

Fire Prevention and Protection

Contents

Subject	Page
1. General	2
1.1 Purpose	2
1.2 Filing Instructions and Supersedures	2
1.3 Reason for Reissuing	2
1.4 Responsibility	2
1.5 Disclaimer	2
2. Overview	3
2.1 Introduction	3
2.2 Definitions	3
2.3 References	9
2.4 Major Organizations	12
2.5 Life Safety	15
2.6 GTE's Fire Protection Philosophy	17
2.6-1 Human Element	17
2.7 Procedures	18
2.7.1 Halon Removal at Sites Equal to \$5 - \$15 Million Property Value	18
2.7.2 Halon 1301 Discharge (Accidental or Intentional)	19
2.7.3 Water Mist	19
2.8. Factory Mutual Plan Reviews	19
2.9 Water Sprinkler Systems	22
2.9.1 Used When Leasing a Space Greater than 20,000 Square Feet	22
2.9.2 Widely Used as a Reliable Means of Fire Protection	22
2.10 Automatic Detection Systems	23
3. Central Offices Toll Centers, and Remote Equipment Sites and Other Locations..	24
3.1 Introduction	24
3.2 Fire Detection Application	24
3.3 Communication Equipment Areas	24
3.4 Noncommunication Equipment Areas	24
3.5 Panel Zoning	25
3.5.1 Indicating Lamp Control Detection Equipment	25
3.5.2 Air Sampling Detection Equipment	25
3.6 Fire Detection/Suppression Alarm Monitoring	25
3.6.1 Network and Critical Nonnetwork Buildings	25
3.6.2 Nonnetwork Buildings	25
3.7 Other Locations	26
3.8 Location Protection	26
4. Garages and Repair Facilities	32
4.1 introduction	32
4.2 Application	32
5. Warehouses	33
5.1 introduction	33
5.2 Application	33
6. Hydraulic Fluids	35
6.1 Hydraulic Fluids	35

1.1 This practice provides the following for GTE properties:

Purpose

- Building life safety guidelines.
- GTE fire prevention and protection philosophy.
- Loss prevention considerations.

NOTE: **In all cases, local building codes take precedence over the general requirements outlined in this practice.**

**1.2
Filing
Instructions
and
Supersedures**

Discard all previous issues and associated addenda of this practice and file this issue numerically in your GTE Telephone Operations practices set.

This practice supersedes and cancels:

- All policies, procedures, general instructions, letters, and memoranda which address this subject.
- Any document which provides information contrary to the information contained in this practice.

**1.3
Reason for
Reissuing**

This practice has been reissued to incorporate multiple changes in the content. Read this entire practice to ensure your familiarity with the new information.

**1.4
Responsibility**

This practice was published by the GTE Telephone Operations Administrative Services Department. For more information about this practice, contact headquarters Support Assets Real Estate and Building Standards Department.

**1.5
Disclaimer**

This practice was prepared solely for the use of GTE Telephone Operations. It must be used only by its employees, contractors, customers, and end users when installing, operating, maintaining, and repairing GTE Telephone Operations' equipment, facilities and services. Any other use of this practice is forbidden. The information contained in this practice may not be applicable in all circumstances and is subject to change without notice. By using this practice the user agrees that GTE Telephone Operations will have no liability (to the extent permitted by applicable law) for any consequential, incidental, special, or punitive damages that may result.

2. Overview

2.1

Introduction

This practice provides:

- Information on the following requirements:
 - Life safety.
 - Fire protection.
 - Loss prevention.
- References for additional detailed information.
- Requirements for UL and/of FM approved products.

It is through the continued application of the Fire Protection and Loss Prevention Practices that GTE maintains its excellent loss prevention record.

2.2

Definitions

The following chart provides definitions for the acronyms and terms used in this practice.

Acronym or Term	Definition
Active	Active fire measures include: <ul style="list-style-type: none">• Fire detection:<ul style="list-style-type: none">- Alarm systems.- Suppression systems.• Provision of:<ul style="list-style-type: none">- Sprinklers.- Standpipe.- Fire fighting equipment.- Halon systems.- Smoke controls.- Exhaust systems.
ADA	Americans with Disability Act.
Air Sampling	Air sampling is a detection system capable of detecting fires in the incipient stage, at the point of highly diluted smoke and before flames are present. This advanced warning allows for early intervention by personnel before a fire condition is out of hand. The greater sensitivity of an air sampling system enables early detection in communication sites that typically have high air flow environments.
Approved	Acceptable to the authority having jurisdiction.
ASTM	American Society for Testing and Materials

(continued)

2. Overview, continued

2.2 Definitions, continued

Acronym or Term	Definition
Authority Having Jurisdiction	The organization, office, or individual responsible for approving: <ul style="list-style-type: none">• Equipment.• An installation.• A procedure.
CO	Central Office
COE	Central Office Equipment
Combustible Material	A material or structure that can burn. NOTE: Many materials that will not burn under one set of conditions will burn under others.
DC	Direct Current
DOT	Department of Transportation
EPA	Environmental Protection Agency
Fire Barrier Walls	Barrier walls are categorized as fire partitions and fire walls. Barrier wall construction provides effective protection against the spread of fire. NOTE: The term fire includes fire-resistive barriers that are more properly defined as fire partitions. Those who are directly involved in fire protection must reserve the use of the term fire wall to the superior type of self-standing barrier. Refer to fire partitions and fire wall definitions in Section 2.
Fire Damper	A device installed in an air distribution system designed to close automatically upon detection of heat. This interrupts migratory air flow and restricts the passage of flame.

(continued)

2. Overview, continued

2.2

Definitions, continued

Acronym or Term	Definition
Fire Partitions	<ul style="list-style-type: none">• Fire partitions, in contrast to fire walls, generally enclose small areas of hazardous occupancies with fire resistance ratings of one or two hours.• Fire partitions are made of various materials:<ul style="list-style-type: none">- For cost reasons fire resistance is obtained by using layers of gypsum board with metal or wood studding.- Metal studding is preferable and ensures that fire partitions are entirely noncombustible.• The fire partitions fire resistance rating must be sufficient for the combustible loading (usually one hour is required).
Fire Resistance	A term, used with a numerical rating or modifying adjective, that indicates the resistance of a material or structure to the effects of fire (i.e. 1hr, 2hr, etc.).
Fire Resistive	<ul style="list-style-type: none">• Properties or designs for resisting the effects of any fire that materials or structures are subjected to.• Fire resistive materials or assemblies of materials are noncombustible, but noncombustible materials are not necessarily fire resistive.• Fire resistive implies a higher degree of fire resistance than noncombustible.
Fire Retardant	<ul style="list-style-type: none">• Describes a substantially lower degree of fire resistance than fire resistive.• The term also refers to materials or structures that are combustible in whole or in part, but have been subjected to treatments or have surface coverings to prevent or retard ignition or the spread of fire under the conditions they were designed for.

