1996 Maxi-Lift

TOWN OF ADDISON

FIRE DEPARTMENT (214) 450-7200 FAX (214) 450-7208

Post Office Box 144 Addison, Texas 75001 4798 Airport Parkway

MAXI-LIFT INC. SPECIFICATION SUMMARY INDEX

Document A
Maxi-Lift Inc. letter and proposal to Fire Dept. requesting waiver in code requirements. Fire Dept. memos and response letter.

Document B
Portions of Article 81 of 1991ed. Uniform Fire Code which is adopted by city and enforced by Fire Department. These sections show the requirement for smoke and heat venting as for this application.

Document C
Formal interpretation of the Uniform Fire Code from **International Fire Code Institute.** Pursuant to the removal of smoke and heat vents. International Fire Code Institute, this organization is responsible for writing the fire codes.

Document D
Portions of the 1994ed. Uniform Fire Code, Article 81. This edition has not been adopted by city as of now. However, this edition should be adopted early in 1995. This edition contains the same requirements for smoke and heat venting in regards to this application. Please note D-14 to D-16. This is the Uniform Fire Code Standards concerning smoke and heat venting. The Standards Manual gives explanations and interpretations to the code.

Document E
National Fire Protection Association (NFPA) standards for ESFR sprinkler systems. This standard illustrates the many different standards that address an ESFR system.

Document F
NFPA standard for warehousing. F-2 addresses smoke and heat venting.

Document G
Factory Mutual study presented by Maxi-Lift as the basis of their request.

(A-1)

Maxi-Lift, inc.

AUGUST 17, 1994

MAXI-LIFT, INC. PROPOSED WAREHOUSE AND MANUFACTURING FACILITY
MIDWAY ROAD, ADDISON, TEXAS

SUBJECT: FIRE CODES ON SMOKE VENTS AND DRAFT CURTAINS OF CITIES SURROUNDING THE CITY OF ADDISON.

1) DAVID SESSIONS (CODE SUPERVISOR)
CITY OF DALLAS - 948-4480

THE CITY OF DALLAS REMOVED ALL CODE REQUIREMENTS FOR SMOKE VENTS AND DRAFT CURTAINS IN BUILDINGS THAT HAVE ANY TYPE SPRINKLER SYSTEM IN 1985.

2) CHARLES HOSEY (FIRE CHIEF)
CITY OF CARROLLTON - 466-3070

ELIMINATED THE CODE REQUIREMENTS FOR SMOKE VENTS AND DRAFT CURTAINS WHEN USING AN ESFR SPRINKLER SYSTEM. STILL REQUIRE MELT DROP OUT PANELS (WHICH ARE MUCH CHEAPER THAN SMOKE VENTS).

3) STEVE BOONE (CODE SUPERVISOR)
CITY OF RICHARDSON - 238-4160

SMOKE VENTS ONLY REQUIRED WITH A SPACE GREATER THAN 250 FEET FROM AN EXIT DOOR. MAXI-LIFT'S WAREHOUSE HAS NO AREA GREATER THAN 250 FEET FROM DOOR AND THUS WOULD NOT BE REQUIRED TO USE SMOKE VENTS. NO DRAFT CURTAINS ARE REQUIRED BY CITY CODE.

4) RAY KIRBY (BUILDING CODE OFFICAL)
CITY OF PLANO - 578-7209

PLANO IS IN THE PROCESS OF REVISING CODE REQUIREMENTS IN VIEW OF THE ESFR SPRINKLER SYSTEM AND IS CURRENTLY GIVING RELIEF TO PROPOSED BUILDING OWNERS ON A CASE BY CASE BASIS.

FURTHER:

PER THE ATTACHED INFORMATION, FACTORY MUTUAL STATES THAT AS A RESULT OF THEIR TESTING, SMOKE VENTS SHOULD BE AVOIDED WHEN USING AN ESFR SPRINKLER SYSTEM. THEY MAY, IN FACT, EVEN FUEL THE FIRE UNDER CERTAIN CONDITIONS.

CONCLUSION:

I BELIEVE THE ABOVE INFORMATION CLEARLY INDICATES THE CITY OF ADDISON NEEDS TO RE-EVALUATE THEIR SMOKE VENT FIRE CODE POLICY, AS ALL THE CITIES SURROUNDING US HAVE.

P.O. BOX 11-0518 • CARROLLTON, TEXAS 75011-0518
1223 CROWLEY DRIVE • CARROLLTON, TEXAS 75006
(214) 245-2542 U.S. WATS (800) 527-0657

A.2

Factory Mutual Engineering

12222 Merit Drive, Suite 1800
Dallas, Texas 75251-3209
Telephone (214) 661-9202
Fax (214) 661-1402

FAX TRANSMISSION MEMORANDUM

DATE: August 1, 1994

PLEASE DELIVER THE FOLLOWING MESSAGE TO:

NAME: Mr. Vic Sahm
COMPANY: Maxilift
FAX: 242-8203

RE: Smoke Vents with ESFR Sprinkler Protection

Dear Mr. Sahm:

I have enclosed page 2 from the Factory Mutual Data Sheet 2-2. Please refer to the marked paragraphs. The data sheet indicates from testing it has been concluded that smokes vents are not needed for ESFR sprinkler protection.

Also the ESFR sprinkler design will not allow a fire to produce as much smoke as conventional sprinklers since ESFR protection is considered a suppression mode type protection where as conventional sprinklers are of the control mode. This means ESFR's are designed to put out a fire where-as conventional sprinklers are only designed to control the fire until manual fire fighting can extinguish it.

Per our conversation you indicated some interest in finding more about one of our insurance companies. I have listed the name of the insurance company and a contact.

If you should have any further questions please feel free to call.

Regards,

Michael P. Herrmann

Michael P. Herrmann
Loss Prevention Consultant
Dallas District Office

Encl: page 2 of D.S. 2-2

MPH/mph

Mr. Wes Cellers
Allendale Mutual Insurance
991-3737 => Phone #
Dallas, TX

A.3

If provided, ceilings should be of substantial construction, capable of withstanding fire plume uplift velocity pressures of at least 3 lb/sq ft (14.6 kg/sq m). Material suitable for such a purpose includes ⅜ in. (0.95 cm) plywood, ⅜ in. (0.95 cm) gypsum board, corrugated or sheet steel, or mineral tile. Sheets of these materials should be securely fastened to the supporting framework. Hold-down clips typical of the type used to anchor ceiling tiles in Halon 1301 installations will suffice for use with mineral tile. If the ceiling is hung from the existing roof framework, it should be verified that the roof can withstand the additional dead load.

2.2.2 Steel Protection

When ESFR sprinkler systems are installed in accordance with this data sheet, fire protection of roof and column steel is not needed.

2.2.3 Heat and Smoke Venting

Recommended protection is based on construction without roof vents. Fire tests have not shown automatic vents to be cost effective; they may even increase sprinkler water demand. Thus, the use of permanent heat and smoke vents should be avoided.

If vents are unavoidable, they should be the manually operated type, or equipped with fusible links rated at a minimum 360°F (182°C). Drop-out (or melt-out) type plastic vents should not be used because they cannot be arranged for manual or delayed operation.

ESFR sprinklers, as compared to conventional sprinklers, are expected to reduce greatly the amount of smoke generated during a fire. As an alternative to automatic roof vents, smoke removal during mop-up operations can frequently be achieved through eave-line windows, doors, monitors, nonautomatic exhaust systems (gravity or mechanical), or manually operated heat and smoke vents. Fire departments can cut holes in steel or wood roofs and also use smoke exhausters.

2.2.4 Draft Curtains

Draft curtains are intended for use in two ways: 1) in combination with heat and smoke vents as required by building codes to subdivide roof areas, and; 2) to divide roof areas protected by ESFR sprinklers from roof areas protected by conventional sprinklers. Both applications are discussed as follows:

1. Draft curtains used in conjunction with heat or smoke vents should be avoided, if possible. With the early fire suppression expected, it is anticipated that draft curtains will provide little benefit because heat and smoke generation will be minimized. Also, in sprinklered storage fires, smoke is generally driven to floor level once sprinklers operate. If draft curtains must be installed, they should be limited in depth and located with respect to sprinklers so that the guidelines in Table 2 are followed. The obstruction to sprinkler discharge which would be created by an improperly designed draft curtain could adversely affect sprinkler system performance. The need to avoid obstructions to sprinkler discharge far outweighs the benefits which may (or may not) be derived from installing the draft curtains in the first place.

2. A draft curtain should be installed between areas protected by ESFR sprinklers and areas protected by other types of sprinklers. This applies in all cases, whether the roofs over the two areas are at the same elevation or at different elevations. The draft curtains should extend at least 4 ft (1.2 m) below the ceiling, be noncombustible and fit tightly against the underside of the roof. Maintain a clear aisle at least 5 ft (1.5 m) on each side of the centerline beneath the draft curtain. ESFR sprinklers may operate unnecessarily and deplete water supplies if a fire occurs in the area protected by other, standard-response type sprinklers unless physical separation between the two areas is provided.

2.3 Storage Arrangements

ESFR sprinklers are intended for use as protection for a wide range of storages. They can be used to protect palletized and solid-piled storage, bin box, and open-frame single-row, double-row, multiple-row, and portable rack storage of most common materials of any height *up to* 25 ft (7.6 m) high, in buildings of any height *up to* 30 ft (9.1 m) high. Lesser storage heights in buildings less than 30 ft (9.1 m) high can also be protected as outlined in this data sheet.

Specific commodities protectable by ESFR sprinklers include:

- Class I, II, III and IV commodities, encapsulated or unencapsulated;
- unexpanded and expanded plastics inside cardboard or paper cartons, encapsulated or unencapsulated;
- solid five-sided totally noncombustible containers used to store commodities having a hazard level of expanded plastics or less;
- certain roll paper storage as covered in Data Sheet 8-21S, *Roll Paper Storage with ESFR Sprinklers;*
- certain aerosol storage as covered in the Technical Advisory Bulletin (filed with Data Sheet 7-29S), entitled *Storage of Aerosol Products – ESFR Protection.*

Specific commodities and storage arrangements for which ESFR sprinklers cannot be used are:

- Exposed plastics which have not been successfully tested;
- flammable or combustible liquids in plastic or metal containers (except Class III combustible liquids in closed metal containers);
- racks with solid shelves (i.e., shelves greater than 20 sq ft [1.9 sq m] in area);
- open-top combustible containers;
- Unusual commodities or storage arrangements which have not been judged, by either testing *or* analysis, to be appropriate for ESFR sprinkler protection.

Rev. 4/93

(A-4)

TOWN OF ADDISON

FIRE DEPARTMENT

(214) 450-7200 FAX (214) 450-7208

Post Office Box 144 Addison, Texas 75001

4798 Airport Parkway

August 23, 1994

Mr. Vic Sahm
Maxi-Lift Inc.
1223 Crowley Drive
Carrollton, Texas
75006

Dear Mr. Sahm:

Further to your meeting of August 19, 1994 with Chief Wallingford, please be advised that the Prevention Division was instructed to further research the smoke and heat vent requirements and ESFR sprinkler systems.

The information was complied and upon further review, the Fire Department's position on this issue remains **unchanged**.

We would certainly welcome your business to Addison but you should understand that the construction of the building **must comply** with Article 81 of the Uniform Fire Code 1991 and in principle, the installation of smoke and heat vents as stated by the code.

The Fire Prevention Division has found nothing to support your request for the waiver and elimination of this requirement but has, in fact, found substantial documentation to contradict your proposal.

Please note that at this time, the water line supplying the required fire hydrants {a minimum of six (6)} will have to remain as a looped system.

However, should you supply this office with proper documentation from a certified, registered engineering firm that states the water flow from a "dead end line", non-looped system, is sufficient to supply an ESFR sprinkler system and support fire fighting efforts, this office would then consider an alternative method. This would require a submittal of hydraulic calculations and drawings on the ESFR sprinkler system and related fire pump capacity.

. . .2/continued

Mr. Vic Sahm
Maxi-Lift Inc.
Carrollton, Texas
August 23, 1994

Also, please be advised of a further requirement which will be necessary for your company to comply with. The Uniform Fire Code, Article 81, Section 81.103, mandates that any building used for high-piled combustible storage is required to have a permit issued by the Fire Prevention Division. A representative of your company will need to make application for this permit after all other Fire Department requirements are met.

Please do not hesitate to contact my office, should you have any questions, comments or concerns regarding this matter.

Yours sincerely,

Jim Stephens
Fire Prevention Officer
ADDISON FIRE DEPARTMENT

JGS/le
cc: Bob Wallingford, Fire Chief
Lynn Chandler, Building Official
Carmen Moran, City Secretary

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TOWN OF ADDISON

FIRE DEPARTMENT (214) 450-7200 FAX (214) 450-7208

Post Office Box 144 Addison, Texas 75001 4798 Airport Parkway

MEMORANDUM

August 24, 1994

TO: ***Bob Wallingford, Fire Chief/Fire Marshal***
FROM: ***Bruce A. Mueller, Inspector/Investigator*** BAM
SUBJECT: ***Fire Code Requirements on Smoke and Heat Venting of Cities Around Addison***

Based on the information received from Maxi-Lift, Inc. on their proposed warehouse and manufacturing facility on Midway Rd. I surveyed the same cities and received some different information. Draft curtains were not covered in my questions since we are not requiring them anyway.

1) Jerry Dempster (Fire Protection Engineer)
Dallas Fire Department - 670-3782

Dallas did indeed remove requirements for smoke and heat venting in buildings with approved automatic sprinkler systems in 1985. This change was apparently based on conclusions of the Shirmer Report (a staffing study of the Dallas Fire Department) that they were not necessary. Dallas has adequate manpower to manually ventilate even a large warehouse type structure by cutting the roof.

2) Charles Hosey (Fire Marshal)
Carrollton Fire Department - 466-3210

Based upon Factory Mutual Loss Prevention Data Sheet 2-2 and appendix information in NFPA 231, Standard for General Storage and NFPA 231C, Standard for Rack Storage of Materials, Carrollton changed requirements by policy. They do not require automatic smoke and heat venting if an approved ESFR sprinkler system is installed. Melt drop out panels are required as well as capability to use mechanical ventilation equipment for smoke removal. We have discovered that Factory Mutual's recommendations may be misguided and NFPA's appendices state that vents should not be open prior to sprinkler activation and that design curve data is based on roof vents not being used. Our fire code as adopted requires use of automatic smoke and heat vents and recommends setting to activate after sprinkler activation.

3) Steve Boone (Code Supervisor)
Richardson Building Department - 238-4180

Richardson uses Southern Standard codes, as opposed to Uniform codes which are used by almost every other municipality in the Metroplex. Southern Standard codes consider exit travel distance for the occupants and do not consider smoke removal for manual fire fighting and overhaul operations.

4) David Kerr (Fire Protection Engineer)
Plano Fire Department - 578-7161

Plano evaluates requirements for this type facility on a case-by-case basis based on commodity, building area, storage height, etc. (per 1991 UFC Article 81). A 100,000+ sq ft plastics manufacturing/storage facility with storage above 15 ft would need smoke/heat vents and sprinklers. They are not revising code requirements.

One reason for the differing information is that without details of building size, layout and processes involved it is difficult to make a determination. My impression is that the cities which gave me different interpretation than they gave Maxi-Lift were not given complete information by Maxi-Lift to analyze.

Use of smoke and heat vents in sprinklered buildings is an age-old question which has generated more disagreement among fire protection professionals than any other high-piled fire protection issue. Currently adopted codes (which are nationally recognized) is our best source of information on this subject. I recommend we require compliance with our code.

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TOWN OF ADDISON

FIRE DEPARTMENT (214) 450-7200 FAX (214) 450-7208

Post Office Box 144 Addison, Texas 75001 4798 Airport Parkway

M E M O R A N D U M

September 01, 1994

TO: Bob Wallingford, Fire Chief
FROM: Jim Stephens, Fire Prevention Officer
SUBJECT: Code Enforcement Survey, Area Departments

Pursuant to our conversation and in response to the survey conducted by Maxi-Lift, please make note of the following findings.

This survey was conducted in an effort to further solidify our position on the issue of smoke and heat vents. It was also conducted in a continuing effort to try and help Maxi-Lift resolve this issue. However, despite the effort I was unable to uncover any documentation to further support Maxi-Lift's position.

All of the following departments were asked the same questions and presented with the same scenario as this Department has before it.
1. Building a 100,000+sq.ft. building
2. Plastics molding manufacturing plant with high pile storage.
3. Installation of an ESFR sprinkler system.
4. Are smoke and heat vents required?

Arlington F.D.(817) 459-5526-James Patterson, Deputy Fire Marshal.
Smoke and heat vents are required by U.F.C. '91ed.

Irving F.D.(214) 721-2651-Mary Pettigrew, Assistant Fire Marshal.
Smoke and heat vents are required by U.F.C. '91ed.

Coppell F.D.(214) 462-1133-John Linstrom, Assistant Fire Marshal.
Smoke and heat vents are required by U.F.C. '91ed.

The Colony F.D.(214) 625-3944-David Wallace, Fire Marshal.
Answer same as above.

Farmers Branch F.D.(214) 919-2656-Gordon Robbins, Fire Marshal.
Answer same as above.

Fort Worth F.D.(817) 871-6808-Jim Tidwell, Assistant Fire Marshal.
Answer same as above.

B-1

ARTICLE 81
HIGH-PILED COMBUSTIBLE STORAGE

Scope

Sec. 81.101. Storage of high-piled combustible material and high-rack storage systems shall be in accordance with this article. Factors such as method and height of stock piling, combustibility of materials, fuel load and rate of heat release, areas and size of piles, aisles, automatic fire-extinguishing systems, smoke-removal systems, fire protection and fire separations are considered. In the absence of specific provisions in the article, U.F.C. Standard No. 81-1 or 81-2 shall apply.

Definitions

Sec. 81.102. For definitions of AEROSOL, COMMODITY, DESIGNATED HIGH-PILED COMBUSTIBLE STORAGE AREA, HIGH-PILED COMBUSTIBLE STORAGE and HIGH-RACK STORAGE SYSTEMS, see Article 9.

