- Facemasks
- Safety glasses
- Hose clamps
- Buckets
- Sponges, squeegees

3.2 Leak Detection and Monitoring Devices

Leak detection and monitoring devices are becoming more affordable. Smart devices are now able to learn normal characteristics and respond to unusual conditions. Detection can come in the form of monitoring flow or pressure in pipe, or detecting liquids on the floor using floor pads, wire grids, or pods.

The type and placement of the devices should be based on how to most efficiently and reliably detect a leak before significant damage occurs. For example, areas with high-value equipment may be effectively protected with leak devices installed on the floor adjacent to piping or equipment that could leak or at low spots. On the other hand, residential or retail locations may be more effectively covered by devices that monitor for unusual flow conditions while supplemented by use of floor-mounted devices. Using multiple flow or pressure devices will help identify the area of the leak and thus reduce the amount of time to find it.

4.0 REFERENCES

4.1 FM Global

Data Sheet 1-3, High-Rise Buildings

Data Sheet 1-40, Flood

Data Sheet 1-34, Hail Damage

Data Sheet 1-28, Wind Design

Data Sheet 1-29, Roof Deck Securement and Above Deck Roof Components

Data Sheet 1-52, Field Verification of Roof Uplift Resistance

Data Sheet 1-54, Roof Loads for New Construction

Data Sheet 2-8, Earthquake Protection for Water-Based Fire Protection Systems

Data Sheet 5-32, Data Centers and Related Facilities

Data Sheet 6-20, Space Heaters

Data Sheet 7-29, Ignitable Liquid Storage in Portable Containers

Data Sheet 7-83, Drainage Systems for Ignitable Liquids

Data Sheet 9-0/17-0, Asset Integrity

Data Sheet 9-18/17-18, Prevention of Freeze-Ups

Liquid Damage - Guidelines for Healthcare and Education Facilities (P14004)

Liquid Damage - Guidelines for Commercial Properties (W151500)

Protecting Your Facilities from Winter Storms (P0101)

Freeze-up Checklist (P9521)

Understanding the Hazard: Water Leakage (P10086)

Understanding the Hazard: Freeze (P0148)

Understanding the Hazard: Idle, Vacant, or Strikebound Facilities (P0274)

FM Global online water damage resources:

www.fmglobal.com/research-and-resources/tools-and-resources/water-damage-resource

<https://web.fmglobal.myriskmanagement.com/LiquidDamage>

APPENDIX A GLOSSARY OF TERMS

FM Approved: Products and services that have satisfied the criteria for FM Approval. See the *Approval Guide*, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

April 2020. Interim revision. The following changes were made:

- A. Highlighted the need to quickly discover and stop a liquid leak in order to minimize damage and the impact on normal operations.
- B. Revised several recommendations to address the need to recommend FM Approved equipment for leak detection and backflow devices.
- C. Added new recommendations to address temperature monitoring of key spaces and providing heat to those areas with low temperature alerts.
- D. Added new recommendation to address protection of dish washing and clothes washing machines.
- E. Added new recommendation to address hot water tanks in occupancies with frequent losses.
- F. Revised liquid cart recommendation include equipping the cart with an acoustic leak listening device.
- G. Revised recommendation 2.3.1 to include specific areas where leak detection and monitoring is recommended.
- H. Revised the recommendation of valve labeling to include chilled water and steam.
- I. Revised the recommendation for the availability of drawings to include plumbing riser diagrams.

April 2018. This document has been completely revised. Major changes include the following:

- A. Moved all guidance related to ignitable liquids to Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*, and Data Sheet 7-83, *Drainage Systems for Ignitable Liquids*.
- B. Expanded recommendations related to the prevention and mitigation of liquid damage losses.

April 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

June 2009. Editorial changes were made for this revision.

July 1999. This revision of the document has been reorganized to provide a consistent format.

May 1998, Reformatted

Sept. 1997 Data Sheet 1-24 is a revision of Handbook Chapter 9.