(continued)

2. Overview, continued

2.2

Definitions, continued

Acronym or Term	Definition
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Fire Wall

Fire walls:

- Possess a varying degree of fire resistance, depending on the hazards involved.
- Preferably have no wall penetrations, particularly at the upper portion of the wall.
- Have a fire resistance rating of three or four hours in most cases.
- Are normally of masonry construction (brick, reinforced concrete, or concrete block); however, materials other than heavy masonry can be used.
- Must be ground supported and extend through all stories.
- Supported by structural members requiring special design considerations for stresses that can develop.

If the roof deck is combustible or if it is possible to transmit heat through the roof decks, (Le., an insulated metal deck or an all metal building) parapets are required.

Parapets:

- Must be 36 inches high, but a compromise might be required for aesthetic reasons.
- Are not considered necessary above a noncombustible roof deck constructed of concrete or gypsum.

Openings in exterior masonry walls, on either side of a fire wall, must be protected or blocked up a minimum of three feet on each side of the fire wall. Where combustible exterior walls are encountered, the fire walls must end in a "Tee" extending a minimum of three feet from each side of the fire wall.

Openings in fire walls and vertical enclosures (i.e., stair and elevator shafts) are the weakest point of any wall or enclosure. It is important to design a fire wall with as few penetrations as possible.

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2. Overview, continued

2.2 Definitions, continued

Acronym or Term	Definition
Flammable Material	<p>A material that:</p> <ul style="list-style-type: none">● Ignites easily.● Burns intensely● Has a rapid rate of flame spread. <p>Flammable is used in a general sense without reference to specific limits of ignition temperature, rate of burning, or other properties. Where exact differentiations are necessary, numerical divisions are made (i.e., Class I and Class II).</p> <p>NOTE: Flammable and inflammable are identical in meaning. Flammable is preferred to avoid confusion. The prefix in indicates the negative in many words (e.g., incoherent).</p>
Flash Point	<p>The minimum temperature when a liquid gives off enough vapor to form an ignitable mixture with the air:</p> <ul style="list-style-type: none">● Near the surface of the liquid. <p>OR</p> <ul style="list-style-type: none">● Within the vessel being used.
FM	Factory Mutual
GPM	Gallons per minute.
IDF	Intermediate Distribution Frame
Inflammable	See definition of Flammable Material
MDF	Main Distribution Frame
MSDS	Material Safety Data Sheets
NFPA	National Fire Protection Association
Noncombustible Material	<p>A material which does not:</p> <ul style="list-style-type: none">● Aid combustion. <p>OR</p> <ul style="list-style-type: none">● Add appreciable heat to an ambient fire.
OSHA	Occupational Safety and Health Administration

(continued)

2. Overview, continued

2.2 Definitions, continued

Acronym or Term	Definition
OSP	Outside Plant
Passive	Passive fire measures include: <ul style="list-style-type: none">• Limiting the size of buildings.• Providing good separation between buildings.• Using noncombustible construction.• Compartmentalizing building areas.• Using fire rated assemblies for fire separation of areas.• Providing adequate and well protected means of evacuation.
PSI	Pounds per square inch.
PVC	Polyvinyl chloride
SA	Support Assets
UL	Underwriters Laboratories
UPS	Uninterruptible Power Source
UV	Ultra Violet

2. Overview, continued

2.3 References

The following chart provides sources of supplementary information relating to this practice. The documents could be required for performing certain tasks.

See...	For Information About...
008-200-001	Emergency Response Procedures Central Off ice
622-206-200	Conduit Multiple Plastic - installation
628-020-202	Underground Cable Rubber Conduit Plugs - installation and Removal
740-100-073	Laberm Cable Entrance and Vault Structural Details
742-100-101	Building Fire Fighter Apparatus - Description, Use, Placement, and Maintenance -Additional information about fire prevention and protection in: <ul style="list-style-type: none">● Printing areas.● Garages and repair facilities.● Warehouses.
742-100-103	Fenwai Low Voltage-A description of fire and smoke detection and Halon 1301 fire suppression systems.
742-100-104	Fire and Smoke Detection and Haion 1301 Fire Suppression Systems Engineering Application
742- 100- 105	Fenwal Low Voltage Fire and Smoke Detection and Halon 1301 Fire Suppression Systems - Installation Procedure
742-100-106	Fenwai Low Voltage Fire and Smoke Detection and Halon 1301 Fire Suppression Systems - Operation and Maintenance
742-101-070	Sprinkler System - Engineering Applications
742-l 01-500	Automatic Sprinkler System - Maintenance - information about automatic sprinklers and fire prevention and protection in warehouses.
742-200-070	Sealing Cable Openings and Penetrations - Fire Protection Measures
742-205-070	Battery Room or Area Ventilation Engineering Application
Factory Mutual Approval Guide	Guide Book of Approved Products/Systems

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2. Overview, continued

2.3 References, continued

See...	For Information About...
FM I-19	Fire Walls Partitions, and Draft Curtains
FM I-21	Fire Resistance of Building Assemblies
FM 1-23	Protection of Openings
FM-2-8N	Automatic Sprinklers
FM 2-8N	Installation of Sprinkler Systems
FM 3-26	Information about fire prevention and protection in garages and repair facilities.
FM 4-8N	Halogenated Fire Extinguishing Agent Systems - Halon 1301
FM 5-14	Telephone Central Offices
FM 5-48	Automatic Fire Detectors
FM 7-15	Garages – Information about fire prevention and protection in garages and repair facilities.
FM 7-29	Flammable Liquids in Drums and Small Containers
FM 7-29s	Storage of Aerosol Products – Information about fire prevention and protection in warehouses.
FM 7-35	Flammable Liquids – General Safeguards
FM 7-96	Printing – Fire prevention and protection in printing areas.
FM 7-98	Hydraulic Fluids – Contains information about flammable and combustible liquids.
FM 8-O	General Storage Safeguards – Information about-Additional information about: <ul style="list-style-type: none">• Stored plastics.● Fire prevention and protection in warehouses.
FM 8-OS	Commodity Classification – Information about – Additional information about stored plastics and fire prevention and protection in warehouses.