Permits

Sec. 81.103. For permits to use buildings for high-piled combustible storage, see Section 4.108.

Commodity Classifications

Sec. 81.104. (a) **General.** Commodity classifications shall be as defined and in accordance with this section.

Plastic materials listed within each commodity classification are assumed to not be modified for improved combustibility characteristics. Use of flame-retarding modifiers or the physical form of the material can change the classification.

(b) **Class I Commodities.** Class I commodities are commodities which are essentially noncombustible products on wooden or nonexpanded polyethylene solid deck pallets, in ordinary corrugated cartons with or without single-thickness dividers, or in ordinary paper wrappings with or without pallets. Examples of Class I commodities include, but are not limited to, the following:

Appliances, electrical
Beer or wine up to 20 percent alcohol
Cement in bags
Ceramics
Dairy products in nonwax-coated containers
Dry insecticides
Foods in noncombustible containers
Frozen foods
Fresh fruits and vegetables in nonplastic trays or containers
Glass

Nationally recognized standards or guidelines as applicable may be used when approved by the chief.

Automatic Fire-extinguishing Systems

Sec. 81.106. (a) **General.** When required by Table No. 81.105-A, an approved automatic fire-extinguishing system shall be provided. The design and installation of automatic fire-extinguishing systems shall be in accordance with the Building Code and U.F.C. Standard No. 81-1 or No. 81-2. The design and installation of automatic fire-extinguishing systems for the storage of Level 2 and Level 3 aerosol products shall also be in accordance with Article 88.

(b) **System Design.** The fire-extinguishing systems shall be designed by a registered engineer or an approved designer. When approving a system design, the chief may consider the standards and recommendations of the National Fire Protection Association, Factory Mutual Engineering or other nationally recognized fire-protection authorities.

Smoke Venting, Smoke Removal Systems and Curtain Boards

Sec. 81.107. (a) **General.** When required by Table No. 81.105-A, smoke and heat vents or mechanical smoke removal systems shall be provided, and shall be in accordance with this section.

(b) **Smoke and Heat Vents and Curtain Boards.** 1. **General.** The design and installation of smoke and heat vents and curtain boards shall be as specified in the Building Code, except as modified by this subsection.

2. **Vent design.** Smoke and heat vents shall be approved and shall be operated automatically by actuation of a heat-responsive device rated at between 100°F. and 220°F. above ambient. Approved smoke and heat vents shall activate fully when the vent cavity is exposed to a simulated fire or a time/temperature gradient that reaches an air temperature of 500°F. within five minutes. Smoke and heat vents shall have the capability of being opened by an approved manual operation.

3. **Vent dimensions.** The minimum dimension of any smoke and heat vent opening shall not be less than 4 feet.

4. **Location of vents and curtain boards.** Smoke and heat vents and curtain boards shall be installed in accordance with Table No. 81.107-A.

(c) **Mechanical Smoke Removal Systems.** 1. **General.** Mechanical smoke removal system capability shall be determined as set forth in this subsection.

2. **Location of curtain boards.** Curtain boards shall be provided in accordance with Table No. 81.107-A.

3. **System capacity.** The volume of mechanical ventilation required shall be determined by the following formula:

$$V = A \times 300$$

WHERE:

V = volume of mechanical ventilation required, in cubic feet per minute.

A = area of roof vents required by Table No. 81.107-A, in square feet.

TABLE NO. 81.105-A—REQUIREMENTS FOR FIRE PROTECTION

COMMODITY CLASS	DESIGNATED STORAGE AREA[1] (sq. ft.)	AUTOMATIC FIRE-EXTINGUISHING SYSTEM	SMOKE DETECTION SYSTEM[2]	BUILDING ACCESS (Sec. 81.109)	MINIMUM AISLE WIDTH	MAXIMUM PILE DIMENSION[3] (ft.)	MAXIMUM USABLE STORAGE HEIGHT[4,5,6] (ft.)	MAXIMUM PILE VOLUME (cu. ft.)	SMOKE REMOVAL		SMALL HOSE CONNECTION	
									Mechanical	Vents	1½" Valves	Additional Equipment[7]
I-IV	0-500	N/R	N/R	N/R[8]	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R
	501-2,500	N/R	Yes	N/R[8]	8 ft.	100	40	100,000	N/R	N/R	N/R	N/R
	2,501-12,000 Option 1	Yes	N/R	N/R[8]	[9]	100	40	400,000	N/R	N/R	N/R	N/R
	2,501-12,000 Option 2	N/R	Yes	Yes	8 ft.	100	40	200,000	Not allowed	Yes	Yes	Yes
	12,001-20,000	Yes	N/R	Yes	[9]	100	40	400,000	[10]		N/R	N/R
	20,001-300,000	Yes	N/R	Yes	[9]	100	40	400,000	[10]		Yes	Yes
	Greater than 300,000[11]	Yes	[12]	Yes	[9]	100	Unlimited	Unlimited	[10]		[12]	Yes
V	0-500	N/R	N/R	N/R[8]	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R
	501-2,500[13]	N/R	Yes	N/R[8]	8 ft.	50	20	50,000	N/R	N/R	Yes	Yes
	2,501-50,000[13]	Yes	[12]	Yes	8 ft.[7]	50	30	75,000	[10]		Yes	Yes

[1]High-piled stock area is allowed to be treated as a separate area if it is separated from other areas of the building with a two-hour area separation wall or if individual areas are a minimum 60 feet apart measured horizontally in a direct line and there is no combustible storage between piles.

[2]Smoke detection systems shall be supervised and installed throughout the building.

[3]Not applicable to double- or single-row rack storage with adjacent aisles.

[4]Usable storage height is the distance from the floor to a point not less than 18 inches below the ceiling sprinkler head deflectors.

[5]For storage in excess of 40 feet in height, protection shall be provided as required for designated storage areas exceeding 300,000 square feet.

[6]For Level 2 and Level 3 aerosol products, see Article 88.

[7]When "yes" appears in this column, hoses, nozzles, hose racks and cabinets shall be provided as required by the chief.

[8]Article 10, Division II shall apply.

[9]Access aisles shall be provided as specified in 81.108. Where precluded by high-rack storage systems, alternate methods of access and alternate approved methods of protection may be provided as approved by the chief.

[10]Smoke and heat vents or mechanical smoke-removal systems shall be provided. The type of system to be used, mechanical or vents, shall be approved by the chief based on nationally recognized engineering practices.

[11]Special fire-protection provisions, such as but not limited to, area separation walls, fire protection of exposed steel, in-rack smoke detection, increased sprinkler density or additional in-rack sprinklers shall be provided when required by the chief.

[12]As required by the chief.

[13]Nationally recognized standards or guidelines as applicable to specific commodities may be used when approved by the chief.

N/R—Not Required

C-1

INTERNATIONAL FIRE CODE INSTITUTE™

UNIFORM FIRE CODE INTERPRETATION

SUBJECT: **Recent Factory Mutual Test Data and Elimination of Smoke and Heat Vents and Draft Curtains When ESFR Sprinkler Systems are Installed**

Q: What is IFCI's position on the eleimination of smoke and heat vents based on the Factory Mutual Loss Prevention Data Sheet 2-2 regarding Early Suppression Fast Response (ESFR) sprinklers which recommends construction without roof vents and draft curtains?

A: At this time, the tests upon which this recommendation is based do not appear to have been exhaustive enough to warrant elimination of roof vents and draft curtains required in Article 81. In fact, recent fire test summaries from FM state that test data should be considered preliminary and may be subject to correction or change. Without exhaustive tests and a thorough review of the test results by qualified independent fire protection engineers and our membership, IFCI's position, based on the current U.F.C. requirements is that roof vents and draft curtains should not be eliminated. We will continue to take this position regarding application of Article 81 with respect to roof vents and draft curtains until such time that a code change to review the code requirements is successful. You may wish to note that the U.F.C. requirements for draft curtains did change in the 1994 edition to only require curtains around the perimeters of ESFR sprinkler systems.

Attached, please find a copy of a recent code interpretation that expands further on the subject.

(#1502:ufc\interps\drftcrtns.91)

C-2

Uniform Fire Code Interpretation

American Fire Journal
June 1994 Issue

by: Jeffrey M. Shapiro, P.E.
Coordinator, Uniform Fire Code

SUBJECTS: Clearance Below Ceilings
Section 11.303 (b)

Storage of Pesticides
Section 80.301 and Article 86

Acceptability of using an early suppression, fast response (ESFR) sprinkler system in lieu of the required smoke venting and draft curtain requirements
Table No. 81.105

Uniform Fire Code, 1991 Edition

Q1: What is the purpose of the requirement in Section 11.303 (b) 1 requiring a 2-foot clearance from ceilings for storage of combustible materials in buildings, and does this regulation apply to storage along exterior walls?

A1: Section 11.303 (b) 1 requires a 2-foot separation between the top of combustible storage and ceilings to provide a space for firefighters to direct hoses on top of or over storage during firefighting operations. The code does not provide an exception to this requirement for storage located along exterior walls; however, from a practical standpoint if the storage along walls is relatively shallow, there may be adequate access for firefighters to extinguish a fire in such areas without the required ceiling clearance. This determination would be within the scope of the chief's authority by accepting shallow storage along walls as providing equivalent firefighting access to the code specified 2-foot clearance.

Q2: Is a commercial pest control company allowed to store their pesticides in a residential shed next to a house?

A2: Yes. The building containing the pesticides must be properly classified with respect to occupancy. In addition, local zoning regulations should be evaluated regarding the storage of commercial products in a residential area.

The building in question should be classified as either a Group B, Division 2 or Group B, Division 4 Occupancy, provided that exempt amounts are not exceeded, and it must meet all related regulations. The Group B, Division 4 classification should only be applied if all stored material, containers, shelves, etc. are noncombustible. In addition, all regulations in U.F.C. Article 86 will be applicable.

C-3

Q3: What does Article 80 require for storage of pesticides that are toxic solids or liquids below the exempt amounts on Table 80.312-A?

A3: Storage of hazardous materials in quantities less than exempt amounts are regulated by Section 80.301(a) 3 and Article 80, Division I.

Q4: A proposed facility will have an area of approximately 100,000 square feet. The building will be fully sprinklered and provided with a monitored fire alarm system. The facility is to be used for storage of Class IV commodities on pallets, stacked to height of approximately 16 feet without racks. The owner has proposed using an early suppression-fast response (ESFR) sprinkler system in lieu of smoke and heat removal systems and draft curtains. Is this an acceptable alternative method?

A4: No. First consider the possible elimination of venting. Most certainly it can be argued that if a sprinkler system, ESFR or standard, is able to control a fire, the need for smoke and heat venting or a mechanical smoke removal system is primarily for salvage and overhaul and restoring the building to operational capacity. Furthermore, it can be argued that the early suppression-fast response sprinkler system is likely to control the fire more rapidly than a standard sprinkler system when the system is operating properly and the commodity protected is commensurate with the design of the system. However, these two contingencies, the system operating properly and a commodity commensurate with design, among others create enough of a margin for failure of the sprinkler system to control a fire that the overall level of protection would be compromised if smoke and heat venting were not provided. Venting, at a minimum, serves as an added factor or safety.

Unlike most storage warehouses, warehouses containing high-piled combustible storage present a significantly greater fire load arranged in a manner which increases the burning rate of materials stored. Should the sprinkler system be unable to control a fire; perhaps because the system is out-of-service for maintenance, the commodity stored has changed to one which requires a greater density, the fire is ignited in such a manner to overpower the sprinkler system (such as aerosols, flammable liquids or perhaps a leaking fuel tank from a forklift), or if the fire is shielded in some manner from the sprinkler water, the potential for disaster exists if adequate ventilation is not provided.

In the event that the sprinkler system does not control the fire, vents and high volume mechanical smoke ventilation systems provide a means of releasing smoke and heated gases to facilitate a manual fire attack. The issue of whether the operation of vents would inhibit the proper operation of sprinkler systems can be avoided by using operating mechanisms on vents which are arranged to actuate only after sprinklers have operated and failed to adequately control a fire. Such an arrangement can be created by studying the response time indices of the links used on the venting system versus those used on the sprinklers. Without high volume venting, it can be stated with a great degree of certainty that the fire department will be unable to achieve control of a fire within this building if the sprinkler system fails to provide control.

C.4

With high volume venting, there is a possibility that interior conditions could to allow firefighters to enter a building for an interior attack and perhaps achieve control. Elimination of venting places the entire burden for protection in the hands of the sprinkler system.

Another related feature required by the U.F.C. is draft curtains. The purpose of draft curtains is primarily to reduce the spread of smoke and heated gases along the ceiling and also to limit the number of sprinklers operated from a flash fire. Both of these purposes seem commensurate with, rather than in conflict with, the use of an ESFR sprinkler system; however, concerns have been expressed that draft curtains in a building protected with ESFR sprinklers may deflect sprinkler discharge and risk system failure for these closely engineered systems. Also, desires have been expressed to encourage the use of ESFR systems and recognize the increased safety provided by reducing the draft curtain requirements in ESFR protected buildings. As a result, a code revision allowing draft curtain requirements to be reduced, providing curtains only around the perimeters of ESFR Systems was successful, and in the 1994 edition of the U.F.C., Article 81 reflects this revision.

In conclusion, we do not feel that it would be appropriate to allow elimination of venting and draft curtains based on the installation of an ESFR sprinkler system. Such a reliance would reduce the secondary level of safety required by the code, and should a fire occur in the building which is not controlled by the sprinklers, it may require an inordinate demand on fire suppression forces to contain the fire to the warehouse. A reduction in draft curtains commensurate with the revisions for ESFR Systems in the 1994 Code would be reasonable.

ARTICLE 81 — HIGH-PILED COMBUSTIBLE STORAGE

SECTION 8101 — GENERAL

8101.1 Scope. Buildings containing high-piled combustible storage shall be in accordance with Article 81. In addition to the requirements of Article 81, aerosols shall be in accordance with Article 88, flammable and combustible liquids shall be in accordance with Article 79, and hazardous materials shall be in accordance with Article 80.

8101.2 Definitions.

8101.2.1 General. For definitions of AEROSOL; ARRAY; ARRAY, CLOSED; BINBOX; COMMODITY; CURTAIN BOARD; EARLY SUPPRESSION FAST-RESPONSE SPRINKLER; EXPANDED PLASTIC; EXTRAHIGH-RACK COMBUSTIBLE STORAGE; HIGH-PILED COMBUSTIBLE STORAGE; LONGITUDINAL FLUE SPACE; MANUAL STOCKING METHODS; MECHANICAL STOCKING METHODS; SHELF STORAGE; AND TRANSVERSE FLUE SPACE, see Article 2.

8101.2.2 Limited application. For the purpose of Article 81, certain terms are defined as follows:

HIGH-PILED STORAGE AREA is an area within a building which is designated, intended, proposed or actually used for high-piled combustible storage.

SOLID SHELVING is shelving that is solid, slatted, mesh, or grated located within racks that obstructs sprinkler water penetration through the racks.

8101.3 Permits and Plan Submittal.

8101.3.1 Permits. For a permit to use a building for high-piled combustible storage, see Section 105, Permit h.3.

8101.3.2 Plans and specifications submittal. At the time of permit application, plans and specifications including the information specified in Section 8101.3.2 shall be submitted for review and approval. Following approval of the plans, a copy of the approved plans shall be maintained on the premises in an approved location. The plans shall include the following:

1. Floor plan of the building showing locations and dimensions of high-piled storage areas.
2. Useable storage height for each storage area.
3. Number of tiers within each rack, if applicable.
4. Commodity clearance between top of storage and the sprinkler deflector for each storage arrangement.
5. Aisle dimensions between each storage array.
6. Maximum pile volume for each storage array.
7. Location and classification of commodities in accordance with Section 8101.4.
8. Location of commodities which are banded or encapsulated.
9. Location of required fire department access doors.
10. Type of fire-suppression and fire-detection systems.
11. Location of valves controlling the water supply of ceiling and in-rack sprinklers.
12. Type, location and specifications of smoke-removal and curtain board systems.
13. Dimension and location of transverse and longitudinal flue spaces.
14. Additional information regarding required design features, commodities, storage arrangement and fire-protection features within the high-piled storage area shall be provided at the time of permit, when required by the chief.

8101.3.3 Evacuation plan. When required by the chief, an evacuation plan for public accessible areas and a separate set of plans indicating location and width of aisles, location of exits and exit signs, height of storage, and locations of hazardous materials shall be submitted at the time of permit application for review and approval. Following approval of the plans, a copy of the approved plans shall be maintained on the premises in an approved location.

8101.4 Commodity Classification.

8101.4.1 General.

8101.4.1.1 Classification of commodities. Commodities shall be classified as Class I, II, III, IV or high hazard in accordance with Section 8101.4.1. Materials listed within each commodity classification are assumed to be unmodified for improved combustibility characteristics. Use of flame-retarding modifiers or the physical form of the material could change the classification. See Section 8101.4.2 for classification of Groups A, B and C plastics.