APPENDIX C PLUMBING AND MECHANICAL BLUEPRINT SYMBOLS

Common plumbing and mechanical symbols used in blueprints are provided in this appendix.

Plumbing and Mechanical Blueprint Symbols															
LINES, RISERS, LINECODES & DESIGNATORS															
LINES		RISERS		PLUMBING RISERS & LINES SYMBOLS				PLUMBING LINECODES SYMBOLS				MECHANICAL LINECODES SYMBOLS		CONTROL SYMBOLS - LINES & LINE DESIGNATORS	
NAME	ABBV	NAME	ABBV	NAME	ABBV	NAME	ABBV	NAME	ABBV	NAME	ABBV	NAME	ABBV	NAME	ABBV
	BHS		BHS		BHS	Branch and Heat Soil Riser			MU		MU	MU	MU	Makeup Water	
	CHWR		CHWR		CHWR	Chilled Water Return			MG		MG	MG	MG	Medium Pressure Gas	
	CHWS		CHWS		CHWS	Chilled Water Supply			MPR		MPR	MPR	MPR	Medium Pressure Gravity Return	
	CW		CW		CW	Cold Water			RWL		RWL	RWL	RWL	Rain Water Leader	
	CWR		CWR		CWR	Cold Water Return			R		R	R	R	Reduction (usually pump)	
	CWV		CWV		CWV	Combustion Waste and Vent			SAN SW SS		SAN SW SS	SAN SW SS	SAN SW SS	Sanitary Sewer	
	A		A		A	Compressed Air			SHW		SHW	SHW	SHW	Sanitary Hot Water Supply	
	CD		CD		CD	Condensate Drain			SP FLD LCH LN		SP FLD LCH LN	SP FLD LCH LN	SP FLD LCH LN	Septic Flush Latch Line	
	CWR		CWR		CWR	Condensate Water Return			SW TL		SW TL	SW TL	SW TL	Sewer, Combined	
	CWS		CWS		CWS	Condensate Water Supply			SW TL		SW TL	SW TL	SW TL	Sewer, Tile	
	D		D		D	Drain (Indirect/Backflow Drain)			CSI		CSI	CSI	CSI	Sewer (Cold Iron)	
	DWS		DWS		DWS	Drinking Water Supply			SCT		SCT	SCT	SCT	Sewer (City/Tie Back/Special)	
	DSP		DSP		DSP	Dry Standpipe			SW		SW	SW	SW	Softened Water	
	F		F		F	Fine Line			SWLA		SWLA	SWLA	SWLA	Soil Waste or Leader (above grade)	
	G		G		G	Gas			SWLB		SWLB	SWLB	Soil Waste or Leader (below grade)		
	G LN		G LN		G LN	Gas Line			SD		SD	SD	SD	Storm Drain	
	HG		HG		HG	High Pressure Gas			S		S	S	S	Storm or roof leader	
	HPR		HPR		HPR	High Pressure Gravity Return			TS		TS	TS	TS	Tempered Water Supply	
	HWS		HWS		HWS	Hot Water Supply			V		V	V	V	Vacuum	
	HWR		HWR		HWR	Hot Water Return			VC		VC	VC	VC	Vacuum Cleaning	
	IW		IW		IW	Indirect Waste			V		V	V	V	Vent	
	LPG		LPG		LPG	Low Pressure Gas			VL		VL	VL	VL	Vent Line	
	LPR		LPR		LPR	Low Pressure Gravity Return			WL		WL	WL	WL	Waste Line	
	S		S		S	Main Supplies Spillkins			W		W	W	W	Water Line	
	WSP		WSP		WSP	Wet Standpipe			WT LN		WT LN	WT LN	WT LN	Water Line	
	NAME		NAME		NAME	NAME			NAME		NAME	NAME	NAME	NAME	
	NAME S		NAME S		NAME S	NAME S			NAME R		NAME R	NAME R	NAME R	NAME R	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME E		NAME E	NAME E	NAME E	NAME E	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)			NAME (DETAIL)		NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	NAME (DETAIL)	
	NAME (DETAIL)		NAME (DETAIL)												