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2. Overview, continued

2.3 References, continued

See...	For Information About...
FM 8-9	Storages – Information about stored plastics and fire prevention and protection in warehouses.
FM 8-21	Roll Paper Storage -- Fire prevention and protection in printing areas.
FM 8-24	Idle Pallet Storage-Information about fire prevention and protection in warehouses.
NFPA 12A	Standard on t-talon 1301 Fire Fighting Systems
NFPA 13	Standard for the Installation of Sprinkler Systems -Additional information about: <ul style="list-style-type: none">• Automatic sprinklers.• Fire prevention and protection in warehouses.
NFPA 30	Flammable and Combustible Liquids Code
NFPA 70	National Electrical Code
NFPA 70B	Electrical Maintenance
NFPA 70E	Electrical Safety Requirements for Employee Workplace
NFPA 72	Standard on Automatic Fire Detectors
NFPA 80/101	Standard for Fire Doors and Windows
NFPA 88B	Standard for Repair Garages – Information about fire prevention and protection in garages and repair facilities.
NFPA 101	Safety to Life from Fire in Buildings and Structures (Life Safety Code)
NFPA 231	Indoor General Storage -Additional information about: <ul style="list-style-type: none">• Stored plastics.• Fire prevention and protection in warehouses.
NFPA 231 C	Rack Storage of Materials – information about fire prevention and protection in warehouses.

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Overview, continued

2.3 References, continued

See...	For Information About...
NFPA 321	Basic Classification of Flammable and Combustible Liquids
NFPA 325	Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids

2.4 Major Organizations

The following chart describes the major organizations involved in life safety, fire protection, and loss prevention.

Organization	Description
EPA 401 M. Street NW Washington, DC 20460	An independent agency with regulatory authority for the permissible levels of air and water pollution.
FM System 1151 Boston-Providence Turnpike Norwood, MA 02062	Consists of: <ul style="list-style-type: none">● The following mutual property insurance companies:<ul style="list-style-type: none">- Allendale Mutual Insurance.- Arkwright.- Protection Mutual Insurance.● System associates are:<ul style="list-style-type: none">- Factory Mutual International.- Factory Mutual Engineering and Research. FM is a multinational organization that: <ul style="list-style-type: none">● Minimizes:<ul style="list-style-type: none">- Fire and extended coverage losses.- Machinery losses.- Business interruptions.● Provides the following to the insureds:<ul style="list-style-type: none">- Insurance.- Property loss prevention inspections.- Research.- Consultation services.● Provides testing and approval services

2. Overview, continued

2.4 Major Organizations, continued

Organization	Description
OSHA 200 Constitution Avenue Washington, DC. 20210	Created within the Department of Labor to: <ul style="list-style-type: none">● Encourage employers and employees to reduce hazards in the workplace.● Implement new or improve existing safety and health programs.● Establish separate bulk dependent responsibilities and rights for employers and employees for achieving better safety and health conditions.● Establish reporting and record keeping procedures to monitor job-related injuries and illness.● Develop and enforce mandatory job safety and health standards.● Encourage all states to assume the fullest responsibility for establishing and administering their own occupational safety and health programs. The programs must be as effective as the Federal programs.
NFPA 1 Batterymarch Park Quincy, MA 02269-9101	A scientific and educational membership organization concerned with the causes, prevention, and control of destructive fires. Organized in 1896 and incorporated in 1930 under the Laws of Massachusetts, NFPA is a private, voluntary, charitable, and tax-exempt association. The Association's activities include: <ul style="list-style-type: none">● Developing fire safety technical standards.● Exchanging information.● Providing technical advisory services.● Educating the public.● Fire safety research.● Providing service to public protection agencies.
DOT 400 Seventh Street SW Washington, D.C. 20590	Regulates the movement on highways of dangerous cargo through the Federal Highway Administration.

(continued)

2. Overview, continued

2.4

Major Organizations, continued

Organization	Description
Underwriters Laboratories Inc. 33 Pingsten Road Northbrook, IL 60062	<p>A nonprofit-corporation that:</p> <ul style="list-style-type: none">• Promotes public safety through conducting scientific:<ul style="list-style-type: none">- investigation.- Experiments.- Study.- Tests. <p>NOTE: These efforts determine the relation of various materials, devices, products, equipment, constructions, methods, and systems to hazards effecting life and property.</p> <ul style="list-style-type: none">• Determines, defines, and publishes standards, classifications, and specifications for materials, devices, products, equipment, construction, methods, and systems effecting such hazards.• Publishes other information designed to reduce or prevent:<ul style="list-style-type: none">- Bodily injury.- Loss of life.- Property damage. <p>The fire insurance industry founded the organization in 1894. In 1968 it became an independent public service corporation. It has no capital stock and no shareholders. It exists solely for the service it renders in the fire, crime, and casualty insurance fields. Refer to the National Fire Prevention Association (NFPA) fire code and Factory Mutual (FM) data sheets.</p>

2. Overview, continued

2.5 Life Safety

A reasonable level of life safety in building design and arrangement can be produced by observing the steps in the following chart.

Step	How lo...
1	Provide buildings or structures designed for human occupancy with sufficient exits to permit occupants a quick escape in case of fire or other emergencies (refer to NFPA 101).
2	Design the exits and safeguards with back-up safety systems in case of fire or other emergencies. Provide additional safeguards for life safety in the event any safeguard is ineffective due to human or mechanical failure.
3	Construct, arrange, equip, maintain, and operate property in a way that avoids posing undue danger to the lives and safety of its occupants from: <ul style="list-style-type: none">• Fire.• Smoke.• Gases.• Panic.
4	Ensure that the occupants have enough time to escape from the building or structure during an emergency.
5	Provide the property with exits that are of the appropriate kind, number, location, and capacity for allowing all occupants convenient escape routes. Consider the: <ul style="list-style-type: none">• Individual building or structure.• Character of the occupancy.• Number of people exposed.• Fire protection available.• Height and type of construction of the building or structure.• ADA Requirements.
6	Arrange and maintain exits to provide free and unobstructed exit from all parts of the building or structure at all times. WARNING: Do not install locks or fastening devices that prevent escape from any building.
7	Ensure that all exits are clearly visible and that the exit routes are marked so that each building-or structure occupant that is physically and mentally capable of knowing and finding the escape route can escape from any point in the building or structure. Arrange and/or mark building and structure exit escape routes with unmistakable markings.