8101.4.1.2 Class I commodities. Class I commodities are essentially noncombustible products on wooden or nonexpanded polyethylene solid deck pallets, in ordinary corrugated cartons with or without single-thickness dividers, or in ordinary paper wrappings with or without pallets. Class I commodities are allowed to contain a limited amount of Group A plastics in accordance with Section 8101.4.3. Examples of Class I commodities include, but are not limited to, the following:

Alcoholic beverages not exceeding 20 percent alcohol

Appliances—noncombustible, electrical

Cement in bags

Ceramics

Dairy products in nonwax-coated containers (excluding bottles)

Dry insecticides

Foods in noncombustible containers

Fresh fruits and vegetables in nonplastic trays or containers

Frozen foods

Glass

Glycol in metal cans

Gypsum board

Inert materials, bagged

Insulation, noncombustible

Noncombustible liquids in plastic containers having less than a 5-gallon (18.9 L) capacity

Noncombustible metal products

8101.4.1.3 Class II commodities. Class II commodities are Class I products in slatted wooden crates, solid wooden boxes, multiple-thickness paperboard cartons or equivalent combustible packaging material with or without pallets. Class II commodities are allowed to contain a limited amount of Group A plastics in accordance with Section 8101.4.3. Examples of Class II commodities include, but are not limited to, the following:

Alcoholic beverages not exceeding 20 percent alcohol, in combustible containers

Foods in combustible containers

Incandescent or fluorescent light bulbs in cartons

Thinly coated fine wire on reels or in cartons

8101.4.1.4 Class III commodities. Class III commodities are commodities of wood, paper, natural fiber cloth, or Group C plastics or products thereof, with or without pallets. Products are allowed to contain limited amounts of Group A or B plastics, such as metal bicycles with plastic handles, pedals, seats and tires. Group A plastics shall be limited in accordance with Section 8101.4.3. Examples of Class III commodities include, but are not limited to, the following:

Aerosol, Level 1 (see Article 88)

Combustible fiberboard

Cork, baled

Feed, bagged

Fertilizers, bagged

Food in plastic containers

Furniture: wood, natural fiber, upholstered, nonplastic, wood or metal with plastic-padded and covered arm rests

Glycol in combustible containers not exceeding 25 percent

Lubricating or hydraulic fluid in metal cans

Lumber

Mattresses, excluding foamed rubber and foamed plastics

Noncombustible liquids in plastic containers having a capacity of more than 5 gallons (18.9 L)

Paints, oil base, in metal cans

Paper, waste, baled

Paper and pulp, horizontal storage, or vertical storage that is banded or protected with approved wrap

Paper in cardboard boxes

Pillows, excluding foamed rubber and foamed plastics

Plastic-coated paper food containers

Plywood

Rags, baled

Rugs, without foamed backing

Sugar, bagged

Wood, baled

Wood doors, frames and cabinets

Yarns of natural fiber and viscose

8101.4.1.5 Class IV commodities. Class IV commodities are Class I, II or III products containing Group A plastics in ordinary corrugated cartons and Classes I, II and III products, with Group A plastic packaging, with or without pallets. Group B plastics and free-flowing Group A plastics are also included in this class. The total amount of nonfree-flowing Group A plastics shall be in accordance with Section 8101.4.3. Examples of Class IV commodities include, but are not limited to, the following:

Aerosol, Level 2 (see Article 88)

Alcoholic beverages, exceeding 20 percent but less than 80 percent alcohol, in cans or bottles in cartons

Clothing, synthetic or nonviscose

Combustible metal products (solid)

Furniture, plastic upholstered

Furniture, wood or metal with plastic covering and padding

Glycol in combustible containers (greater than 25 percent and less than 50 percent)

Linoleum products

Paints, oil base in combustible containers

Pharmaceutical, alcoholic elixirs, tonics, etc.

Rugs, foamed back

Shingles, asphalt

Thread or yarn, synthetic or nonviscose

8101.4.1.6 High-hazard commodities. High-hazard commodities are high-hazard products presenting special fire hazards beyond those of Class I, II, III or IV. Group A plastics not otherwise classified are included in this class. Examples of high-hazard commodities include, but are not limited to, the following:

Aerosol, Level 3 (see Article 88)

Alcoholic beverages, exceeding 80 percent alcohol, in bottles or cartons

Flammable solids (except solid combustible metals)

Glycol in combustible containers (50 percent or greater)

Lacquers, which dry by solvent evaporation, in metal cans or cartons

Lubricating or hydraulic fluid in plastic containers

Mattresses, foamed rubber or foamed plastics

Pallets and flats which are idle combustible

Paper, asphalt, rolled, horizontal storage

Paper, asphalt, rolled, vertical storage

Paper and pulp, rolled, in vertical storage which is unbanded or not protected with an approved wrap

Pillows, foamed rubber and foamed plastics

Pyroxylin

Rubber tires

Vegetable oil and butter in plastic containers

8101.4.2 Classification of plastics.

8101.4.2.1 General. Plastics shall be designated as Group A, B or C in accordance with Section 8101.4.2.

8101.4.2.2 Group A plastics. Group A plastics are plastic materials having a heat of combustion that is much higher than that of ordinary combustibles, and a burning rate higher than that of Group B plastics. Examples of Group A plastics include, but are not limited to, the following:

ABS (acrylonitrile-butadiene-styrene copolymer)

Acetal (polyformaldehyde)

Acrylic (polymethyl methacrylate)

Butyl rubber

EPDM (ethylene-propylene rubber)

FRP (fiberglass-reinforced polyester)

Natural rubber (expanded)

Nitrile rubber (acrylonitrile-butadiene rubber)

PET or PETE (polyethylene terephthalate)

Polybutadiene

Polycarbonate

Polyester elastomer

Polyethylene

Polypropylene

Polystyrene (expanded and unexpanded)

Polyurethane (expanded and unexpanded)

PVC (polyvinyl chloride greater than 15 percent plasticized, e.g., coated fabric unsupported film)

SAN (styrene acrylonitrile)

SBR (styrene-butadiene rubber)

8101.4.2.3 Group B plastics. Group B plastics are plastic materials having a heat of combustion and a burning rate higher than that of ordinary combustibles, but not as high as those of Group A plastics. Examples of Group B plastics include, but are not limited to, the following:

Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)

Chloroprene rubber

Fluoroplastics (ECTFE, ethylene-chlorotrifluoroethylene copolymer; ETFE, ethylene-tetrafluoroethylene copolymer; FEP, fluorinated ethylene-propylene copolymer)

Natural rubber (nonexpanded)

Nylon (Nylon 6, Nylon 6/6)

PVC (polyvinyl chloride greater than 5 percent, but not exceeding 15 percent plasticized)

Silicone rubber

8101.4.2.4 Group C plastics. Group C plastics are plastic materials which have a heat of combustion and a burning rate similar to those of ordinary combustibles. Examples of Group C plastics include, but are not limited to, the following:

Fluoroplastics (PCTFE, polychlorotrifluoroethylene; PTFE, polytetrafluoroethylene)

Melamine (melamine formaldehyde)

Phenol

PVC (polyvinyl chloride, rigid or plasticized less than 5 percent, e.g., pipe, pipe fittings)

PVDC (polyvinylidene chloride)

PVDF (polyvinylidene fluoride)

PVF (polyvinyl fluoride)

Urea (urea formaldehyde)

8101.4.3 Limited quantities of Group A plastics in mixed commodities. Figure 8101.4-A shall be used to determine the quantity of Group A Plastics allowed to be stored in a package or carton or on a pallet without increasing the commodity classification.

8101.5 Designation of High-piled Storage Areas.

8101.5.1 General. High-piled storage areas, and portions of high-piled storage areas intended for storage of a different commodity class than adjacent areas, shall be designed and specifically designated to contain Class I, Class II, Class III, Class IV or high-hazard commodities. The designation of a high-piled combustible storage area, or portion thereof intended for storage of a different commodity class, shall be based on the highest hazard commodity class stored except as provided in Section 8101.5.2.

8101.5.2 Designation based on engineering analysis. The designation of a high-piled combustible storage area, or portion thereof, is allowed to be based on a lower hazard class than that of the highest class of commodity stored when a limited quantity of the higher hazard commodity has been demonstrated by engineering analysis to be adequately protected by the sprinkler system provided. The engineering analysis shall consider the ability of the sprinkler system to deliver the higher density required by the higher-hazard commodity. The higher density shall be based on the actual storage height of the pile or rack and the minimum allowable design area for sprinkler operation as set forth in the density/area figures provided in U.F.C. Standards 81-1 and 81-2. The contiguous area occupied by higher-hazard commodity shall not exceed 120 square feet (11.15 m^2), and additional areas of higher-hazard commodity shall be separated from other such areas by 25 feet (7620 mm) or more.

The sprinkler system shall be capable of delivering the higher density over a minimum area of 900 square feet (83.6 m^2) for wet pipe systems and 1,200 square feet (111.5 m^2) for dry pipe systems. The shape of the design area shall be in accordance with the Building Code (see U.B.C. Standard 9-1).

8101.6 Housekeeping and Maintenance.

8101.6.1 Rack structures. The structural integrity of racks shall be maintained.

8101.6.2 Ignition sources.

8101.6.2.1 General. Clearance from ignition sources shall be provided in accordance with Section 1109.

8101.6.2.2 Smoking. Smoking shall be prohibited. Approved NO SMOKING signs shall be conspicuously posted. See Section 1109.4.

8101.6.3 Aisle maintenance. When restocking is not being conducted, aisles shall be kept clear of storage, waste material and debris. Fire department access doors, aisles and exit doors shall not be obstructed.

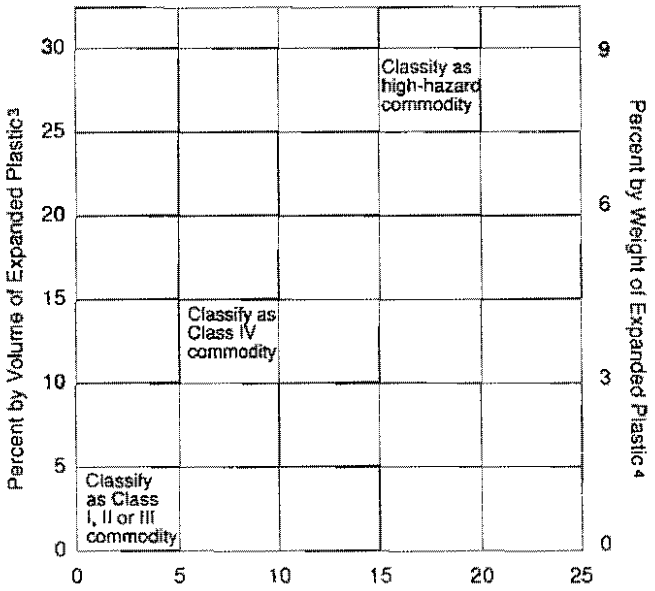
During restocking operations using manual stocking methods, a minimum unobstructed aisle width of 24 inches (609.6 mm) shall be maintained in 48-inch (1219.2 mm) or smaller aisles, and a minimum unobstructed aisle width of one half of the required aisle width shall be maintained in aisles greater than 48 inches (1219.2 mm). During mechanical stocking operations, a minimum unobstructed aisle width of 44 inches (1117.6 mm) shall be maintained. See Section 8102.9.

8101.6.4 Pile dimension and height limitations. See Section 8103.3.

8101.6.5 Arrays. See Section 8103.4.

8101.6.6 Flue spaces. See Section 8104.3.

FIGURE 8101.4-A—MIXED COMMODITIES[1,2]
(See Section 8101.4.3)



[1]This table is intended to determine the commodity classification of a mixed commodity in a package, carton or on a pallet when plastics are involved.

[2]The following is an example of how to apply the table: A package containing a Class III commodity has 12 percent Group A expanded plastic by volume. The weight of the unexpanded plastic is 10 percent. This commodity is classified as a Class IV commodity. If the weight of the unexpanded plastic is increased to 14 percent, the classification changes to a high-hazard commodity.

$$[3]\text{Percent by volume} = \frac{\text{Volume of plastic in pallet load}}{\text{Total volume of pallet load, including pallet}}$$

$$[4]\text{Percent by weight} = \frac{\text{Weight of plastic in pallet load}}{\text{Total weight of pallet load, including pallet}}$$

SECTION 8102 — GENERAL FIRE-PROTECTION AND LIFE-SAFETY FEATURES

8102.1 General. Fire-protection and life-safety features for high-piled storage areas shall be in accordance with Section 8102. Nationally recognized standards or guidelines, as applicable, are allowed to be used when approved by the chief.

8102.2 Separation of High-piled Storage Areas. Portions of buildings that do not meet the requirements of Article 81 for high-piled storage areas shall be separated from high-piled storage areas by one of the following methods:

> **EXCEPTION:** Separation is not required between accessory areas that are fully protected with automatic sprinkler systems. Accessory areas shall include, but need not be limited to, loading areas, check out areas, restrooms, employee lounges and offices. Fire protection for high-piled storage and smoke and heat venting shall extend a minimum of 15 feet (4572 mm) beyond the high-piled storage area.

1. A two-hour area-separation wall between areas not protected with automatic sprinkler systems or high-piled storage areas in excess of the maximum allowable areas set forth in Table 81-A,

2. A 60-foot (18 288 mm) space not used for combustible storage, or

3. A minimum of a one-hour occupancy separation wall between other sprinklered areas that are not accessory to the high-piled storage area.

8102.3 Fire Sprinklers. Fire sprinkler systems shall be provided in accordance with Sections 8103 and 8104.

8102.4 Fire Detection. When fire detection is required by Table 81-A, an approved automatic fire-detection system shall be installed throughout the high-piled storage area. The system shall be monitored and shall be in accordance with Section 1007.

8102.5 Building Access.

8102.5.1 Access roadways. When building access is required by Table 81-A, access roadways shall be provided to within 150 feet (45.7 mm) of all portions of the exterior walls of buildings used for high-piled storage.

EXCEPTION: When access roads cannot be installed due to topography, railways, waterways, nonnegotiable grades or other similar conditions, the chief is authorized to require additional fire protection as required for special hazards in Section 1001.9.

Specifications for fire apparatus access roads shall be in accordance with Section 902.2.

8102.5.2 Access doors.

8102.5.2.1 General. When building access is required by Table 81-A, fire department access doors shall be provided in accordance with Section 8102.5.2. Access doors shall be accessible without the use of a ladder.

8102.5.2.2 Number of doors required. One or more access doors shall be provided in each 100 lineal feet (30 480 mm), or major fraction thereof, of the exterior walls which face required access roadways.

8102.5.2.3 Door size and type. Access doors shall not be less than 3 feet (914 mm) in width and 6 feet 8 inches (2032 mm) in height. Roll-up doors shall not be used unless approved by the chief.

8102.5.2.4 Locking devices. Only approved locking devices shall be used.

8102.6 Smoke and Heat Removal.

8102.6.1 General. When smoke and heat removal are required by Table 81-A, smoke and heat vents shall be provided in accordance with Section 8102.6.

EXCEPTIONS: 1. When the installation of smoke and heat vents is determined by the chief to be impractical, mechanical smoke-removal systems are allowed to be provided in accordance with U.F.C. Standard 81-3.

2. Frozen food storage classified as a Class I or Class II commodity is not required to be provided with smoke and heat vents or mechanical smoke removal when protected by an automatic sprinkler system.

8102.6.2 Types of vents. Smoke and heat vents shall be of an approved type and shall be operated automatically by activation of a heat-responsive device rated between 100 and 200°F. (37.8 and 182.2°C.) above estimated ambient temperatures. The heat-responsive device shall be listed and labeled. Smoke and heat vents shall activate fully when the vent cavity is exposed to a simulated fire or a time/temperature gradient that reaches an air temperature of 500°F. (260°C.) within five minutes. Smoke and heat vents shall have the capability of being opened by an approved manual operation.

8102.6.3 Vent dimensions. The effective venting area shall not be less than 16 square feet (1.49 m^2) with no dimension less than 4 feet (1219 mm), excluding ribs or gutters having a total width not exceeding 6 inches (152.4 mm).

8102.6.4 Vent locations. Smoke and heat vents shall be located in accordance with Table 81-B. Vents shall be located 20 feet (6096 mm) or more from lines of adjacent properties and 10 feet (3048 mm) or more from occupancy separation walls separating other high-piled storage areas. Vents shall be uniformly located within the roof area above high-piled storage areas.

8102.7 Curtain Boards.

8102.7.1 General. When curtain boards are required by Table 81-A, curtain boards shall be provided in accordance with Section 8102.7.

8102.7.2 Construction. Curtain boards shall be constructed of sheet metal, lath and plaster, gypsum wallboard, or other approved materials which provide equivalent performance that will resist the passage of smoke. Joints and connections shall be smoke tight.

8102.7.3 Location and depth. The location and depth of curtain boards shall be in accordance with Table 81-B.

8102.8 Hose Stations and Hose Connections.

8102.8.1 Small hose stations. When small hose valves and stations are required by Table 81-A, approved $1^1/_2$-inch (38.1 mm) hose valves shall be provided at approved locations. When required by the chief, hose, nozzles, hose racks, and cabinets or covers shall be provided. See U.F.C. Standards 81-1 and 81-2.

8102.8.2 Fire department hose connections. When exit passageways are required by the building code for egress, a Class I standpipe system shall be provided in accordance with the Building Code. See U.B.C. Standard 9-2.

8102.9 Aisles.

8102.9.1 General. Aisles providing access to exits and fire department access doors shall be provided in high-piled storage areas exceeding 500 square feet (46.45 m^2) in accordance with Section 8102.9. For aisles separating storage piles or racks, see also U.F.C. Standards 81-1 and 81-2 and Article 88.

EXCEPTION: Where aisles are precluded by rack storage systems, alternate methods of access and protection are allowed when approved by the chief.

8102.9.2 Width.

8102.9.2.1 General. Aisle width shall be in accordance with Section 8102.9.2.

EXCEPTIONS: 1. Cross aisles used only for employee access between aisles shall be 24 inches (609.6 mm) or more in width.

2. Aisles separating shelves classified as shelf storage shall be 30 inches (762 mm) or more in width.

8102.9.2.2 Sprinklered buildings. Aisles in sprinklered buildings shall be 44 inches (1117.6 mm) or more in width. Aisles shall be 96 inches (2438.4 mm) or more in width in high-piled storage areas exceeding 2,500 square feet (232.26 m^2) in area and designated to contain high-hazard commodities.

Aisles shall be 96 inches (2438.4 mm) or more in width in public accessible areas where mechanical stocking methods are used.

8102.9.2.3 Nonsprinklered buildings. Aisles in nonsprinklered buildings shall be 96 inches (2438.4 mm) or more in width.

8102.9.3 Clear height. The required aisle width shall extend from floor to ceiling. Rack structural supports and catwalks are allowed to cross aisles at a height 6 feet 8 inches (2032 mm) or more above the level of the finished floor, provided that such supports do not interfere with fire department hose stream trajectory.

8102.9.4 Dead ends. Dead end aisles shall be in accordance with the Building Code (see U.B.C. Chapter 10).

8102.10 Portable Fire Extinguishers. Portable fire extinguishers shall be provided in accordance with U.F.C. Standard 10-1.

SECTION 8103 — SOLID-PILED AND SHELF STORAGE

8103.1 General. Shelf storage and storage in solid piles, solid piles on pallets and binbox storage in binboxes not exceeding 5 feet (1524 mm) in any dimension shall be in accordance with Sections 8102 and 8103.

8103.2 Fire Protection.

8103.2.1 General. When fire sprinklers are required by Table 81-A, an approved automatic fire sprinkler system shall be installed. The design and installation of the automatic fire sprinkler system and other applicable fire protection shall be in accordance with the Building Code (see U.B.C. Standard 9-1) and U.F.C. Standard 81-1.

8103.2.2 Shelf storage. Shelf storage greater than 12 feet (3658 mm) but less than 15 feet in height shall be in accordance with the fire-protection requirements set forth in U.F.C. Standard 81-1. Shelf storage 15 feet (4572 mm) or more in height shall be protected in an approved manner with special fire protection, such as in-rack sprinklers.

8103.3 Pile Dimension and Height Limitations. Pile dimensions, the maximum permissible storage height and pile volume shall be in accordance with Table 81-A.

8103.4 Array. When a fire sprinkler system design utilizes protection based on a closed array, array clearances shall be provided and maintained as specified by the standard used.

SECTION 8104 — RACK STORAGE

8104.1 General. Rack storage shall be in accordance with Sections 8102 and 8104. Binboxes exceeding 5 feet (1524 mm) in any dimension shall be regulated as rack storage.

8104.2 Fire Protection.

8104.2.1 General. When fire sprinklers are required by Table 81-A, an approved automatic fire sprinkler system shall be installed. The design and installation of the automatic fire sprinkler system and other applicable fire protection shall be in accordance with the Building Code (see U.B.C. Standard 9-1) and U.F.C. Standard 81-2.

8104.2.2 Plastic pallets and shelves. Storage on plastic pallets or plastic shelves shall be protected by approved specially engineered fire-protection systems.

8104.2.3 Racks with solid shelving.

8104.2.3.1 General. Racks with solid shelving having an area greater than 32 square feet (2.97 m^2), measured between approved flue spaces at all four edges of the shelf, shall be in accordance with Section 8104.2.3.

> **EXCEPTION:** Racks with mesh, grated, slatted or similar shelves having uniform openings not more than 6 inches (152.4 mm) apart, comprising at least 50 percent of overall shelf area, and with approved flue spaces, are allowed to be treated as racks without solid shelves.

8104.2.3.2 Fire protection. Fire protection for racks with solid shelving shall be in accordance with the requirements for racks with solid shelving set forth in U.F.C. Standard 81-2 or other nationally recognized standards. See Article 90, Standard f.1.1.

8104.3 Flue Spaces.

8104.3.1 General. Flue spaces shall be provided in accordance with Section 8104.3. Required flue spaces shall be maintained.

8104.3.2 Transverse flues. Racks that are not protected with an approved in-rack sprinkler system shall have nominal 3-inch (76.2 mm) transverse flue spaces provided between loads or at rack uprights. Random variation in width or in vertical alignment is allowed, provided the configuration does not obstruct water penetration.

8104.3.3 Longitudinal flues. Six-inch (152.4 mm) longitudinal flue spaces shall be provided in double and multirow racks.

EXCEPTION: Longitudinal flue spaces in double-row racks not exceeding 25 feet (7620 mm) without solid shelving that are provided with 6-inch (152.4 mm) transverse flue spaces.

8104.3.4 ESFR sprinklers. Longitudinal flue spacing shall be provided in rack configurations that are protected by early suppression-fast response (ESFR) sprinklers.

8104.4 Column Protection. Steel building columns shall be protected in accordance with U.F.C. Standard 81-2.

8104.5 Extrahigh-rack Storage Systems.

8104.5.1 Required approvals. Approval of the chief shall be obtained prior to installing extra-high-rack combustible storage.

8104.5.2 Fire protection. Buildings with extrahigh-rack combustible storage shall be protected with a specially engineered automatic sprinkler system. Extrahigh-rack combustible storage shall be provided with additional special fire protection, such as separation from other buildings and additional built-in fire-protection features and fire department access, when required by the chief.

TABLE 81-A—GENERAL FIRE-PROTECTION AND LIFE-SAFETY REQUIREMENTS

COMMODITY CLASS	SIZE OF HIGH-PILED STORAGE AREA[1] (sq. ft.) (See Section 8102.2) × 0.0929 for m^2	ALL STORAGE AREAS (See Sections 8102, 8103 and 8104)[2]						SOLID-PILED STORAGE, SHELF STORAGE AND PALLETIZED STORAGE (See Section 8103.3)		
		Automatic Fire-extinguishing System (See Section 8102.3)	Fire-detection System (See Section 8102.4)	Building Access (See Section 8102.5)	Smoke and Heat Removal (See Section 8102.6)	Curtain Boards (See Section 8102.7)	Small Hose Valves and Stations (See Section 8102.8)	Maximum Pile Dimension[4] (ft.) × 3048 for mm	Maximum Permissible Storage Height[5] (ft.) × 3048 for mm	Maximum Pile Volume (cu. ft.) × 0.0283 for m^3
I-IV	0-500	NR	NR	NR[6]	NR	NR[3]	NR	NR	NR	NR
	501-2,500	NR	Yes	NR[6]	NR	NR[3]	NR	100	40	100,000
	2,501-12,000 Public accessible	Yes	NR	NR[6]	NR	NR[3]	NR	100	40	400,000
	2,501-12,000 Nonpublic accessible (Option 1)	Yes	NR	NR[6]	NR	NR[3]	NR	100	40	400,000
	2,501-12,000 Nonpublic accessible (Option 2)	NR	Yes	Yes	Yes	Yes	Yes	100	30[7]	200,000
	12,001-20,000	Yes	NR	Yes	Yes	Yes	Yes	100	40	400,000
	20,001-500,000	Yes	NR	Yes	Yes	Yes	Yes	100	40	400,000
	Greater than 500,000[8]	Yes	NR	Yes	Yes	Yes	Yes	100	40	400,000
High hazard	0-500	NR	NR	NR[6]	NR	NR[3]	NR	50	NR	NR
	501-2,500 Public accessible	Yes	NR	NR[6]	NR	NR[3]	NR	50	30	75,000
	501-2,500 Nonpublic accessible (Option 1)	Yes	NR	NR[6]	NR	NR[3]	NR	50	30	75,000
	501-2,500 Nonpublic accessible (Option 2)	NR	Yes	Yes	Yes	Yes	Yes	50	20	50,000
	2,501-300,000	Yes	NR	Yes	Yes	Yes	Yes	50	30	75,000
	300,001-500,000[8,9]	Yes	NR	Yes	Yes	Yes	Yes	50	30	75,000

NR = Not required.

[1]The size of the high-piled storage area to be considered when using this table shall include the high-piled storage area and all portions of the building not separated from the high-piled storage area in accordance with Section 8102.2.

[2]For aisles, see Section 8102.9.

[3]Curtain boards shall be installed as required by the Building Code. See U.B.C. Section 906.

[4]Piles shall be separated by aisles complying with Section 8102.9.

[5]For storage in excess of the height indicated, special fire protection shall be provided in accordance with Footnote 8 when required by the chief. See also Articles 79 and 88 for special limitations for flammable and combustible liquids and aerosols.

[6]Section 902.2 shall apply for fire apparatus access.

[7]For storage exceeding 30 feet (914 mm) in height, Option 1 shall be used.

[8]Special fire-protection provisions such as, but not limited to, fire protection of exposed steel columns; increased sprinkler density; additional in-rack sprinklers, without associated reductions in ceiling sprinkler density; or additional fire department hose connections shall be provided when required by the chief.

[9]High-piled storage areas shall not exceed 500,000 square feet (46 451.5 m^2). A two-hour area separation wall shall be used to divide high-piled storage exceeding 500,000 square feet (46 451.5 m^2) in area.

TABLE 81-B—REQUIREMENTS FOR CURTAIN BOARDS AND SMOKE VENTING[1]
(See Sections 8102.6.4 and 8102.7.3)

COMMODITY CLASSIFICATION	DESIGNATED STORAGE HEIGHT (ft.)	CURTAIN BOARD DEPTH (ft.)	MAXIMUM AREA FORMED BY CURTAIN BOARDS[2] (sq. ft.)	VENT AREA TO FLOOR AREA RATIO	MAXIMUM SPACING OF VENT CENTERS (ft.)	MAXIMUM DISTANCE TO VENTS FROM WALL OR CURTAIN BOARDS[3] (ft.)
	× 3048 for mm		× 0.0929 for m^2		× 3048 for mm	
I-IV (Option 1)	20 or less	6	10,000	1:100	100	60
	over 20-40	6	8,000	1:75	100	55
I-IV (Option 2)	20 or less	4	3,000	1:75	100	55
	over 20-40	4	3,000	1:50	100	50
High hazard (Option 1)	20 or less	6	6,000	1:50	100	50
	over 20-30	6	6,000	1:40	90	45
High hazard (Option 2)	20 or less	4	4,000	1:50	100	50
	over 20-30	4	2,000	1:30	75	40

[1]For rack storage heights in excess of those indicated, see Section 8104.5. For solid-piled storage heights in excess of those indicated, an approved engineered design shall be used.

[2]When curtain boards are provided in buildings equipped with early suppression-fast response sprinklers, the curtain boards shall be located only at the perimeters of sprinkler systems.

[3]The distance specified is the maximum distance from any vent in a particular curtained area to walls or curtain boards which form the perimeter of the curtained area.

D-13

10. Sec. 5-13.2 is revised as follows:

Sec. 5-13.2. Sprinklers shall be installed at the ceiling and beneath shelves in single-, double- and multiple-row racks with solid shelves, as set forth in U.F.C. Section 81.402 (c), in accordance with Table No. 5-13.2. Design curves for combined ceiling and in-rack sprinklers shall be used with this type of storage configuration.

TABLE NO. 5-13.2—SPRINKLER REQUIREMENTS FOR SOLID SHELF STORAGE

COMMODITY CLASS	STORAGE HEIGHT (ft.)	SPRINKLERS REQUIRED IN-RACK	
		Shelf Area 32-50 Square Feet	Shelf Area Greater Than 50 Square Feet
I-IV	Over 12-20	1 level[1]	Every tier of storage
	Over 20-25	2 levels[2]	Every tier of storage
	Over 25	[3]	[3]
High hazard	Over 12	Every tier of storage	Every tier of storage

[1]Locate one level of in-rack sprinklers at a height of one half to two thirds of the rack height.

[2]Locate one level of in-rack sprinklers at a height of one fourth to one third of the rack height and a second level at two thirds to three fourths of the rack height.

[3]Protect in accordance with nationally recognized standards. See U.F.C. Section 2.304 (b), Standard No. f.1.1.

11. Sec. 6-1 is revised by substituting the phrase "the Building Code. See U.B.C. Standard No. 38-1" for the phrase "Installation of Sprinkler Systems, NFPA 13."

12. Sec. 7-1 is revised by substituting the phrase "the Building Code. See U.B.C. Standard No. 38-1" for the phrase "Installation of Sprinkler Systems, NFPA 13."

13. Sec. 8-1.4, Exception 4, is revised by substituting the phrase "the Building Code. See U.B.C. Standard No. 38-1" for the phrase "NFPA 13, Standard for Installation of Sprinkler Systems."

14. Sec. 8-1.5 is revised by substituting the phrase "the Building Code. See U.B.C. Standard No. 38-1" for the phrase "NFPA 13, Standard for Installation of Sprinkler Systems."

15. Sec. 9-1.2 is revised by substituting the phrase "the Building Code. See U.B.C. Standard No. 38-1" for the phrase "NFPA 13, Installation of Sprinkler Systems."

16. Sec. 10-2.3 is revised by substituting the phrase "the Building Code. See U.B.C. Standard No. 38-1" for the phrase "NFPA 13, Installation of Sprinkler Systems."

17. Chapters 11, 12 and 13 are deleted.

Part II

Also:

Add a U.F.C. standard as follows:

UNIFORM FIRE CODE STANDARD NO. 81-3
MECHANICAL SMOKE-REMOVAL SYSTEMS
See Section 81.206 (a), *Uniform Fire Code*

Scope

Sec. 81.101. Mechanical smoke-removal systems designed to remove smoke from high-piled storage areas after a fire is extinguished and assist the fire department during suppression operations shall be in accordance with this standard. When mechanical smoke-removal systems are provided, curtain boards shall be provided as required by U.F.C. Section 81.207.

System Capacity

Sec. 81.102. The volume of mechanical ventilation required shall be determined by the following formula:

$$V = A \times 300$$

WHERE:

V = volume of mechanical ventilation required, in cubic feet per minute.

A = area of roof vents required by Table No. 81-B, in square feet.

Supply Air

Sec. 81.103. Supply air for exhaust fans shall be provided at or near the floor level and shall be sized to provide a minimum of 50 percent of required exhaust. Openings for supply air shall be uniformly distributed around the periphery of the area served.

Fans

Sec 81.104. Fans shall be in accordance with the following:

(a) The individual capacity of a fan shall not exceed 30,000 cubic feet per minute;

(b) One or more exhaust fans shall be provided in each curtained area, and when more than one exhaust fan is provided in a curtained area, the fans shall be uniformly spaced within the curtained area. The distance between fans within a curtained area shall not exceed 100 feet;

(c) Wiring and smoke-removal fan units shall be thermally protected in a manner that will provide continued operation for not less than 15 minutes while exposed to a temperature of 1,000°F.; and

EXCEPTION: Wiring and electrical equipment installed on the exterior of the building.

(d) Controls for mechanical smoke-removal systems shall be as follows:

1. On combination comfort air-handling and smoke-removal systems, and on independent comfort air-handling systems, fans shall be controlled to shut down in accordance with the automatic shutoff requirements of the Mechanical Code or by activation of automatic extinguishing or detection systems;

2. Electrical service to the smoke-removal systems shall be connected on the line side of the main electrical disconnect; and

3. The smoke-removal system shall be provided with a fire department control panel located in an approved location and clearly identified. The control panel room shall be protected by not less than a one-hour occupancy separation in accordance with the Building Code. The room shall be accessible from the exterior of the building. Automatic sprinkler protection shall be provided in the control room.

Reason: The revisions were too comprehensive to be fully reviewed at the hearing.

Staff Note: *The Code Development Committee directed staff to print the disapproval as revised version in the* Annual Report of the Code Development Committee *to allow challenges to be based on the revised version. Following the hearing, staff met with the proponents to resolve additional outstanding issues. As a result of this meeting, numerous additional revisions beyond those submitted at the hearing have been made. The version printed herein has been provided by the proponents to resolve the concerns presented at the hearing and to incorporate staff comments.*

Proponent's Reason Substantiating the Revised Proposal: This updated version of the Article 81 rewrite is based on the activity of the Article 81 rewrite subcommittee that was formed by the Southern California Fire Prevention Officers Uniform Fire Code Committee. This subcommittee has been in operation for two years and has committed over 30 eight-hour days of meetings, plus countless hours of individual research, to assemble this rewrite of Article 81. This committee was made up mainly of fire marshals and fire protection engineers from fire departments around the United States. Other contributing members included fire protection consultants, representatives from Factory Mutual Engineering, fire sprinkler contractors, representatives from the smoke and heat vent industry, and fire sprinkler manufacturers. The purpose of the rewrite is to update the requirements for high-piled combustible storage to reflect more current fire-protection philosophy. The changes that have been made to the current articles are outlined below.

Overall. Article 81 has been rewritten to include three divisions. Division I includes administrative and general requirements, Division II includes general fire- and life-safety provisions and directly correlates with Table No. 81-A, Division III includes specific requirements for solid-pile and similar storage, and Division IV includes specific requirements for rack and similar storage. The

article was divided into four divisions to make the code more user friendly and make the application of the code by the fire inspector an easier task.

Division I. For consistency with code format, all general definitions will be located in Article 9. Many new definitions have been added. These include "array"; "array, closed"; "binbox"; "curtain board"; "extrahigh-rack combustible storage"; "shelf storage"; "solid shelving"; and "transverse flue space." The current definition of solid shelving is one of the major areas of enforcement problems with Article 81. The committee agreed that the 1991 Uniform Fire Code Standard No. 81-2 allows solid shelves that are much too large. For example, assuming standard 8-foot rack uprights, and a rack depth of 4 feet, Uniform Fire Code Standard No. 81-2 would allow double-row racks less than 25 feet in height to have solid shelves 64 square feet in area (rack width times distance between uprights times two for each side of the rack, 4 feet × 8 feet × 2 = 64 square feet) Note that longitudinal flue spaces are not required for double-row racks under 25 feet in height. Factory Mutual Engineering Loss Prevention Data Sheet 8-33 defines solid shelves as shelves having an area greater than 20 square feet. Different protection requirements are provided based on 20 square feet, 20 to 50 square feet, and over 50 square feet. The committee evaluated these two positions and used engineering judgment to conclude that solid shelves greater than 32 square feet create a fire hazard significant enough to require rack sprinkler protection. This decision is based on research that showed no conclusive fire testing has been conducted to clarify this issue. Factory Mutual Engineering's position is based on judgment that greater than one pallet (approximately 20 square feet) could obstruct sprinkler water penetration through a rack. The position taken by the 1991 Uniform Fire Code Standard No. 81-2 is also based on engineering judgment. Section B-5-13.2 states that "these tests [solid shelving fire tests] did not yield sufficient information to develop a comprehensive protection standard for solid shelf racks. Items such as increased ceiling density, use of bulkheads, other configurations of sprinklers in racks, and limitation of shelf length and width require consideration."

Submittal requirements have been increased to require the permit applicant for high-piled storage buildings to provide specific information that is needed for the fire department to provide for proper regulation. In Section 81.103 (b), required information includes 14 different informational items that are needed by the fire department so that proper determination for fire protection can be made.

Classifications of commodities were updated. A tremendous amount of research and effort went into this process. Individuals from throughout the United States contributed to this effort. The list provided reflects the very latest results of research and technology.