(continued)

2. Overview, continued

2.5 Life Safety, continued

Step	How To...
a	Mark any doorway or passageway that is not an exit or a route to an exit "Not an Exit". This eliminates any possibility that people trying to escape from a fire could confuse a dead end space (e.g., cellar or storeroom) as an exit.
9	Provide adequate and reliable emergency lighting where required by code for all exits in buildings equipped with artificial illumination.
10	Provide fire alarms where required by code or GTE practices to warn occupants of the fire so they can take appropriate action.
11	If the size, occupancy, or arrangement of a section or area of the property could endanger the occupants by having a single exit blocked by fire or smoke, the property requires two exits that are <ul style="list-style-type: none">• Remote from each other.• Arranged to minimize any possibility of both exits being blocked by fire, smoke, or any other emergency.
12	Enclosing and protecting vertical exit routes and other vertical openings between floors: <ul style="list-style-type: none">• Allows occupants to safely use the exits.• Prevents fire, smoke, or dangerous gases from spreading through the vertical openings from floor to floor before the occupants enter the exits.

The maximum fire safe construction is obtained by applying engineering judgement to the building's construction plans and specifications.

In certain instances (e.g., peculiar characteristics of design and occupancy), it might be desirable to deviate from these requirements. In such cases, present deviation to the Support Assets Real Estate and Building Standards Department.

There are limitations concerning to what extent Life Safety Alterations can be applied to existing buildings. However, even in such cases, steps can and should be taken to improve the overall features related to loss prevention.

2. Overview, continued

2.6 GTE's Fire Protection Philosophy

Fire protection systems provide a means to detect fires at an early stage. This minimizes the loss of property, service, and lives. In accordance with risk and financial consideration, **GTE must install fire detection systems in all facilities greater than a designated threshold property value (See Section 3.2)**. GTE's fire suppression policy had been based on installing Halon in equipment areas (e.g., telephone switching areas, frame rooms, data processing centers). Environmental concerns with Halon require that GTE undertake a program to search for other effective ways to protect their facilities and employees.

GTE presently employs the following means to protect facilities and employees.

- Where economically feasible, GTE installs automatic sprinklers in all buildings of combustible construction or occupancy (i.e., warehouses or office areas). GTE does not believe that sprinklers provide adequate protection for telephone equipment areas and continues to search for improved methods of fire protection in these areas.
- GTE has upgraded its products of combustion requirements to include air sampling detection technology and microprocessor based fire control systems. These technologies increase fire detection response time and reduce operating costs to maintain these systems.
- GTE does not want to adopt a chemical to replace halon that could endanger human life or the environment, therefore, GTE is not considering the current chemical alternatives. When a chemical is developed that meets GTE environmental and safety requirements, that product will be given serious consideration.
- GTE removes halon in facilities with a property value less than \$15,000,000 (building, equipment, and contents) and leaves the fire detection systems in place. In new and renovated facilities, GTE is committed to air sampling technology for the electronic equipment areas when economically feasible (See Practice Section 2.7.1 for application). At these facilities, coupled with the application of Practices associated with Cable Sealing, sprinkler, and other fire protection, will lead to maintaining GTE's excellent fire protection record.

2.6.1 Human Element

GTE conducts and records a monthly self-inspection of sprinkler systems and sprinkler control valves (refer to NFPA13/local code requirements). Fire alarm detection systems are to be inspected annually with a visual inspection semi-annually. Smoke detectors are to be tested for sensitivity every other year or 50% annually, (refer to GTE Telephone Operations Practice 742-100-006 and NFPA72).

2. Overview, continued

2.7 Procedures

GTE developed the following Fire Suppression and Plan Review procedures.

- Halon removal at sites equal from \$5 - \$15 million property value.
- Halon 1301 discharge (accidental or intentional).
- Water mist.
- Plan reviews.

~~2.7.1 Halon Removal at Sites Equal to \$5 - \$15 Million Property Value~~

Procedures for sites equal from \$5 - \$15 million property value.

- Sites with newer technology fire panels (i.e., Fenwal 2210, 3210, or microprocessor based systems) must have the halon removed and the associated pull stations disconnected and removed from the site. The remaining equipment serves as the facility's fire detection system.
- Sites with older control panels (e.g., 040/Pyro high voltage systems) will have the halon and fire detection equipment removed and replaced with analog addressable fire control panels and air sampling technology.
- Sites having a property value greater than \$15,000,000 will have air sampling installed prior to Halon being removed. Ionization detectors are to be removed at these locations. The rate compensated detectors remain and are cross zoned with the air sampling detection. In accordance with GTE's current practice for Cross Zoned release of Halon, both the air sampling and rate compensated detectors must activate for the system to discharge. (See Practice 742- 1 00- 104).
- When local building codes require a fire suppression system in newly constructed switching facilities, avoid installation of a sprinkler system over equipment areas if possible. Explore other alternatives with the local building code authorities (refer to GTE Telephone Operations Practice 742-101-070). With certain precautions a preaction sprinkler system can be installed to meet code. Halon 1301 must not be installed in newly constructed facilities.
- When local building codes require a fire suppression system in an existing equipment switching area, Halon 1301 removal must be scheduled as a low priority (i.e., removal is conducted near the end of the phase out program, year 2000). Prior to removal of the Halon 1301, the site may have to be provided with an alternate suppression system to conform to local building codes.
- Illinois requires that the nonswitching areas of a facility over 1,600 square feet be provided with a fire suppression system (e.g., sprinklers, Halon 1301, etc.). Nonswitching areas include all areas of the facility except rooms housing switching, toll, main distribution frame, power, auxiliary power, and AC switchboard equipment. Nonswitching areas (including vaults) in facilities over 1,600 square feet must be equipped with a preaction sprinkler system.

2. Overview, continued

2.7 Procedures, continued

2.7.2 H&n 1301 Discharge (Accidental or intentional)

Use the following procedures when Halon 1301 is discharged intentionally or by accident at the site. Sites with a property value:

- Greater than \$15,000,000 (including radio/microwave sites) requires that any discharge of Halon 1301:
 - Be replenished through the existing **GTE** Halon 1301 inventory.
 - After January 1999 have the Halon 1301 equipment removed and proceed with the installation of air sampling technology and an appropriate suppression system.
- Less than \$15,000,000 (whether all zones discharge or partial zones discharge) requires that the Halon 1301 system be disconnected and removed.

2.7.3 Water Mist

Water mist technology is a promising technology. GTE has donated telephone switching equipment to individual companies to test water spray technology. GTE is interested in using this new technology to combat fire hazards in electronic equipment areas.

2.8 Factory Mutual Plan Reviews

Plan reviews are conducted on all fire detection or suppression systems in buildings with a \$500,000 property value or greater for:

- New construction.
- Roofing.
- Fuel tanks.
- Major renovation/additions.

It is the responsibility of the Corporate Support Assets-Building Services Organization to insure that plans are submitted. In some Business Units it is the responsibility of the organization who installs the Fire Protection and manages Facility Construction/Renovations.

The following chart describes how to conduct a plan review.

Step	How To Conduct a Plan Review
1	Discuss concepts or plans and specifications for new facilities or major changes at existing facilities with the local FM Engineering district office before a contract is awarded or the work is started.
2	After the initial review, forward the plans (a minimum of two sets) and specifications to the local FM Engineering district office.

(continued)

2. Overview, continued

2.8

Factory Mutual Plan Reviews, continued

Step	How To Conduct a Plan Review
3	<p>For GTE Telephone Operations only- Fire detection and/or automatic sprinkler proposals must be submitted to the closest geographical FM Engineering district office location for review before construction starts. The four district offices have been selected to minimize the number of District offices GTE deals with, and to provide standard information/protection recommendations.</p> <ul style="list-style-type: none">• Eastern – (OH, PA, KY, VA, NC, SC, AL, FL) Factory Mutual Engineering Suite 60 5445 Seventy-Seven Ctr. Dr. Charlotte, NC 28217 (704) 525-9000• Central – (MI, IN, IL, IA, MN, NE, MO, AR, TX, OK, NM) Factory Mutual Engineering Birmingham Office Park Suite 141 30150 Telegraph Road Birmingham, MI 48010 (313) 540-0500• Western – (CA, AZ, HI, OR, WA, ID, AK) Factory Mutual Engineering PO. Box 5409 Suite 1500 333 City Blvd. West Orange, CA 926135409 (714) 634-4888• Canada - (BC Tel, Quebec Tel, and other Canada BU. Factory Mutual Engineering Suite 550 5757 Cavendish Blvd. Cote St-Luc PQH4WZW8PQ Montreal, Canada
4	<p>The review must take place before the contract is awarded to the installation contractors. This review ensures that:</p> <ul style="list-style-type: none">• All factors are considered in selecting and using the equipment.<ul style="list-style-type: none">a The system is properly designed.

(continued)

2. Overview, continued

2.8

Factory Mutual Plan Reviews, continued

Step	How To Conduct a Plan Review
5	<p>The FM district office sends a copy of the proposal to the area FM district office servicing the GTE location and returns the remaining copies of the proposal with a review letter to the submitting GTE entity. A copy of the review letter is sent to the:</p> <ul style="list-style-type: none">• Senior Administrator – Property Insurance Insurance and Pensions Department GTE Service Corporation One Stamford Forum Stamford, CT 06904 (203) 965-2398• Account Engineering for GTE Corporation Allendale Mutual Insurance Company Four Stanford Plaza 107 Elam Street Stamford, CT 06902 - 3851 (293) 846-2511• Property Loss Control Consultant Johnson & Higgins Two Stamford Plaza PO. Box 10006 Stamford, CT 06904-2006 (293) 353-6239• Support Assets - Department Real Estate and Building Standards 5 Campus Circle, West Lake TX 76262 PO. Box 152134 Irving, TX 75015 <p>NOTE: Plan review will be completed within 10 working day from receipt.</p>

2. Overview, continued

2.9 Water Sprinkler Systems

GTE considers automatic sprinkler protection a very effective means of fire protection against physical damage and life safety perspective and must be installed in all new buildings and renovation where required by code. Water sprinkler systems are:

- Used when leasing a space greater than 20,000 feet.
- Widely used as a reliable means of fire protection.
- Used in Communication/Computer spaces under certain conditions.

2.9.1 Used When Leasing a Space Greater than 20,000 Square Feet

Sprinkler protection must be considered when plans include leasing a space greater than 20,000 square feet and in high rise buildings (a building outside the reach of the local fire department aerial ladder).

The exception is for areas that house electronic equipment (i.e., telephone equipment or computer sites). Sprinklers must be installed when required by the code for occupancy around equipment/computer areas. Sprinklers are permitted above GTE electronic equipment areas under certain conditions (refer to GTE Telephone Operations Practice 742-I 01-070).

2.9.2 Widely Used as a Reliable Means of Fire Protection

Automatic sprinklers are a widely used means of fire protection. Automatic sprinkler systems:

- Detect fire.
- Transmit an alarm.
- Control or extinguish the fire.
- Operate only as needed in the immediate vicinity of the fire.
- Promptly discharge water where it effectively protects both structure and contents.
- Are much more efficient than hose streams directed through windows from outdoors or through heavy smoke.

The installation of sprinklers can produce a savings by permitting the use of:

- More economical types of construction.
- Larger fire areas.
- Less space between buildings.
- Less restrictive arrangements or occupancy.

NOTES: Without sprinklers, a fire can grow to a destructive size and ultimately result in a total loss.

For most occupancies, sprinklers are desirable whenever combustible construction and/or contents are present.

2. Overview, continued

2. 10 Automatic Detection Systems

All automatic fire detectors are expected to detect a fire early enough to allow for effective counteractions (e.g., evacuating personnel and/or extinguishing the fire).

However, different types of fire detectors do not detect all types of fires with the same degree of speed or reliability for the following reasons:

- Fires vary in nature and development.
- Each fire detection principle examines some, but not all fire phenomena.

Detection systems are custom designed to provide early warning on the physical characteristics of the space being monitored. The following chart describes the system components and their functions.

Function	What is done...
Detectors	<ul style="list-style-type: none">• Sense the presence of heat, smoke, or combustion.• Referred to as detector heads or heads.• Located in the space being monitored. <p>NOTE: Most detectors are located at ceiling level since heat, smoke, or combustion particles rise. However, others are located in air ducts or below raised flooring. The devices are connected together in groups or zones. This allows the alarm source to be quickly identified.</p>
Control Panels	<p>Distribute electrical power to:</p> <ul style="list-style-type: none">• Operate the detectors.• Provide a central point where all alarms can be displayed visually and operate audible alarms.• Perform logic and algorithm functions for early detection and fire alarm minimization. <p>Contain relays for:</p> <ul style="list-style-type: none">• Transmitting alarms to remote locations.• Activating or deactivating:<ul style="list-style-type: none">- Fans.- Electrical power.- Door releases.- Fire dampers.
Remote Alarm	At the visible locations, remote alarm lamps identify those detectors that are not otherwise readily seen or are behind locked doors.
Remote Annunciator Panels	Identify the zone or location where the alarm originates. In multistory buildings the remote annunciators are: <ul style="list-style-type: none">• Located on each floor.• Used to identify the floor where the alarm originated.

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations

3.1 Introduction

This section describes fire protection and loss prevention consideration features for communication equipment areas and other locations. The following requirements are necessary for detecting and/or suppressing a fire condition as rapidly as possible.

3.2 Fire Detection Application

GTE Business Units (BU) will install automatic fire detection systems at locations with a property value in excess of \$500,000. (This includes includes Equipment and Contents) Sites that may be of lesser value could be considered for a fire detection system if it serves critical customers (i.e. FAA, Military etc.).