At the request of the Code Development Committee, descriptions of Groups A, B and C plastics have been added in Section 81.104 (b). Accompanying the descriptions are lists of common plastics by group classification. The Code Development Committee decided that these descriptions were needed by a fire inspector enforcing the *Uniform Fire Code*. The classification of PVC, based on the amounts of plasticizer, has been added to the code. This was based on research done with members of the NFPA 231 committee. The age-old problem of classifying mixed commodities has been addressed in Section 81.104. The amount of unexpanded and expanded Group A plastics which may be allowed in a package, carton or pallet load without increasing the commodity classification is found in Figure No. 81.104-A, an adaptation of Factory Mutual Engineering and Industrial Risk Insurers standards. Once the commodity classification for the box, carton or pallet load is determined, Section 81.104 (c) provides guidance for how much of a higher-hazard commodity is allowed in a given product mix without increasing the commodity classification and the fire-protection requirements. The new Article 81 also introduces a new concept of designating the storage area to indicate the commodity class that the area was designed for. Normally, this will correspond to the highest commodity class stored, but Section 81.105 (b) allows small quantities of higher-hazard commodity of the sprinkler system to deliver high enough water density from the first sprinklers operating to meet the required density for controlling the small quantity of higher-hazard commodity. The amount of the higher-hazard commodity allowed must be determined by an engineering analysis. This analysis must consider the following two principles:

1. It is generally believed that the most important factor in protecting a commodity is the sprinkler density. The higher the density, the greater the chance of controlling the fire. This appears to be the rationale used by Factory Mutual in reducing the area density curves of Data Sheet 8-25, General Indoor Storage (essentially NFPA 231), and Data Sheet 8-33, Rack Storage (essentially NFPA 231C), to single-point area/density parameters depending on the commodity classification.

2. Research shows that the area of operation of sprinklers responding to a fire is normally approximately five to 10 times the area of the fire.

Therefore, given a sprinkler system capable of providing a specified density over a specified operating area, the number of sprinklers which can operate at a higher density can be used to determine the quantity of a higher class commodity which can be stored with a lower class commodity.

Hydraulic calculations must be provided which verify the ability of the sprinkler system to provide this higher density. Section 81.105 (b) provides further safety factors by limiting the maximum area of the higher-hazard commodity to 120 square feet in any contiguous area. Use of this method will allow the inspector or plan checker to accurately limit and protect mixed commodity storage.

Requirements for aisle maintenance, ignition control, smoking areas and portable fire extinguishers have been provided in a consolidated section for maintenance, Section 81.106.

Also, the requirements for evacuation plans in public-occupied warehouses have been added based on the fire chief's discretion, depending on the size and risk of the building in question. These are in Section 81.103 (c).

Division II. A new Division II has been created to set forth the general fire- and life-safety requirements. The sections in Division II track closely with requirements in Table No. 81-A. Division II addresses many major issues. For example, problems with aisles have been resolved, and the size and width of aisles based on the different standard requirements of the *Uniform Building Code* have been corrected.

Requirements for small hose connections have been maintained. The requirements for small hose on the hose connections is still left to the discretion of the fire chief. In very large warehouses where travel distances to exits would exceed the allowable code limits, exit passageways would be required. The new Section 81.208 (b) would require a Class I standpipe, which complies with Uniform Building Code Standard No. 38-2, to be installed in these cases. Requirements for regulating industrial trucks and battery charges have been placed in Article 11 so that they apply to all cases where industrial trucks are used in buildings.

Ventilation requirements are located in Sections 81.206 and 81.207 for improved organization. The ventilation topic was the portion of article on exiting which the proponent committee felt needed the most work. The basis for and documentation to support the use of smoke and heat vents and curtain boards in sprinklered buildings is an age-old question which has generated more disagreements among fire-protection professionals than any other high-piled fire-protection issue.

The reason for this problem is the lack of full-scale fire testing using smoke and heat vents and curtain boards. None of the current NFPA or Factory Mutual Engineering tests, which are the primary basis for all current fire-protection standards, incorporated smoke and heat vents and draft curtains in the testing process. Thus, one's position on this issue is probably based on insight gained from real-life fire experience, theoretical evaluation or speculation.

Two important questions needed to be addressed:

1. Do smoke and heat vents affect automatic fire sprinkler activation times?

2. Are smoke and heat vents beneficial for manual firefighting, and when is the optimum time for the smoke and heat vents to activate in relation to fire sprinkler activation?

To answer these questions and hopefully put this issue to rest once and for all, a two-part program was established. First, documentation of all existing testing in this area was compiled and analyzed. Next, testing and research currently underway was examined. The proponent committee hoped that by looking at the research in an analytical manner, the myths and misconceptions could be separated from the science and engineering, and a logical conclusion could be reached.

The proponent committee reached the following conclusions:

1. All completed research indicates that smoke and heat vents do not have a detrimental affect on automatic sprinkler operations. Smoke and heat vents do reduce ceiling temperatures and improve visibility for manual firefighting.

2. The smoke and heat vents should probably activate prior to activation of the fire sprinklers to reduce the thickness of the upper layer and, thus, the potential for smoke-logging of the building.

3. Curtain boards provide no benefit in a sprinklered building and could adversely affect sprinkler activation and increase the likelihood of smoke-logging.

Ventilation requirements proposed in this rewrite were written with these conclusions in mind. Venting ratios have been revised and curtain boards have been eliminated from sprinklered buildings. Due to an apparent lack of performance of mechanical smoke-removal systems, smoke and heat vents were selected as the primary requirement, with an exception to allow mechanical smoke removal if smoke and heat vents are deemed to be impractical by the chief (i.e., in cold storage buildings or where weather conditions restrict the reasonable application of roof vents).

Design requirements for mechanical smoke removal have been placed in a newly created Uniform Fire Code Standard No. 81-3.

The history of smoke and heat vents and curtain boards in buildings used for high-piled storage is something of a mystery. The first use of these devices, although not documented, was reported to be in 1966 by a Southern California fire department. This application was based on judgments by the fire marshal. There was no fire testing to confirm this decision.

In the 1971 edition of the *Uniform Fire Code*, Article 35 was introduced for high-piled combustible storage. Requirements for smoke and heat vents and curtain boards were established for all buildings containing high-piled storage, regardless of automatic fire protection. Section 35.107 stated that "draft curtains shall be provided to limit the area of sprinkler operation and to aid the operation

of roof vents." No fire testing or research was done at that time to justify this position. Article 35 remained unchanged in the 1973 and 1976 editions.

A major rewrite of Article 35, which was later renamed Article 81, was undertaken for the 1979 edition of the *Uniform Fire Code*. Research conducted during this rewrite indicated that a mechanical smoke-removal system was preferred and that smoke and heat vents and curtain boards were not required in buildings protected by an approved fire-extinguishing system as stated in Section 81.107 (a). Smoke and heat vents and curtain boards were also not required in fully sprinklered buildings in the 1982 edition of the *Uniform Fire Code*.

In the 1985 edition, the *Uniform Fire Code* again changed the smoke and heat vent and draft curtain requirements. Since the 1985 edition, the *Uniform Fire Code* has required either smoke and heat vents and draft curtains or mechanical smoke removal and draft curtains in buildings used for high-piled storage, regardless of whether the building was sprinklered. No new research or fire testing was done to support this change in position.

The most well-known and widely distributed testing on smoke and heat vents was work done by the Factory Mutual Researeh Corporation in its Rhode Island testing facility in 1974. Factory Mutual's conelusion was that smoke and heat vents were detrimental to automatic fire sprinkler operation and, thus, should not be installed in sprinklered buildings. Unfortunately, what is not commonly known is that, due to the constraints of the Factory Mutual testing facility, these tests had no similarity to real-world application or use of smoke and heat vents. The most striking problem, for example, is that the testing used vents placed on vertical wall sections, not on a horizontal ceiling, as is found in most real-world applications. This and other problems, in the committee's opinion, completely invalidated Factory Mutual's testing.

In 1982, the Illinois Institute of Technology Research (IITRI) began IITRI Project JO 8385—Fire Venting of Sprinklered Buildings. This project consisted of experiments and testing designed to assess the influence of automatic fire venting on automatic fire sprinklers. Eleven full-scale fire tests were conducted with automatic sprinklers and smoke and heat vents to determine the behavior of each. The IITRI testing concluded that "the ability of 165°F.-rated automatic sprinklers to control, or nearly control, a fire otherwise capable of growth in a large one-story structure is not impaired by the presence of automatic fire vents of typical spacing and area." Furthermore, "venting appears to play a stronger positive role on 286°F. sprinkler controlled fires, based solely on tests with propane fires." In other words, the smoke and heat vents were determined to have no detrimental effect on the automatic fire sprinkler system activation.

The National Institute of Standards and Technology (NIST) Building and Fire Research Laboratory is nearing the conclusion of a two-year study designed to investigate the interaction of fire sprinklers and smoke and heat vents. The key objectives of the project were to complete a collaborative research effort between NIST and Factory Mutual Research; develop a computer model, LAVENTS (link-activated vents and sprinklers), to simulate the interaction of fire sprinklers and smoke and heat vents; and finally to conduct full-scale fire tests to validate the LAVENTS model. All but the full-scale fire testing has been completed. One result from this study indicated that ceiling vents can have a significant effect on controlling the thickness and temperature of smoke layers, thereby avoiding the deleterious effect of smoke logging associated with sprinkler operation.

Other research projects are underway in Europe. The Swedish Fire Research Board has established an ad hoc committee to study this topic. This committee consists of an international collection of experts on smoke and heat venting. From this committee, a recent research project conducted by COLT International in Ghent, Belgium, was published. This project consisted of full-scale fire testing to explore fire sprinkler/smoke vent interaction. Preliminary results show that the ventilation system had little effect on the opening times of the first operating sprinklers. Other testing done in Portsmouth, England, also by COLT International, indicated that the temperature rise during fires in buildings without fire ventilation was over three times greater than the temperature rise for buildings with fire ventilation. In addition, operation of the ventilation system did not hamper the operation of the fusible-link devices which were set to simulate the operation fire sprinklers.

Another important discovery was made through NIST research. Due to interaction with the various gas layers appearing during a fire within a sprinklered building, the role of curtain boards had become somewhat questionable. The likelihood of smoke logging a building seems to increase as the depth of the upper layer (smoke layer along the ceiling) increases. The deeper the upper layer, the greater the amount of smoke that will be entrained by the water droplets from the sprinkler system and "downdragged" into the lower layer. This lower layer is typically clean air, and infiltration of smoke into this layer increases the likelihood of smoke logging the building. Thereby, since curtain boards increase the depth of the smoke layer, they may increase smoke damage.

Additionally, standard automatic sprinklers control a fire by cooling the fire itself and prewetting the area around the fire, thus impeding fire growth. Installation of curtain boards could prevent this prewetting of adjacent areas and adversely affect sprinkler effectiveness.

The activation of a sprinkler is affected by many factors, including the ceiling temperature and ceiling jet or heat velocity. The LAVENTS model showed that installing curtain boards will cause turbulence as the ceiling jet makes contact with a curtain board. The turbulence could affect the response of the sprinklers and cause skipping of adjacent sprinklers.

This concept is suggested by NFPA 13, which requires reduced sprinkler spacing (130 square feet maximum) for sprinklers located below panelized roof systems versus sprinkler spacing below a smooth ceiling (200 square feet maximum). National Fire Protection Agency 13 predicts that the irregularities in the surface below a panelized roof system, pocketing of heat and turbulence can cause skipping of adjacent sprinklers. Thus, sprinklers are required to be placed within these pocket areas.

Division III. This division addresses solid-piled and shelf storage.

Sec. 81.301. The applicability of the division was refined from the general scope of the article in Division I to clearly identify that it applies to solid-pile and shelf storage.

Sec. 81.302. Provisions for fire protection were reworded for clarity; however, the contents remain similar to Section 81.105 in the 1991 edition.

Sec. 81.303. This section was added to identify that pile dimensions and height limits are established in Table No. 81-A. The section also identifies the need for maintenance of aisles as an ongoing housekeeping issue.

Sec. 81.304. This section alerts the user about clearances for closed arrays (when used) that must be maintained. As the clearances vary widely among types of commodities, the information could not be condensed into precise code text. It is hoped that the user will be alerted to the possible presence of a closed array and refer to the appropriate fire-protection standard used for that commodity.

Division IV. This division addresses rack storage.

Sec. 81.401. The applicability of the division was refined from the general scope of the article in Division I to clearly identify that this division applies to high-rack combustible storage.

This section also provides for regulation of large binboxes. The previous edition of Article 81 did not specifically identify binboxes. This section highlights that binboxes greater than 5 feet in any dimension are of sufficient size to result in fires similar to those in rack storage, so it regulates oversized binboxes as high-rack storage. The related section in Division III identifies that smaller binboxes (less than 5 feet in any dimension) are classified as solid-pile storage.

Sec. 81.402. Similar to Division II, provisions for fire protection were reworded for clarity; however, the contents remain essentially the same as Section 81.105 in the 1991 U.F.C.

Storage on plastic pallets or plastic shelves creates a hazard which is beyond the typical hazard considered by this division and the section requires that specially engineered fire protection must be employed.

Sec. 81.403. Requirements that flue spaces be provided and maintained are established. Provisions are identified for nonsprinklered racks to maintain transverse flue spaces to allow overhead sprinklers or manual hose streams to effectively attack a fire. Longitudinal flue spaces are required for all racks (except double-row racks not exceeding 25 feet in height without solid shelving). Because of the special considerations used for the design of ESFR sprinkler protection, this section defers to the identified *Uniform Fire Code* standard.

Sec. 81.404. The section on column protection was specifically added to require that protection be provided. The previous adoption of Uniform Fire Code Standard No. 81-2 deleted all of Chapter 3, which also contained these provisions. This deletion resulted in significantly less protection than was being afforded under (unmodified) NFPA 231C.

Sec. 81.405. Due to the concerns that extrahigh-rack storage systems raise, a provision was added that the chief approve all buildings proposed for such use. As these systems are out of reach of conventional ground-fire attack methods, this section also requires that all buildings used for extrahigh-rack storage systems be provided with sprinklers. The difficulty in controlling this type of fire and reliance on aerial apparatus prompted further requirements for additional built-in fire protection.

Uniform Fire Code Standard No. 81-1. Uniform Fire Code Standard No. 81-1 has been updated to the latest NFPA 231 (1990 edition). Amendments have been made to Part I to basically keep it in line with the requirements of the Uniform Fire and Building codes. This will bring the standard up to the current requirements and standards for the installation of fire protection in solid-pile storage warehouses.

Uniform Fire Code Standard No. 81-2. Uniform Fire Code Standard No. 81-2 has been updated to the most current edition of NFPA 231C (1991 edition). Part I provides amendments to resolve any conflicts between the *Uniform Fire Code* and the *Uniform Building Code*. Changes to NFPA 231C include a new Chapter 8, which specifically addresses the protection of Group A plastics. It was thought that this standard was greatly needed.

Section 5-13.2 has been revised to provide specific requirements for racks with solid shelving. The amount and placement of rack sprinklers is based on the size of the solid shelf, the commodity of material stored and the storage height. These requirements are similar to those appearing in Factory Mutual Engineering Loss Prevention Data Sheets 8-9 and 8-33.

E-1

Chapter 9 Early Suppression Fast Response (ESFR) Sprinklers

9-1* General.

9-1.1 ESFR sprinklers shall be permitted for the protection of cartoned plastics (Group A, B, or C) and Class I through IV commodities in palletized and solid pile storage up to a height of 25 ft (7.6 m).

Exception: ESFR protection as now defined does not apply to:

1. exposed plastics or expanded polystyrene plastic in cartons.

2. storage involving combustible open top cartons or containers.

9-1.2* ESFR sprinklers shall be permitted for use in buildings having a maximum roof or ceiling height of 30 ft (9.1 m) and one of the following types of roof construction:

(a) Smooth ceiling

(b) Bar joist

(c) Beam and girder

(d) Panel

9-1.3 Roof slope shall not exceed 1 in./ft.

9-2* Water Supplies.

9-2.1* ESFR sprinkler systems shall be designed to provide a minimum operating pressure of 50 psi (3.4 bars) to the 12 most hydraulically remote sprinklers, based on flowing four sprinklers in each of three branch lines.

9-2.2 A minimum of 250 gpm (16L/s) shall be added to the sprinkler demand for combined large and small hose streams.

9-2.3 Water supply duration shall be at least 1 hr.

9-2.4 ESFR sprinklers shall be limited to wet-pipe systems.

9-3 Sprinkler System Design.

9-3.1 All requirements contained in NFPA 13, *Standard for the Installation of Sprinkler Systems*, particularly Chapter 9 shall apply, except as modified by this standard.

Chapter 10 Building Equipment, Maintenance, and Operations

10-1* Mechanical Handling Equipment.

10-1.1* Industrial Trucks. Power-operated industrial trucks shall comply with NFPA 505, *Firesafety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance and Operation.*

10-2 Building Service Equipment.

10-2.1 Electrical equipment shall be installed in accordance with the provisions of NFPA 70, *National Electrical Code®*.

10-3 Cutting and Welding Operations.

10-3.1* When welding or cutting operations are necessary, the precautions contained in NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, shall be followed. When possible, work shall be removed to a safe area.

10-3.2 Welding, soldering, brazing, and cutting shall be permitted to be performed on building components that cannot be removed, provided no storage is located below and within 25 ft (7.6 m) of the working area, and flameproof tarpaulins enclose this section. During any of these operations the sprinkler system shall be in service. Extinguishers suitable for Class A fires with a minimum rating of 2A and charged and manned inside hose lines, where provided, shall be located in the working area. A fire watch shall be maintained during these operations and for not less than 30 min following completion of open flame operation.

10-4 Waste Disposal. Rubbish, trash, and other waste material shall be disposed of at regular intervals.

10-5 Smoking. Smoking shall be strictly prohibited, except in locations prominently designated as smoking areas. "No Smoking" signs shall be posted in prohibited areas.

10-6 Maintenance and Inspection.

10-6.1 Fire walls, fire doors, and floors shall be maintained in good repair at all times.

10-6.2 The sprinkler system and the water supplies shall be maintained and serviced. (*For further information see NFPA 13A, Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems.*)

10-7 Refrigeration Systems. Refrigeration systems, if used, shall conform to the recommendations of *Safety Code for Mechanical Refrigeration*, ANSI/ASHRAE 15-70.

Chapter 11 Referenced Publications

11-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

11-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10-1990, *Standard for Portable Fire Extinguishers*

NFPA 11A-1988, *Standard for Medium- and High-Expansion Foam Systems*

A-4-3.2 Storage should be separated by aisles so that piles are not more than 50 ft (15.2 m) wide or 25 ft (7.6 m) wide if they abut a wall. Main and cross aisles should be located opposite window or door openings in exterior walls. This is of particular importance in buildings where exterior openings are few. Aisle width should be at least 8 ft (2.4 m). In judging the adequacy of existing sprinkler protection, aisle spacing and frequency should be given consideration.

A-4-4 Idle pallet storage introduces a severe fire condition. Stacking idle pallets in piles is the best arrangement of combustibles to promote rapid spread of fire, heat release, and complete combustion. After pallets are used for a short time in warehouses, they dry out and edges become frayed and splintered. In this condition they are subject to easy ignition from a small ignition source. Again, high piling increases considerably both the challenge to sprinklers and the probability of involving a large number of pallets when fire occurs.

A-4-4.1.1 (*See Table A-4-4.1.1.*)

Table A-4-4.1.1 Recommended Clearance Between Outside Idle Pallet Storage and Building.

Wall Construction		Minimum Distance, ft(m) of Wall from Storage of		
Wall Type	Openings	Under 50 Pallets	50 to 200 Pallets	Over 200 Pallets
Masonry	None	0	0	0
	Wired glass with outside sprinklers 1-hr doors	0	10 (3.0)	20 (6.1)
	Wired or plain glass with outside sprinklers ¾-hr doors	10 (3.0)	20 (6.1)	30 (9.1)
Wood or metal with outside sprinklers				
Wood, metal, or other		20 (6.1)	30 (9.1)	50 (15.2)

Notes:
1. Fire-resistive protection comparable to that of the wall should also be provided for combustible eave lines, vent openings, etc.
2. When pallets are stored close to a building, the height of storage should be restricted to prevent burning pallets from falling on the building.
3. Manual outside open sprinklers generally are not a reliable means of protection unless property is attended to at all times by plant emergency personnel.
4. Open sprinklers controlled by a deluge valve are preferred.

A-4-4.2 A fire in stacks of idle plastic and wooden pallets is one of the greatest challenges to sprinklers. The undersides of the pallets create a dry area on which a fire can grow and expand to other dry or partially wet areas. This process of jumping to other dry, closely located, parallel, combustible surfaces continues until the fire bursts through the top of the stack. Once this happens, very little water is able to reach the base of the fire. The only practical method of stopping a fire in a large concentration of pallets with ceiling sprinklers is by a great amount of prewetting. In high stacks this cannot be done without abnormally high water supplies. The storage of empty wood pallets should not be permitted in an unsprinklered warehouse containing other storage.

A-5-4 At windowless warehouses and where windows are scant, hydrants should be located at or in the vicinity of entrances.

A-5-5 Manual fire fighting operations in a storage warehouse are not a substitute for sprinkler operation. The sprinkler system should be kept in operation during manual fire fighting operations until visibility has cleared so that the fire can be clearly seen and the extent of fire reduced to a stage requiring only mopping up. It is essential that charged hose lines be available before venting is started because of a possible increase in fire intensity. When a sprinkler valve is closed, a responsible person should remain at the valve so it can be opened promptly if necessary. The water supply for the sprinkler system should be augmented where possible and care exercised that the water supply for the sprinkler system is not rendered ineffective by the use of excessive hose streams.

Where a private fire brigade is provided, sufficient large hose [2½ in. (64 mm)] and related equipment should be available.

A-6 The following procedure should be followed in determining the proper density and area as specified in Chapter 6.

1. Determine the commodity class.

2. Select the density and area of application from Figure 6-1.2(a) or Figure 6-1.2(b).

3. Adjust the required density for height of storage in accordance with Figure 6-2.2.

4. Increase operating area by 30 percent in accordance with 6-2.4 when a dry pipe system is used.

5. Satisfy minimum densities and areas as indicated in 5-1.2, 5-1.2.1, and 5-1.2.2.

The following is an example using these procedures:

Storage – greeting cards in boxes in cartons on pallets

Height – 22 ft (6.7 m)

Clearance – 6 ft (1.8 m)

Sprinklers – decided to use 165°F (74°C) sprinkler system – dry.

1. Classify – Class III

2. Select Density/Area – 0.225 gpm/3000 ft^2 (0.014 L/s/276 m^2) from Figure 6-1.2(a).

3. Adjust for height of storage $1.15 \times 0.225 = 0.259$
From Figure 6-2.2 Round up = 0.26 gpm/ft^2

4. Adjust area of operation for dry system – $1.3 \times 3000 = 3900$ ft^2 (363 m^2)

5. Satisfy minimum densities and areas

In 5-1.2 the minimum for a dry sprinkler system is 0.15/2600 (this has been satisfied) for Class III.

E-3

allowed should be applied cautiously. For evaluation of existing situations, however, the allowances may be quite helpful.

A-7-2.1 An evaluation for each field situation should be made to determine the worst applicable height-clearance relationship that can be expected to appear in a particular case. Fire tests have shown that considerably greater demands occur where clearance is 10 ft (3.0 m) as compared to 3 ft (0.9 m), and where a pile is stable as compared to an unstable pile. Since a system is designed for a particular clearance, the system could be inadequate when significant areas do not have piling to the design height and larger clearances exist between stock and sprinklers. This can also be true where the packaging or arrangement is changed so that stable piling is created where unstable piling existed. Recognition of these conditions is essential to avoid installation of protection that is inadequate or becomes inadequate because of changes.

No tests were conducted simulating a peaked roof configuration. However, it is expected that the principles of Chapter 7 still apply. The worst applicable height-clearance relationship that can be expected to occur should be found, and protection designed for it. If storage is all at the same height, the worst height-clearance relationship creating the greatest water demand would occur under the peak. If commodities are stored higher under the peak, the various height-clearance relationships should be tried and the one creating the greatest water demand used for designing protection.

A-7-2.6 Wet systems are recommended for storage occupancies. Dry-pipe systems are acceptable only where it is impractical to provide heat.

A-9-1 ESFR sprinklers were designed to respond quickly to growing fires and deliver heavy discharge to "suppress" fires rather than "control" them. ESFR sprinklers cannot be relied upon to provide suppression if they are used outside these design parameters.

A-9-1.2 Storage in single story or multistory buildings is permissible provided the 30 ft (10 m) maximum ceiling/roof height is satisfied for each storage area.

A-9-2 Design parameters were determined from a series of full scale fire tests conducted as a joint effort between Factory Mutual and the National Fire Protection Research Foundation. (Copies of the test reports are available from the NFPRF).

A-10-1 Locomotives should not be allowed to enter storage areas.

A-10-1.1 Industrial trucks using gas or liquid fuel should be refueled outside of the storage building at a location designated for that purpose.

A-10-3.1 The use of welding, cutting, soldering, or brazing torches in the storage areas introduces a severe fire hazard. The use of mechanical fastenings and mechanical saws or cutting wheels is recommended.

Appendix B

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

Appendix B explains and gives examples of the methods and procedures to follow in using this standard to determine proper protection for Group A plastics.

Metric Conversion Factors for Examples

To convert from	to	Multiply by
feet (ft)	meter (m)	0.3048
square feet (ft^2)	meter^2 (m^2)	0.0920
gal/min (gpm)	liter/second (L/s)	0.0631
gal per min/ft^2 (gpm/ft^2)	liter per second/m^2 [(L/s)/m^2]	0.679

Example 1

Building height _____ 26 ft

Sprinkler deflector height from floor _____ 25 ft

Commodity _____ rolls of nonexpanded polyethylene film on end on pallets. One roll completely fills one pallet. Each roll with pallet is 5 ft high.

Storage height normally _____ 20 ft

Wet or dry sprinkler system _____ wet

Clearance normally _____ 5 ft

Open or closed array _____ flue spaces are 10 in.: open array.

(The conclusions arrived at for water demand are theoretical minimum. Actual water demand will be greater as a result of system sprinkler design.)

It was decided commodity is a Group A plastic (*see Commodity Classifications, Chapter 2*).

From storage description it was decided it was solid-unit load storage (it would burn only on exterior of unit load) and it was determined it was nonexpanded.

From decision tree (*see Figure 7-1.1*) — Group A, nonexpanded, stable, solid unit load, it says to go to Figure 7-2.2(a).

From Figure 7-2.2(a):

For initial demand there is a range: 0.7 gpm/ft^2 over 400 ft^2 to 0.5 gpm/ft^2 over 780 ft^2.

It is decided to choose..... 0.7 gpm/ft^2 over 400 ft^2.

For secondary demand there is a range: 0.5 gpm/ft^2 over 780 ft^2 to 0.2 gpm/ft^2 over 4,500 ft^2.

At least a 0.25 gpm/ft^2 difference between the initial density and the secondary density is needed. Also a minimum final design area of 2,000 ft^2 for the secondary point is necessary. Therefore, it is decided to pick 0.32 gpm/ft^2 over 1,800 ft^2.

Commodity: Rolls P.E. Film
Stable/Unstable: Stable
Storage Height: 20
Open/Closed Array: Open
Clear Space: 5
Wet/Dry System: Wet

Fig. No.		Density / Area	Hgt. Fact.	Density (Adj.) / Area	Clearance Fact.	Density / Area (Adj.)	Array Fact.	Density / Area (Adj.)	Dry Penalty	Density / Area (Adj.)	Notes:
7-2.2(a)	Initial	0.7 / 400	100%	0.7 / 400	1.02	0.7 / 408	None				285 gpm
	Secondary	0.32 / 1,800	100%	0.32 / 1,800	1.13	0.32 / 2,034	None		None		650 gpm

Commodity: Rolls P.E. Film
Stable/Unstable: Stable
Storage Height: 15
Open/Closed Array: Open
Clear Space: 10
Wet/Dry System: Wet

Fig. No.		Density / Area	Hgt. Fact.	Density (Adj.) / Area	Clearance Fact.	Density / Area (Adj.)	Array Fact.	Density / Area (Adj.)	Dry Penalty	Density / Area (Adj.)	Notes:
7-2.2(a)	Initial	0.7 / 400	90%	0.63 / 400	1.2	0.63 / 480	None				302 gpm
	Secondary	0.32 / 1,800	85%	0.27 / 1,800	2.0	0.27 / 3,600	None		None		972 gpm

Commodity: P.E. Bottles
Stable/Unstable: Stable
Storage Height: 18 ft
Open/Closed Array: Open
Clear Space: 10 ft
Wet/Dry System: Wet

Fig. No.		Density / Area	Hgt. Fact.	Density (Adj.) / Area	Clearance Fact.	Density / Area (Adj.)	Array Fact.	Density / Area (Adj.)	Dry Penalty	Density / Area (Adj.)	Notes:
7-2.2(c)	Initial	0.9 / 600	96%	0.86 / 600	1.26	0.86 / 756	None				650 gpm
	Secondary	0.65 / 1,150	94%	0.61 / 1,150	2.5	0.61 / 2,645	None		None		1,613 gpm

Commodity: P.E. Bottles
Stable/Unstable: Stable
Storage Height: 24 ft
Open/Closed Array: Open
Clear Space: 4 ft
Wet/Dry System: Wet

Fig. No.		Density / Area	Hgt. Fact.	Density (Adj.) / Area	Clearance Fact.	Density / Area (Adj.)	Array Fact.	Density / Area (Adj.)	Dry Penalty	Density / Area (Adj.)	Notes:
7-2.2(c)	Initial	0.9 / 600	108%	0.97 / 600	1.00	0.97 / 600	None				582 gpm
	Secondary	.50 / 2,000	120%	.600 / 2,000	1.00	.600 / 2,000	None		None		1,200 gpm

However, sometimes storage height is 24 ft high with 4-ft clearance.

The demand for 20-ft high storage and 1½-ft to 4½-ft clearance *was*:

Initial demand: 0.9 gpm/ft^2 over 600 ft^2

Secondary demand: 0.65 gpm/ft^2 over 1,150 ft^2.

However, since the clearance factor for increasing the area is going to be small and a final area of at least 2,000 ft^2 is needed, it is decided to pick a density for the secondary point that would create an area demand equal to or closer to the 2,000 ft^2 area.

From Figure 7-2.2(c), the demand for 20-ft high storage and 1½-ft to 4-½-ft clearance decided on was:

Initial demand: 0.9 gpm/ft^2 over 600 ft^2

Secondary demand: 0.50 gpm/ft^2 over 2,000 ft^2.

To adjust for height use Figure 7-2.2.3:

Initial demand: 108 percent × 0.9 gpm/ft^2 = 0.97 gpm/ft^2

Secondary demand: 120 percent × 0.50 gpm/ft^2 = 0.60 gpm/ft^2.

To adjust for clearance use Figure 7-2.2.2:

Initial demand: 1.00 × 600 ft^2 = 600 ft^2

Secondary demand: 1.00 × 2,000 ft^2 = 2,000 ft^2.

Conclusion:

0.86 gpm/ft^2 over 756 ft^2 = 650 gpm
0.61 gpm/ft^2 over 2,645 ft^2 = 1,613 gpm } **18-ft high storage 10-ft clearance**

0.97 gpm/ft^2 over 600 ft^2 = 582 gpm
0.60 gpm/ft^2 over 2,000 ft^2 = 1,200 gpm } **24-ft high storage 4-ft clearance**

The gratest gpm demand would be for 18-ft high storage and 10-ft clearance. Therefore, the protection sepcified would be:

Initial demand: 0.86 gpm/ft^2 over 800 ft^2

Secondary demand: 0.61 gpm/ft^2 over 2,600 ft^2.

(Areas should be rounded to nearest 100 ft^2.)

C-4.3 As the commodity class increases in combustibility, or where storage could be easily ignited from radiation, wider aisles should be provided. Smaller unit piles may be an alternative to wider aisles if yard space is limited.

C-4.4 For outdoor idle pallet storage, see Section 4-4 and A-4-4.1.1 of this standard. Separation between piles of idle pallets and other yard storage should be as follows:

Pile Size	Minimum Distance (Ft)
Under 50 pallets	20 (6 m)
50-200 pallets	30 (9.1 m)
Over 200 pallets	50 (15.2 m)

C-4.5 Boundary posts with signs designating piling limits should be provided to indicate yard area, roadway and aisle limits.

C-5 Buildings and Other Structures.

C-5.1 Yard storage, particularly commodities in the higher heat release category, should have as much separation as is practical from important buildings and structures, but not less than that offered by NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*.

C-5.1.1 As guidance in using NFPA 80A in establishing clear spaces, the following Classification of Severity with Commodity Classes of this standard may be used on the basis of 100 percent openings representing yard storage:

(a) *Light Severity:* Commodity Class I.

(b) *Moderate Severity:* Commodity Class II.

(c) Interpolate between Moderate and Severe Severity for Commodity Class III.

(d) *Severe Severity:* Commodity Class IV and Class A plastics.

NOTE: The above guidelines apply to the equivalent commodity classes of this standard. The severity of the exposing building or structure should also be a consideration when establishing a clear space.

C-6 Yard Maintenance and Operations.

C-6.1 The entire storage site should be kept free from accumulation of unnecessary combustible materials. Vegetation should be kept cut low. Procedures should be provided for weed control and the periodic cleanup of the yard area.

C-6.2 Adequate lighting should be provided to allow supervision of all parts of the storage area at night.

C-6.3 All electrical equipment and installations should conform to the provisions of NFPA 70, *National Electrical Code*.

C-6.4 No heating equipment should be located or used within the storage area. Salamanders, braziers, portable heaters, and other open fires should not be used.

C-6.5 Smoking should be prohibited, except in locations prominently designated as smoking areas. "No Smoking" signs should be posted in prohibited areas.

C-6.6 Welding and cutting operations should be prohibited in the storage area, unless the precautions in NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, are followed.

C-6.7 Tarpaulins, used for protection of storage against the weather, should be of fire retardant fabric.

C-6.8 Locomotives from which glowing particles may be emitted from exhaust stacks should not be permitted in the yard.

C-6.9 Motorized vehicles using gasoline, diesel fuel, or liquefied petroleum gas as fuel should be garaged in a separate detached building.

C-6.9.1 Storage and handling of fuel should conform with NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 58, *Standard for Storage and Handling of Liquefied Petroleum Gases*.

C-6.9.2 Repair operations should be conducted outside the yard unless a separate masonry wall building is provided. Vehicles should not be greased, repaired, painted, or otherwise serviced in the yard. Such work should be conducted in conformity with NFPA 88B, *Standard for Repair Garages*.

C-7 Fire Protection.

C-7.1 Provisions should be made for promptly notifying the public fire department and private fire brigade (if available) in case of fire or other emergency.

C-7.2 Hydrants should be spaced to provide a sufficient number of hose streams. Refer to NFPA 24, *Standard for the Installation of Private Fire Services Mains and Their Appurtenances*.

C-7.2.1 Provisions should be made to permit direction of an adequate number of hose streams on any pile or portion of the storage area that may be involved in fire. It is recommended that, unless adequate protection is provided by the municipal fire department, sufficient hose and other equipment be kept on hand at the storage property, suitably housed, and provision be made for trained personnel available to put it into operation.

C-7.2.2 Hydrants and all fire fighting equipment should be accessible for use at all times. No temporary storage should be allowed to obstruct access to fire fighting equipment, and any accumulation of snow or obstructing material should be promptly removed.

C-7.3 Monitor nozzles should be provided at strategic points where large quantities of highly combustible materials are stored or where average amounts of combustible materials are stored in inaccessible locations.

with overhead cranes. These means should be identified and reviewed by emergency service personnel.

5-3 Warehouse Emergency Organization.

5-3.1 The level of emergency response capabilities and how these capabilities are utilized or interfaced with responding emergency personnel should be noted in the pre-incident plan.

Local procedures might specify total evacuation without any effort to control an emergency incident or might specify an active employee response. The authority having jurisdiction or site management might require the establishment of an emergency response organization of facility employees to specifically control fires, chemical spills, and related emergencies or to facilitate evacuation or deliver emergency medical services.