3.3 Communication Equipment Areas

Communication equipment areas have special fire detection and alarm requirements. A properly designed system detects a fire at the earliest stage so it can be quickly:

- Located.
- Contained.
- Extinguished.

The area being protected determines the type of detection that is used.

Example: The following types of detection are used in communication equipment and electronic data processing areas:

- Air sampling - (Migration to).
- Ionization detectors - (Migration away from).
- Photoelectric detectors - (Preferred spot-type detection).
- 140 degree F rate compensated thermal detectors.

The effects of high air flow is minimized by limiting the detector's coverage area to 400 square feet.

Example: Use 20 ionization detectors to cover a communication equipment area up to 8,000 square feet.

Ceiling heights over greater than 10' - 6" must have every other detector head placed at the 9 foot level to minimize stratification issues and increase response times.

3.4 Non- communication Equipment Areas

Provide noncommunication equipment areas housing combustibles with a detection system. In these cases, the recommended detector spacing is a maximum 900 square feet per detector.

In large buildings with several floors of noncommunication equipment space, detection is provided throughout and based on FM and local code requirements. Provide ionization detectors in all noncommunication equipment areas.

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

3.5 Panel Zoning

Panel zoning can be accomplished with:

- Indicating lamp control detection equipment.
- Air sampling detection equipment.

3.5.1 ~~Indicating Lamp, Control Detection Equipment~~

To minimize the time for locating a fire, zoned control equipment immediately indicates where the alarm initiated. The alarm indicating lamp on the detector pinpoints the detector originating the alarm.

The responding detector must be quickly traceable without using remote alarm lamps on each detector. Remote alarm lamps for each detector are more costly than an adequately zoned system.

NOTE: Arrange communication equipment areas and noncommunication equipment areas into separate control panel zones. This will minimize problems that could affect the communication area zone.

3.5.2 ~~Air Sampling Detection-Equipment~~

Air sampling detection must be installed in:

- New and existing COs and computer rooms greater than \$15,000,000 in property value.
- All new COs with a property value between \$5,000,000 and \$15,000,000.
- All existing COs:
 - With a property value greater than \$5,000,000
 - AND
 - Where remodeling work is occurring.

NOTE: An air sampling system is capable of detection in an area up to 20,000 square feet. However, GTE electronic equipment areas (i.e., communication and computer rooms) are limited to a maximum coverage area of 10,000 square feet.

3.6 Fire Detection/ Suppression Alarm Monitoring

Fire detection/suppression alarm monitoring systems are found in:

- Network and critical non-network buildings.
- Non-network buildings.

3.6.1 ~~Network and Critical Nonnetwork Buildings~~

Extend alarms via a supervised circuit to the GTE NOC and to a central alarm monitoring station where codes require monitoring by a UL listed central station.

3.6.2 ~~Nonnetwork Buildings~~

Extend alarms to a UL listed central alarm monitoring station when required by codes.

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

**3.7
Other Locations**

Protect locations without in-service communication equipment (warehouses, garages, offices, etc.) by more conventional means (i.e., automatic sprinklers or early warning spot type fire detection).

**3.8
Location
Protection**

The following chart describes location protection.

Protect	How...
All Locations	<ul style="list-style-type: none"> ● Seal the following openings (refer to GTE Telephone Operations Practice 742-200-070): <ul style="list-style-type: none"> - Cable tray openings. - All cable openings. - Openings in: <ul style="list-style-type: none"> ● Walls. ● Floors. ● Ceilings. ● Protect duct work entering equipment rooms with automatic-closing fire dampers at point of entry. ● Avoid using concealed spaces, including suspended ceilings, for storage or electrical equipment. ● Provide metal cabinets for storing flammable liquids essential to maintenance operations. ● Provide self-extinguishing waste receptacles for all waste paper. ● Store small quantities of flammable liquids in UL Listed FM approved safety cans. ● Store oily rags in metal containers with self-closing covers. ● Locate combustible material (stored in quantity) in a separate room enclosed by at least a one hour rated fire partition. ● Depending on room size and location, automatic sprinklers, or heat detectors are provided in areas that are used to store combustibles. ● Protect basements used for storage of combustibles with automatic sprinklers. ● Unless adequately protected, separate COs from attached garages, repair facilities, warehouses, or other storage facilities with a two hour fire wall. ● Fire barrier walls separating communication equipment rooms from other occupancies must have a fire rating of at least one hour. ● Fire partitions installed as a separation between communication equipment and main frames must be noncombustible, and have at least a one hour fire rating.

(continued)

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

3.8

Location Protection, continued

Protect

How...

All Locations, continued

- All equipment room ceilings must be noncombustible. Ceilings below wood roofs or wood floors, must be one-hour-fire-rated ceilings, and meet the designs and specifications of UL and/or FM.
- Raised floor decking and structural supporting members for raised floor decking must be concrete, steel, or aluminum.
- Resilient tiles or high pressure plastic laminates are acceptable as wearing surface.
- If the raised floor decking is made of wood or similar core material the floor must be encased on the top and bottom with sheet, cast, or extruded metal. All openings or cut edges must be covered with metal or plastic clips or grommets.

NOTE: **Screen materials used, to ensure they do not contain asbestos.**

- Door openings must have approved fire doors with a fire rating equal to the rating of surrounding walls.
- Interior wall finishings must be noncombustible:
 - Between storage, garage, or repair occupancies and communication equipment rooms.
 - In other rooms with unprotected openings leading to equipment rooms.
- Never store combustibles or flammable materials or liquids in:
 - Equipment rooms.
 - Cable vaults.
 - Battery rooms.
 - Generator rooms.
 - Boiler rooms.
 - Furnace rooms.
 - Transformer rooms.
 - Electrical switch gear rooms.
 - Stair wells.
- Do not allow discarded plastic shipping containers to accumulate in equipment rooms. This material gives off a heavy black smoke when it burns.
- Empty metal containers daily to prevent overflow.
- Do not leave scrap lumber, empty crates, boxes, etc. in an equipment room overnight.
- Smoking is prohibited in telecommunication equipment areas. Smoking is only allowed in designated areas.

(continued)

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

3.8

Location Protection, continued

Protect	How...
All Locations, continued	<ul style="list-style-type: none"> Do not store new equipment within the CO until just before the installation date. Only store equipment necessary to maintain the continuity of work. (Generally, a supply of no more than five days is considered adequate.) Remove all empty crates (cartons, cable reels, etc.) before the work shift ends. All miscellaneous equipment material wrapped with combustible material that is required during the entire installation period must be stored in metal storage cabinets or covered with flame retardant tarpaulins. Do not use combustible material (e.g., scrap lumber, empty crates, cardboard boxes) to construct furniture items. All furniture must be noncombustible.
Battery Rooms	<p>Provide battery rooms and areas with sufficient mechanical ventilation to prevent hydrogen gas from accumulating in excess of the maximum permissible design volume (1.5% hydrogen in air).</p> <p>In all cases, the ventilation must provide the required air exchanges to maintain the hydrogen below 1.5% (refer to GTE Telephone Operations Practice 742-205-070). Ventilation can be provided on a continuous or intermittent basis.</p> <p>NOTE: Incorporate air sampling fire detection in the battery room.</p>
Cable Vaults	<ul style="list-style-type: none"> Separate cable vaults from other occupancies by fire barrier walls with at least a two hour rating. Seal all cable and duct penetration running through walls, floors, or ceilings so that the smoke, toxic gases, and flames cannot migrate to or from the area. Equipment changes in the CO building necessitate frequent cabling additions, removal, and rerouting. During line modifications, all cable and duct openings and penetrations must be sealed at the end of each day to prevent or minimize the transmission of smoke, heat, and flame from one room or floor to another. Sealing systems for all cable openings must maintain a fire rating equal to the surrounding walls. if the cable vault is below grade and unvented, electrical service must meet NEC, NFPA 70 Article 500 for Class 1, Division 2, Group D location requirements (refer to Section 2.4). Combustible gas detection is required for below grade cable vaults. <p>NOTE: Do not install cable pressurization equipment in cable vaults.</p>

(continued)

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

3.8

Location Protection, continued

Protect	How...
Transformer Vaults	<p>Enclose transformers located within telephone buildings in approved vaults designed to protect employees and prevent damage to the building and contents in case of:</p> <ul style="list-style-type: none"> • Fire. • Escaping gases. • Explosions.
Emergency Generator Rooms	<ul style="list-style-type: none"> • Fire barrier walls separating generator rooms from other occupancies must have a fire rating of at least two hours. Protect all wall openings with fire doors having a 2 hour rating. • Locate carbon dioxide or dry chemical fire extinguishers adjacent to the entrance of generator rooms. • When propane, natural gas, or manufactured gas generators are used, either provide ventilation or encase the gas supply line in rigid conduit, vented to the outside. This precludes the possibility of an explosive atmosphere accumulating if gas accidentally escapes. • Provide mechanical ventilation at the rate of one cubic foot per minute per square foot of floor space for below grade generator rooms, which is activated when generator is operational. • Natural ventilation is acceptable at the rate of one square foot of free inlet area for every 500 square feet of floor space for above grade rooms. • Provide a heat actuated automatic closing fuel shutoff arrangement. • Except for day tanks, separate fuel tanks from the generator with at least a two hour rated fire barrier wall. • Emergency generator rooms must be provided with rate compensating thermal detection.
Mechanical Equipment Rooms	<ul style="list-style-type: none"> • Mechanical equipment rooms are those which contain: <ul style="list-style-type: none"> - Fans. - Water pumps. - Electrical distribution/equipment. - Air conditioning. - Elevator equipment. • Fire barrier walls separating machinery rooms from other occupancies must have a fire rating of at least one hour. a Provide mechanical equipment rooms with ionization fire detection.

(continued)

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

3.8

Location Protection, continued

Protect	How...
Printing Area	<ul style="list-style-type: none"> ● Printing facilities and operations include: <ul style="list-style-type: none"> - Ink and paper storage areas. - Composing room. - Press room. - Bindery. ● Provide automatic sprinkler protection in all printing areas. FM must be contacted for guidelines before the installation of any equipment. Locate portable fire extinguishers throughout the plant according to GTE and FM practices. ● Pay special attention to rolled paper storage which requires strong sprinkler protection. Contact GTE Insurance and Pensions Department for more assistance when expanding or renovating printing or warehouse areas. ● Locate extinguishers in press rooms within easy reach of press operators and ink mixing rooms and other locations where flammable liquids are present. ● For quick control of an incipient fire, provide a small hose station with combination nozzles for solid stream and spray in: <ul style="list-style-type: none"> - Press rooms. - Reel rooms. - Rolled paper storage. ● Separate flammable or combustible ink mixing operations from the rest of the plant with a two hour rated fire wall. Arrange and protect them according to standard GTE and FM practices. ● Solvents used for cleaning presses must have flash points as high as possible but at least 100 °F. When cleaning hot surfaces the flash point must be at least 25 °F above the temperature of the surface. ● Electrical equipment must be consistent with the hazard present. Refer to the appropriate NFPA and FM guidelines. ● Proper means for eliminating static electricity on all presses are essential. Pay particular attention to presses using low flash point inks. ● Use FM practices and approved equipment for gas fired dryers with enclosed burners. ● Provide dryers with safety ventilation on presses using low flash point inks (e.g., rotogravure and flexograph). This prevents solvent concentrations in the dryer and associated ducting from exceeding 25% of the lower explosive limit.

(continued)

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

3.8

Location Protection, continued

Protect	How...
Printing Area	<ul style="list-style-type: none"> ink dryers using direct flame impingement, or operating at a temperature high enough to ignite the printed material, is designed to shut down when the press is stopped. in the case of rotary web presses, the web should be automatically removed or the press shut down. Ventilation must continue to prevent accumulation of combustible gases. All wiring must be run in conduit or duct. Install heat or rate compensation detectors to shut off the feed of paper, plastic, or other combustible materials to the presses when a fire alarm condition is detected. A web break detector is adequate for this purpose. Place filters at the duct intake of exhaust ducts in printing press rooms. Provide removable panels in the duct for: <ul style="list-style-type: none"> Periodic inspection. Cleaning the duct system.
Loss Experience	<ul style="list-style-type: none"> Loss experience indicates that fixed carbon dioxide protection systems on printing presses have resulted in significant decreases in both property damage and business interruption.
Housekeeping and Preventive Maintenance	<ul style="list-style-type: none"> Explosions can occur in the press room, particularly with presses using low flash point inks. Every effort is made to use water based inks or high flash point inks (a flash point of at least 100 F). To minimize the frequency and extent of fires, employees must be constantly aware of potentially hazardous conditions. Good housekeeping must be maintained. Periodic cleaning of structural members and equipment helps reduce the accumulation of paper dust. To minimize the fire hazard properly handle flammable and combustible liquids. Keep all equipment bonding and grounding in a satisfactory and secured condition. Properly maintain and periodically test gas fired equipment and safety interlocks on dryers. Smoking is only permitted in designated areas away from printing presses and equipment that generates dust and paper waste. Preplan a fire incident with the emergency organization and the local public fire department.