5-3.2 Organizational Structure. An organizational structure and emergency contact list should be obtained from facility management. The emergency contact list should be updated at least annually. At a minimum, this should include the process (name or location) to be followed to initiate contact during an emergency.

5-3.3 Assignment of Nonfire Fighting Duties. A current list of assigned personnel should be available, and it should specify responsibilities such as shutting off electricity and other related utilities and controlling the HVAC systems.

5-3.4 Special Equipment Operation. Special equipment such as automatic rack retrieval systems and overhead cranes pose unique emergency challenges. Emergency operating procedures and personnel for this equipment should be documented and readily available.

5-3.5 Hazardous Materials Coordinator. Most warehouse facilities have some individual responsible for maintaining material safety data sheets (MSDS) and inventories for hazardous materials. Contacting this person(s) for on-scene assistance should be given priority at any emergency. Locations of MSDS sheets and related data should be indicated in the pre-incident plan.

Chapter 6 Fire Protection Features

6-1 Fire Protection Devices and Systems.

6-1.1 Automatic Sprinkler Systems.

6-1.1.1 Common Causes of Sprinkler System Failure. An important part of pre-incident planning is to anticipate potential sources of sprinkler system failure and to take action to correct any known or suspected problem areas. A fire protection engineer might need to be consulted to identify design adequacy.

6-1.1.1.1 Design Deficiency. This can happen when the water supply available is not adequate to control a fire. The water supply itself might be inadequate, or the sprinkler system might be improperly designed for the facility and the commodities stored inside. Each automatic sprinkler system is designed for a specific occupancy. The original system design might not have been adequate, or a change to a more hazardous commodity or storage array might have rendered a protection system inadequate. Even seemingly minor changes within a warehouse can compromise existing sprinkler protection.

6-1.1.1.2* Impairment to the Sprinkler System Before a Fire. This generally occurs where a sprinkler system is actually shut off during new construction or building renovations, or where an obstruction such as a rock works its way into sprinkler piping and blocks the flow of water.

6-1.1.1.3* Impairment to the System During a Fire. The system is impaired when any sprinkler control valve is shut prematurely during a fire. This obviously turns off the water to sprinklers. Well-meaning facility employees or members of the fire department might shut the valve in order to reduce smoke or to control water damage; however, this action only prevents sprinklers from gaining control of a fire in its critical development stage. Even if the valve is turned on again later, the fire might have grown beyond the point where sprinklers can control it.

6-1.1.2* Sprinkler System Components Unique to Warehouses.

6-1.1.2.1 Rack Storage Sprinkler. This system is used to supplement ceiling sprinklers where rack storage configuration such as height, width, or the use of solid shelves would make control by ceiling sprinklers alone nearly impossible.

6-1.1.2.2 Large-Drop Sprinkler. Delivers more water to the seat of the fire because of larger water droplet size. This head delivers a minimum of 56 gpm (212 L/min) at 25 psi (172 kPa). It is significantly more effective in protecting high-challenge storage occupancies than a standard sprinkler. It uses a 0.64-in. (16.25-mm) orifice, as compared to a standard ½-in. (12.7-mm) or 17/32-in. (17.8-mm) head.

6-1.1.2.3 Early Suppression Fast Response (ESFR) Sprinkler. ESFR is a new concept in warehouse sprinkler design, which is based on suppression of the fire, not just control. The ESFR sprinkler features a more sensitive fusible element to make the sprinkler respond more quickly than standard sprinklers, and a larger orifice to deliver a minimum flow of 100 gpm (380 L/min) at 50 psi (345 kPa) per head. It uses a 0.70-in. (17.8-mm) orifice.

6-1.1.3 Sprinkler Control Valves. Sprinkler control valves are used to turn the water supply to sprinklers on and off. All valves should remain fully open for maximum sprinkler effectiveness. One shut valve can leave a section of a facility completely without automatic sprinkler protection. During plan development, fire service personnel should determine the location of all sprinkler control valves at a facility. Responding personnel should manually try each valve to make sure it is in the open position during the incident.

6-1.1.4 Hydraulically Designed Systems. Most systems installed today are hydraulically designed systems. Hydraulically designed systems should have a placard posted on the riser indicating the specific design characteristics of the system. A piping system where branch lines form a connecting grid or where cross mains or feed mains form a loop are always hydraulically designed, even though a hydraulic placard is not provided at the riser. Sprinkler contractors use a computer to custom-design the exact protection configuration to meet the facility's needs.

F-2

This has become the preferred system for two reasons: (1) it generally requires smaller diameter pipes and allows optimization of pipe sizes and fittings, which saves on costs, and (2) the gridded or looped-type design of the system brings water in from several directions, which reduces friction loss.

6-1.1.4.1 Sprinkler systems that are hydraulically designed are not always adequate or might not remain adequate for the following reasons:

(a) Contractors might install a system that uses every available psi of water pressure available without allowing for any margin of error.

(b) The water supply can deteriorate after the sprinkler installation is completed, resulting in an inadequate supply to meet the custom design.

(c) The warehouse commodity can change to one needing a stronger sprinkler design than that which was provided.

(d) The storage configuration can change to one needing a stronger sprinkler design than that which was provided.

A deterioration in the water supply might provide an inadequate supply to meet the intended custom design.

6-1.1.5 Fire Department Connections. The location of the fire department (siamese) connections should be determined. The connections should be identified as to whether they feed entire buildings, individual sprinkler systems, or standpipes. Threads should be physically checked for compatibility with the fire department thread.

6-1.1.6 Water Supply. Automatic sprinkler systems for warehouse occupancies generally are designed to supply flow rates from between 1500 gpm and 3000 gpm (6000 L/min and 12000 L/min) and to contemplate confining a fire from 2000 ft^2 to 5000 ft^2 (610 m^2 to 1525 m^2) in area within the building. The actual pressure needed is a function of the sprinkler system design for each individual warehouse.

A sprinkler system's water supply should be capable of meeting not only the sprinkler demand, but also the demand for hose streams. There is a vital need to evaluate the water supply and to determine if it is adequate for the sprinkler system design, storage, configuration, and the warehouse occupancy class.

6-1.1.6.1 Public Water Supply. The most common source of water for the automatic sprinkler system is a public water supply. In some cases, a booster pump is connected to the public supply to boost the system's pressure to the necessary level.

6-1.1.6.2 Static Suction Source. A static source would usually require a fire pump to provide the necessary water volume and pressure to the system. Tanks, wells, reservoirs, and rivers are examples of these suction sources.

6-1.1.6.3 Pumps. Where either booster or fire pumps are provided, it is important to note their size, pressure settings, starting arrangement, and power and fuel supply.

6-1.2 Special Extinguishing Systems. A special extinguishing system uses some agent other than water for automatic fire suppression. Except for flammable liquid storage, these systems are not often used to protect the warehouse itself, but they still can be found within warehouse facilities. In most cases, they are considered supplementary to automatic sprinkler systems. These systems include carbon dioxide, dry chemical, foam, and halogenated extinguishing systems.

6-1.3 Alarm Systems. Alarm systems are used to monitor the actuation of both detection (smoke and heat) systems and automatic extinguishing systems. Alarms for automatic sprinkler systems are usually activated by water flow.

6-1.3.1 The presence of an alarm system should not eliminate the need for a followup telephone call from the facility confirming the nature and exact location of the alarm.

6-1.4 Portable Fire Extinguishers. Portable fire extinguishers are provided for immediate use on fires in their incipient stage. Extinguishers of the proper size and rating for the expected fire should be distributed throughout the warehouse. Facility employees should be properly trained to use extinguishers. (*See NFPA 10, Standard for Portable Fire Extinguishers.*)

6-1.5 Standpipes and Hose Stations. The pre-incident plan should note if available standpipe systems are of the wet or dry type, and the size of the hose discharge outlet. Small hose stations can be provided and supplied from the sprinkler system. The pre-incident plan should note if these stations will be impaired if the sprinkler system is shut off.

6-1.6 Hydrants. The location of all hydrants should be determined as part of pre-incident planning, including wall hydrants, private hydrants, aud pump test headers.

6-1.7 Outside Hose and Monitor Nozzles. Hose houses and monitor nozzles may be provided in areas that are inaccessible to vehicles or at concentrated local hazards, such as yard storage. Their location should be noted on the pre-incident plan.

6-1.8 Compatibility. Warehouse emergency equipment and fire brigade tactics should be reviewed to ensure that the equipment and procedures of the facility emergency organization and that of the responding local municipal emergency organization are compatible. Hose coupling threads and radio frequencies are two areas in particular that should be given priority.

6-1.9 Smoke and Heat Venting. Smoke control is important in warehouse occupancies due to the large amounts of commodities stored within. In a large area, smoke tends to lose its buoyancy sooner than it would in a more tightly confined space. This occurs because smoke cools the farther it travels from its source. In all spaces, activated sprinklers also cool any smoke in the immediate area of discharge.

Proper venting of smoke and hot gases minimizes property damage and increases fire fighter effectiveness and safety. The plan should note how venting can be accomplished and the location of any manual or automatic controls.

Venting should be accomplished by means of automatic or manual roof vents, powered smoke removal systems, or available buildiug features such as windows, ridge vents, or overhead doors.

Automatic venting details should be noted in the pre-incident plan, as this could affect fire behavior.

G-1

December 1990
Supersedes May 1988
and April 1987

EARLY SUPPRESSION-FAST RESPONSE SPRINKLERS

TABLE OF CONTENTS

1.0 SCOPE

This standard provides requirements for the installation of Early Suppression-Fast Response (ESFR) sprinklers and discussion on the theory and development of these sprinklers. The ESFR sprinkler relies on the concept of fire suppression, rather than fire control. Fire control is the basis for standard or large-drop sprinkler protection. The ESFR sprinkler has undergone extensive testing and is backed by much scientific research. As with any such product, its reliability is based on close adherence to the guidelines established for its use.

Many of the engineering judgments appropriate to standard or large-drop sprinklers do not necessarily transpose to ESFR sprinklers. Use of conventional judgments for ESFR sprinkler installations may not uniformly transfer to this unique technology. Thus, it is important that the installation requirements contained herein be closely followed.

2.0 INSTALLATION REQUIREMENTS

2.1 General

Installation requirements for ESFR sprinklers provide adequate flexibility for achieving excellent economy while maintaining reliability. Data Sheet 2-8N, *Installation of Sprinkler Systems*, applies for installation details not addressed here. Table 1 of this data sheet gives a summary of ESFR sprinkler installation guidelines.

2.2 Construction

2.2.1 Roof Construction and Slope

Acceptable types of roof construction are not dependent upon the combustibility of the roof. Rather, acceptability is primarily a function of the roof shape and configuration, needed to assure fairly uniform sprinkler response to a growing fire. ESFR sprinklers are not suitable for use beneath roofs that may prevent relatively uniform heat movement, thereby causing a delay in sprinkler operation.

2.2.1.1 Roof Construction

ESFR sprinklers can be installed in buildings with the following types of roof construction:

(a) smooth ceiling;

(b) bar joist;

(c) beam and girder;

(d) panel, up to 300 sq ft (28 sq m). (This includes plywood diaphragm roofs where the purlins and subpurlins are framed into the sides of, rather than on top of supporting members to eliminate open communicating spaces at the roof between panel areas.)

Note: Data Sheet 2-8N, *Installation of Sprinkler Systems*, contains detailed information regarding definitions of roof types.

2.2.1.2 Roof Slope

Roof slope up to and including 1 in./ft (83 mm/m) is acceptable. For roof slope in excess of 1 in./ft (83 mm/m), a suspended ceiling with acceptable slope may be installed above the storage with sprinklers installed below the ceiling. Sprinkler protection should be provided above the ceiling at roof level also if the roof, contents in the concealed space, or ceiling are combustible. (See Data Sheet 1-12, *Ceilings*.)

Storage arrangements used during the testing to develop and determine water demands for ESFR sprinklers were generally symmetrical, well-arranged simulated storages with uniform and well defined flue spaces, with the exception of one successful test involving irregular flue spaces. The following storage area requirements reflect other conditions for protection with ESFR sprinklers. (See also Section 3.2, *Applicability*.)

2.3.1 *Flue Spaces*

It is not necessary to provide flue spaces uniformly throughout the racks. Minimum 3-in. (76-mm) flues in the transverse direction at least every 8 to 10 ft (2.4 to 3.0 m) of rack length are sufficient to allow sprinkler water penetration through the racks to the seat of the fire. Spaces

Table 1. Summary of ESFR Sprinkler Installation Guidelines.

Type of Storage[1]	Single-, double-, multiple-row and portable rack storage (no open-top combustible containers or solid shelves), solid-piled or palletized storage, and bin-box storage.
Commodity	Class I, II, III and IV commodities. Cartoned unexpanded plastics. Cartoned expanded plastics. (All the above either encapsulated or nonencapsulated)
Maximum Height of Storage, ft (m)	25 (7.6)
Maximum Height of Building, ft (m)	30 (9.1)
Roof Construction	Smooth ceiling. Bar joist. Beam and girder. Panel (including plywood diaphragm) *Also,* Maximum roof slope of 1 in./ft (84 mm/m) No exposed expanded plastic No automatic roof vents
Sprinklers	*Type:* ESFR pendent, 165°F (74°C) nominal. *Location:* Centerline of thermal sensing element maximum 13 in. (330 mm) and minimum 4 in. (102 mm) below ceiling preferably 6 to 10 in. (152 to 254 mm) below ceiling. *K-Factor:* 14.0 *Hydraulic Design:* Minimum 50 psi (3.45 bar, 345 kPa) from most remote 12 sprinklers flowing 4 sprinklers on 3 brartch lines. *System type:* Wet-pipe (no dry-pipe or preaction). *Spacing:* 80 to 100 sq ft (7.4 to 9.3 sq m spacing, minimum 8 ft (2.4 m) and maximum 12 ft (3.7 m) between sprinklers or branch lines.
Hose Streams	250 gpm (946 cu dm/min), 1½ in.(38 mm) hose lines, maximum 100 ft (30.5 m) to reach all areas.
Water Supply	One hour duration.

[1]Other types of storage can be protected with ESFR sprinklers when indicated by the data sheet covering the particular type of storage.

formed by vertical rack uprights between each rack bay will provide adequate flue spaces. Spaces normally available to allow accurate loading of pallet loads will provide additional flues randomly located within each rack bay.

Flue spaces are not necessary for solid-piled or palletized storage.

2.3.2 *Solid Shelves*

Like other ceiling-only sprinkler arrangements, ESFR sprinklers should not be used to protect rack storages that have solid shelves. (Solid shelves are defined in Data Sheet 8-33, *Rack Storage of Materials*.) Because solid shelves promote horizontal fire spread while simultaneously shielding burning combustibles from sprinkler discharge, they are not conducive to ESFR protection.

2.3.3 *Open-top combustible containers*

ESFR sprinklers should not be used to protect rack storage of open-top combustible containers. Successful ESFR sprinkler performance depends on sufficient sprinkler water penetration through the racks to the seat of the fire. This penetration is accomplished by direct water spray through the flue spaces, as well as by runoff down the sides of the stored commodities from the top surfaces of the array. Open-top combustible containers will collect a significant portion of the sprinkler water spray, preventing water rundown to the seat of the fire at the lower tiers of storage. Conventional ceiling-only sprinklers are similarly handicapped in this regard.

2.3.4 *Special Considerations*

2.3.4.1 Roof Height Higher Than 30 ft (9.1 m)

When roof slope requirements result in roof peak height up to 32 ft (9.8 m) maximum, ESFR sprinklers may be used if sprinkler design discharge pressure is 60 psi (4.14 bar, 414 kPa) rather than 50 psi (3.45 bar, 345 kPa) as outlined in Section 2.4.1. Maximum storage height is still 25 ft (7.6 m).

2.3.4.2 Solid Mezzanines

When solid mezzanines with storage beneath are installed within a building protected by ESFR sprinklers, provide ESFR sprinklers beneath the mezzanine also, with no storage placed between the outside line of ESFR sprinklers beneath the mezzanine and any edge of the mezzanine which is open to the main building area. Limit storage height beneath the mezzanine to 12 ft (3.7 m) high and design the ESFR sprinkler system beneath the mezzanine to provide six sprinklers (three on two lines) at 50 psi (3.45 bar, 345 kPa). Water demand may be independent from the ceiling ESFR sprinkler system.

2.3.4.3 Conveyors and Walkways

For conveyors and walkways up to 6 ft (1.8 m) wide which can obstruct ceiling sprinkler discharge, provide a line of ESFR sprinklers beneath designed to supply two sprinklers at 50 psi (3.45 bar, 345 kPa), and add the water demand for the two sprinklers to that for the ceiling ESFR sprinkler system.

2.6.3 Clear Space Below Sprinklers

Maintain at least 3 ft (0.9 m) between sprinkler deflectors and the top of storage. This minimum clearance is necessary to ensure adequate distribution of water spray from discharging sprinklers over the top of storage into flue spaces and down the aisle faces.

2.6.4 Obstructions to Distribution

2.6.4.1 General

Effective fire suppression requires direct and prompt attack upon the burning fuel by the sprinkler discharge. Therefore, obstructions to distribution and interference with the discharge pattern must be taken into account in the overall design.

2.6.4.2 Obstructions Located at or Near the Ceiling

Where sprinkler deflectors are located above the bottom of beams, girders, ducts, fluorescent lighting fixtures or other obstructions located near the ceiling, position the sprinklers so that the maximum vertical distance from the bottom of the obstruction to the deflectors is within the guidelines specified in Table 2. Use Figures 1 and 2 in conjunction with Table 2 in positioning sprinkler deflectors.