(cont inued)

3. Central Offices, Toll Centers, Remote Equipment Sites, and Other Locations, continued

3.8

Location Protection, continued

Protect	How...
Duct Protection	<ul style="list-style-type: none">• Install automatic sprinkler protection inside ducts when either the duct is combustible or the product carried inside is combustible.

4. Garages and Repair Facilities

4.1 introduction

Garages are used for storing motor vehicles. Repair facilities are used for maintaining motor vehicles. In most GTE facilities, these occupancies are combined and have similar hazards.

4.2 Application

The following chart describes the application of fire protection.

Protect	How...
Application	<ul style="list-style-type: none">• Buildings must be noncombustible and separated from other areas by construction of one hour rated fire barrier walls and doors.• Due to the possible pressure of flammable fuel vapors, forced ventilation must be provided in garage areas.• Sprinkler protection is provided for all garage and repair facilities (refer to FM Data Sheet 3-26).• Spray booths must be provided with sprinkler protection and mechanical ventilation with an average air velocity across the booth opening of 100 feet/minute (minimum).• Use nonflammable solvents for parts cleaning.• Limit cutting and welding to a designated safe area in the repair shop. Written permits and a fire watch are required for cutting and welding in nondesignated areas.

5. Warehouses

5.1 Introduction

Warehouses are areas used for storing:

- Raw materials.
- Component parts.
- Finished products.

5.2 Application

The following chart describes warehouse fire protection.

Protect	How...
Application	<ul style="list-style-type: none">● Comprehensive studies are required to determine adequate protection based on:<ul style="list-style-type: none">- Commodity classification.- Storage arrangements.- Heights of storage.● Refer to the FM district office and FM Data Sheet 8-05 for commodity class determination.
Construction	<ul style="list-style-type: none">● The building must be constructed with noncombustible materials. Automatic sprinkler protection is required.● Separate warehousing areas from other facilities by at least two hour rated fire barrier walls with approved 2 hour rated fire doors for all openings.
Protection	<ul style="list-style-type: none">● Both FM and NFPA specifies protection details (sprinkler densities, etc.) for both palletized and rack storage in.● Protection requirements for palletized storage only (refer to NFPA231, Indoor General Storage).
Idle Pallets	Idle pallet storage is a severe fire exposure. When stored indoors, idle pallets should be no more than four feet high.
Hose Streams	<ul style="list-style-type: none">● As a supplement to automatic sprinkler systems, outside hydrants with 2½ inch outlets or as specified by Authority having Jurisdiction are essential.● Provide incipient fire fighting and mop-up operations with 1 ½ inch hose lines to cover all areas of the rack structure. Small hose streams are used effectively for the lower sections where fires start more frequently.

(continued)

5. Warehouses, continued

5.2

Application, continued

Protect	How...
Water Supply	<p>The total fire flow demand must be able to concurrently supply:</p> <ul style="list-style-type: none">• Palletized storage:<ul style="list-style-type: none">- Ceiling sprinklers.- Small hose.- Outside hose streams.• Rack storage:<ul style="list-style-type: none">- Ceiling sprinklers.- in-rack sprinklers (if provided).- Small hose.- Outside hose streams. <p>In-rack sprinkler demand depends on the:</p> <ul style="list-style-type: none">• Hazard classification.• Number of in-rack sprinkler levels. <p>NOTE: For combined 1½ inch inside hose lines and 2½ inch outside hose lines, a total of 500 GPM is normally required.</p>

Aerosols	<p>Fire tests indicate that the product base in an aerosol container is a more serious hazard than the propellant. The more hazardous product base containers rupture and rocket over considerable distance when exposed to high heat.</p> <p>NOTE: Consult with FM Personnel for determination of aerosol hazard level.</p> <p>Separation is the best protection. Separate by:</p> <ul style="list-style-type: none">• Providing an outside storage shed.• Obtaining an outside trailer.• Storing cartons in metal fire cabinets.• Providing a cut off room of at least three hour rated fire walls with automatic sprinkler protection. If gypsum wall board is used, the inside must be faced with metal.
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The safeguards in this section apply in principle to all flammable liquids. Use suitable combustible liquids where ever practical to do so.

- The safety of any flammable liquid occupancy depends on proper operator action. Adequate training must be provided.
- Isolate flammable liquids by distance or construction so that they do not expose important buildings or facilities and are protected from fires originating elsewhere.
- Confine flammable liquids and vapors in the equipment and piping. Keep escaping materials to a minimum and prevent their spread. Drain escaping liquids to a safe location.
- Eliminate and carefully control all potential sources of ignition. Control measures must prevent the ignition source from contacting any flammable liquid or vapor.

6. Hydraulic Fluids

6.1 Hydraulic Fluids

When hydraulic oil is released by equipment failing under pressure, the usual result is an atomized spray or mist of oil droplets that can extend up to 40 feet from the break.

The flammable oil spray is readily ignited by hot surfaces (e.g., heated or molten metal, electric heaters, open flames, or welding areas). The resulting fire is like a torch with a very high rate of heat release.

Automatic sprinkler discharge can protect the building structure and prevent the involvement of other combustibles, but the torch-like fire presents little burning surface for cooling or wetting. A high heat release can continue opening sprinklers until the oil discharge is stopped.

The following considerations and information must be understood when working with or there is a presents of hydraulic fluids in GTE facilities:

- Less hazardous hydraulic fluids have been developed to replace petroleum based oils in all types of hydraulic systems.
- These fluids exhibit a high degree of combustibility. If sprayed on very hot surfaces, a fire can occur.
- Loss experience indicates that properly maintained, less hazardous hydraulic fluids significantly reduce the extent of damage in a fire as compared to petroleum based oils.
- The approved, less hazardous fluids are emulsion types, include:
 - Water glycol.
 - Synthetic.
 - Water-in-oil.

Caution: Use caution when converting from petroleum based oils to less hazardous hydraulic fluids.

- Follow the procedures recommended by the manufacturer when converting machines to the less hazardous hydraulic fluid.
- The degree of fire protection needed depends on the total quantity of petroleum based hydraulic oil released by a single hydraulic equipment failure (assuming pumps are not shutoff) and the presence of normal ignition sources during equipment operation.
- For maximum protection provide an automatic switch to shut down the oil pump and shut off the flow from accumulators. The automatic switch is activated by a sprinkler water flow alarm or separate fire detectors.
- Provide fire extinguishers suitable for flammable liquid fires. Provide a small hose with a spray nozzle if:
 - The hydraulic system is large.

OR

 - Any significant areas are shielded from sprinkler discharge.