2.6.4.3 Obstructions Located Below the Sprinklers

When the position of sprinklers with respect to fluorescent lighting fixtures, ducts, and other obstructions wider than 2 ft (0.6 m) is such that the Table 2 deflector distances above obstructions are exceeded, install additional sprinklers beneath obstructions, and include such sprinklers in the water demand. Additional sprinklers beneath obstructions are not needed when: 1) obstructions up to 2 ft (0.6 m) wide are located below a single sprinkler, but not below two or more adjacent sprinklers (including diagonally), or; 2) continuous obstructions, such as sprinkler piping, utility piping or ductwork up to 1 ft (0.3 m) wide are located below sprinklers and offset at least 2 ft (0.6 m) horizontally from the vertical centerline of the sprinklers.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Characteristics of ESFR Sprinklers

ESFR sprinklers were developed for use against high-challenge fires with the goal of achieving lower loss expectancies. They may be economical with ordinary storages as well. The sprinklers are designed to respond quickly to growing fires and to deliver a heavy sprinkler discharge to "suppress" the fire, rather than "control" it, as occurs with standard and large-drop sprinklers. ESFR sprinklers provide a direct attack on the burning fuel by improved sprinkler discharge to achieve early suppression of the fire. Because of the effectiveness of these sprinklers, the need for prewetting storage in surrounding areas and cooling at the ceiling, as is the case with the fire *control* concept, is nearly eliminated. This approach results in a much smaller fire area and sprinkler operating area than control-mode protection, making it a particularly good choice where there are high-value contents.

It is important to realize that the effectiveness of the ESFR sprinklers depends on the combination of fast response and the quality and efficiency of the sprinkler discharge. Other sprinklers, possessing only one of these characteristics, cannot be relied upon to achieve early fire suppression.

Table 2. Position of Deflector When Located Above Bottom of Beam or Other Obstruction.

Horizontal Distance from Sprinkler to Side of Beam or Other Obstruction	Maximum Distance Deflector Above Bottom of Beam or Other Obstruction, in. (mm)
Less than 1 ft (0.3 m)	0 (0)
1 ft (0.3 m) to less than 1½ ft (0.5 m)	1½ (38)
1½ ft (0.5 m) to less than 2 ft (0.6 m)	3 (76)
2 ft (0.6 m) to less than 2½ ft (0.8 m)	5½ (140)
2½ ft (0.8 m) to less than 3 ft (0.9 m)	8 (203)
3 ft (0.9 m) to less than 3½ ft (1.1 m)	10 (254)
3½ ft (1.1 m) to less than 4 ft (1.2 m)	12 (305)
4 ft (1.2 m) to less than 4½ ft (1.4 m)	15 (381)
4½ ft (1.4 m) to less than 5 ft (1.5 m)	18 (457)
5 ft (1.5 m) to less than 5½ ft (1.7 m)	22 (559)
5½ ft (1.7 m) to less than 6 ft (1.8 m)	26 (660)
6 ft (1.8 m)	31 (787)

ESFR sprinklers will provide excellent, reliable protection for those occupancies that have been shown by testing to be suitable. As with any new technology, careful design and close adherence to the rules given in this data sheet are essential. Therefore, judgments intended to extend their use or amend installation requirements may not be consistent with those attributed to other types of sprinklers. The characteristics of ESFR sprinklers are further discussed in the Appendix of this data sheet.

been relaxed to 1 in./ft (84 mm/m). An FMRC research project to evaluate roof slope effects on ESFR sprinkler operations showed that the 1 in./ft (84 mm/min) slope represents a practical maximum for the purpose of avoiding a skewed sprinkler operating pattern.

The goal of any analysis involving heat and smoke vents should be to prevent delayed sprinkler operation if the fire starts under or near a vent. Early vent operation could prevent the buildup of the heat layer beneath the roof which is necessary to operate the sprinklers. At the very minimum, when avoidance of automatic vents is impossible, mechanically operated types should be used with the fusible elements rated 360°F (182°C) or more to allow sprinklers to operate before the vents. Plastic drop-out type vents should be avoided.

3.4.3 Storage Arrangements

The intent of this standard is to allow ESFR use for only those storage arrangements and commodity hazard levels where either 1) successful fire testing has been completed, or 2) a rigorous engineering study allows judgment on the basis of favorable comparisons between existing fire test using data with other types of sprinklers and the intended application using ESFR sprinklers.

3.4.4 Sprinkler System Design

Sprinkler system design criteria is based on results of full-scale fire testing. Because of the rigorous approval requirements for water distribution and fire plume penetration, deviations from the specified design requirements cannot be made.

3.4.5 Sprinkler System Components

Generally, components that are FMRC-Approved for sprinkler system use are acceptable.

3.4.6 Location and Position of Sprinklers

There are four factors which need to be considered when locating sprinklers beneath a ceiling: 1) the sprinkler must be close enough to the underside of the ceiling to ensure that the sprinkler will discharge water quickly enough to suppress the fire; 2) the sprinkler must be located far enough above the top of storage to allow proper distribution of the water discharge over the area covered by the sprinkler; 3) obstructions located horizontally from the sprinkler which could interfere with proper lateral distribution must be minimized; 4) obstructions located beneath the sprinkler which could interfere with both water distribution and penetration of the fire plume must be minimized.

4.0 APPENDIX - DEVELOPMENT OF ESFR SPRINKLERS

4.1 Background

The continuous study of automatic sprinkler protection by FMRC led to the establishment of a sprinkler optimization program initiated in 1968. Under this program, a study was begun into drop size distribution and the aerodynamics of sprinkler sprays. This work led to the design of a large-drop sprinkler which received its first practical demonstration in 1971 when a large-scale fire test of warehouse commodities was conducted, and it culminated in 1980 with FMRC's publication of installation rules for large-drop sprinklers.

In 1976, FMRC accepted a contract with the United States Fire Administration (USFA) to evaluate sprinkler performance in residential occupancies. During the course of that work, FMRC engineers and scientists determined that fast response sprinklers would be required to maintain a safe environment in occupied residential areas. Consequently, research with "fast response" residential sprinklers was undertaken and an effective prototype was developed by 1979.

The success with fast response residential sprinklers prompted FMRC engineers to consider the use of fast response sprinklers for industrial applications. High-challenge fires were of particular interest. Since large-drop sprinklers had been developed for use against high-challenge fires, it was natural to speculate on the benefits to be derived from the use of fast response large-drop sprinklers.

In October 1982, large-drop sprinklers were armed with fast response (Response Time Index [RTI] 50) links and a series of large-scale fire tests was conducted in double-row rack storage of plastics. In accordance with standard fire testing practice, the ignition point was centered below four sprinklers. The result of these tests clearly demonstrated that a dramatic improvement in the protection of high-challenge hazards could be achieved by combining fast response with a sprinkler possessing high suppression capability.

Following the large-scale tests, a series of intermediate scale tests was conducted to study the effects caused by changing various parameters. In these tests, fast response large-drop sprinklers were not as effective when the ignition point was located directly below a sprinkler. This problem is caused by a hollow spot in the discharge pattern, located directly below the sprinkler. A fire started in this area may develop with little hindrance from the sprinkler discharge. As the fire plume develops, it causes the discharge pattern to open up further and even less water will reach the area directly below the sprinkler. The fire will soon reach a size where early suppression cannot be achieved. Although the extent of this deficiency was never quantified, at best the sprinklers would then act in the control mode where the level of performance will approximate that of large-drop sprinklers having normal sensitivity (RTI 300). The benefits of fast response will then be lost.

Obviously, ESFR sprinklers must perform at an acceptable level regardless of the location of the ignition point. Large-drop sprinklers, therefore, were not suitable for ESFR purposes for the conditions tested. However, the tests conducted with fast response large-drop sprinklers did prove that the ESFR concept was viable. Consequently,

4.3.1 Apparatus

RTI is measured using the Plunge Test Apparatus. In a plunge test, the sprinkler is suddenly immersed in a uniform gas flow of constant temperature and velocity. The activation time determines the sprinkler time constant, which

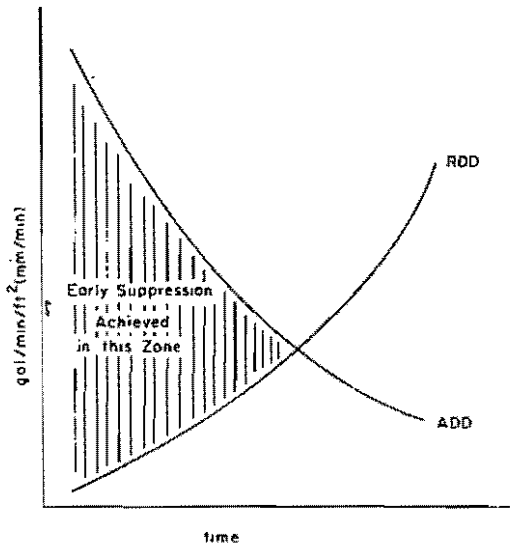


Fig. 3. Generalized RDD-ADD concept.

can be used to predict the activation time in any fire environment defined in terms of temperature and velocity versus time. The RTI value for a sprinkler is the product of the sprinkler time constant and the square root of the air velocity.

RDD is determined using a specially designed water applicator in conjunction with a large-capacity calorimeter called the Fire Products Collector. The water applicator uses a system of small closely spaced nozzles to deliver a known rate of water directly onto the top surface of the burning fuel array. The fire environment of a particular storage array in terms of temperature and velocity versus time is defined by knowing the RTI of prototype ESFR sprinklers and by using the Fire Products Collector. This information is used to predict expected sprinkler operation. When this prediction is input into a computerized heat-release-rate monitoring system, time to turn on the water applicator is known, allowing determination of the RDD needed to suppress a fire in the particular storage array. By varying the water application rate in repetitive tests, minimum RDD needed to achieve early fire suppression in a particular storage array is pinpointed.

ADD of sprinklers is determined using a specially designed automated system for measuring the water flux (density) of sprinkler sprays. The system is comprised of a fire source, simulated commodities, and an ADD measuring system. Using a precisely controlled heptane spray fire source, simulated fire-resistive commodities and a computerized water collection system, the apparatus defines the amount of sprinkler spray that actually penetrates a fire plume and is deposited on to the top horizontal surface of a burning combustible array. Heat-release rates determined from RDD testing are simulated. An analysis of ADD data is compared to RDD requirements to determine whether a sprinkler is capable of providing an ADD in excess of the required RDD. If so, then early suppression would be expected in a real-life fire; if not, early suppression would not be expected in a real-life fire. The major factors that affect ADD and that can be measured using the ADD apparatus are 1) intensity of the fire; 2) clearance between sprinklers and the top of the burning array; 3) spacing of sprinklers on piping beneath the ceiling; 4) sprinkler discharge pressure; 5) number of discharging sprinklers; 6) fire ignition location with respect to the discharging sprinklers, and; 7) sprinkler characteristics, such as geometry and uniformity of water density and drop size distribution.

4.3.2 Full-Scale Fire Tests

Full-scale fire tests were conducted using an ESFR prototype sprinkler. This prototype had been tested using the ADD apparatus and had been shown to be theoretically capable of providing early fire suppression in actual full-scale storage arrangements. The purpose of the full-scale testing was two-fold: 1) to confirm the validity of the theory that a fire will be suppressed when ADD exceeds RDD, and 2) to establish ESFR sprinkler system hydraulic design criteria. Both of these purposes were confirmed by full-scale tests. A summary of these fire tests is presented in Table 3.

Full-scale fire testing did confirm the validity of the ESFR concept while simultaneously providing data to permit determination of ESFR sprinkler system hydraulic design criteria.

4.4 Retrofit Considerations

When evaluating the potential for ESFR sprinklers to be retrofitted into existing sprinkler systems, the following items should be considered:

1. Because of the criticality of maintaining proper ceiling-to-thermal sensing element distances, and the fact that the vast majority of existing sprinkler systems use upright sprinklers, retrofitting the pendent ESFR sprinkler to an existing system could require major piping relocation.

2. The presence of existing lighting, ductwork, etc., may create obstructions to distribution.

3. Sprinkler systems originally designed for high-hazard storages are usually more able to supply ESFR water demands than those designed for low to moderate hazards. A ceiling system designed for use with in-rack sprinklers would have significantly less capacity then a ceiling system designed without in-rack sprinklers because of the credit given for use of in-rack sprinklers.

4. The most hydraulically favorable systems are loops, followed by tree-shaped systems and grids.

5. Calculations generally show that a system capable of providing 15 k=11.2 (large-drop) sprinklers at 50 psi (3.45 bar, 345 kPa) would also be capable of supplying 12 k=14.0 sprinklers at 50 psi (3.45 bar, 345 kPa).

G-7

Loss Prevention Data
Technical Advisory Bulletin

File With: 2-2

June 1992

EARLY SUPPRESSION-FAST RESPONSE (ESFR) SPRINKLERS FOR BUILDINGS TO A MAXIMUM OF 40 FT (12.1 M) IN HEIGHT

RECOMMENDATION

1. ESFR sprinklers which are Factory Mutual Research Corporation (FMRC) Approved for installation in 40 ft (12.1 m) high buildings may be used to protect *solid-piled, palletized* and *open-frame* rack storage of cartoned unexpanded plastics up to 35 ft (10.6 m) high in buildings up to 40 ft (12.1 m) high, subject to the following conditions:

a) **CAUTION:** Only those sprinklers specifically FMRC-Approved for use in 40 ft (12.1 m) high buildings can be used. *At this time, only the Grinnell Model ESFR-1 the Reliable Model H and the "Automatic" Model K1 are FMRC-Approved for 40 ft (12.1 m) buildings. The "Automatic" Model K is only FMRC-Approved for use in 30 ft (9.1 m) high buildings and is not acceptable for 40 ft (12.1 m) high building applications.* When any other ESFR sprinkler models become FMRC-Approved for 40 ft (12.1 m) high building applications, notice will be issued immediately. Once specific listings of ESFR sprinklers FMRC-Approved for use in 40 ft (12.1 m) high buildings appear in the *FMRC Approval Guide,* that guide may be consulted for information.

b) Commodity hazard limited to Class 1, 2, 3 and 4 commodities and cartoned unexpanded plastic. All flammable and combustible liquids are excluded.

c) Design the system to provide 12 sprinklers at 75 psi (5.17 bar), plus 250 gal/min (946 L/min) for hose streams.

d) Maximum spacing between branch lines and between sprinklers on branch lines is 10 ft (3 m), with area of coverage between 80 and 100 sq ft (7.4 to 9.3 sq m).

e) Criteria for obstructions to distribution from both Data Sheets 2-2, *Early Suppression-Fast Response Sprinklers*, and 2-7, *Installation Rules for Sprinkler Systems Using Large-Drop Sprinklers*, must be met.

f) All other criteria from Data Sheet 2-2 apply. No deviations from the above guidelines are permitted.

DISCUSSION

A series of eight rack storage fire tests has been conducted to determine if adequate sprinkler protection for cartoned unexpanded plastics to 35 ft (10.6 m) in height under a 40 ft (12.1 m) high ceiling can be provided by an ESFR sprinkler system discharging at 75 psi (5.7 bar). Three FMRC-Approved ESFR sprinklers were used: "Automatic" K, "Automatic" K1 and Grinnell ESFR-1. Sprinkler spacing was maintained at 10 ft by 10 ft (3 by 3 m) and sprinkler discharge pressure was 75 psi (5.7 bar).

The test conditions and results are provided in Table 1.

The first four tests were conducted to investigate the case with ignition directly below a sprinkler. The "Automatic" K sprinkler was used in Tests 1 and 3; the Grinnell ESFR-1 sprinkler was used in Tests 2 and 4. In Test 3, the storage height was 25 ft (7.6 m) with 15 ft (4.6 m) clearance from top of storage to the sprinkler. The fire was not suppressed with the "Automatic" K sprinkler. For the other three tests, the fire was suppressed successfully.

Three additional tests were conducted to investigate the case with ignition centered between two sprinklers, using the Grinnell ESFR-1 sprinkler. The storage height was 35 ft (10.6 m); the clearance between sprinklers and top of storage was 3 ft (0.9 m). One test was conducted with a plugged head at 5 ft (1.5 m) from centerline of the ignition stack and the other without any plugged heads. For the test with a plugged head, the fire was not suppressed and a total of 20 heads operated. For the testing without any plugged head, the fire was suppressed with two heads operating. Because of the plugged head test results, obstruction to distribution criteria are more stringent.

The last test was conducted to investigate whether the "Automatic" Model K1 sprinkler could successfully be used within the guidelines of this bulletin. This test was successful.

Data Sheet 2-2 will be revised and proposals will be made to appropriate NFPA technical committees.

Factory Mutual System

2. Water services for each lot shall be stubbed out with an angle stop to the location required as shown on the standard details. A meter box conforming to the requirements of the standard specifications shall be installed over the end of each service.

3. Valves and fire hydrants shall be located at intervals of three hundred (300) feet in industrial, commercial or local retail areas and at intervals of five hundred (500) feet in apartment or residential areas.

4. Should the subdivision or addition abut and use a water main of the city, the developer shall pay to the Town of Addison a "pro rata" charge as prescribed by the pro rata ordinance of the city for use of the same.

E. *Other utilities.*

1. The developer shall furnish all easements and rights-of-way necessary for construction of electrical, gas, and telephone service to the subdivision.

2. The developer shall pay for the number of street lights required in the subdivision as determined by the director of public works. Maximum distance between street lights shall be approximately six hundred (600) feet. After acceptance of the subdivision, service charges for electricity will be paid by the city.

3. The developer shall be responsible for all damage to improvements caused during installation of utilities.

F. *Miscellaneous.*

1. The developer shall provide street signs for the subdivision. There shall be one sign for each three (3) way intersection and two (2) signs for each four (4) way intersection. The signs will be ordered by the public works department and the developer billed a fixed fee for each sign. Such price shall include cost of the sign assembly, pole and installation.

2. Sidewalks shall be constructed in accordance with the sidewalk ordinance of the Town of Addison on all lots

of 150 feet from a water supply on a public street, as measured by an approved route around the exterior of the facility or building, on-site fire hydrants and mains capable of supplying the required fire flow shall be provided when required by the chief.

Type of Water Supply

Sec. 10.402. Water supply may consist of reservoirs, pressure tanks, elevated tanks, water mains or other fixed systems capable of providing the required fire flow. In setting the requirements for fire flow, the chief may be guided by the provision in Appendix III-A.

Fire Hydrants

Sec. 10.403. The location, number and type of fire hydrants connected to a water supply capable of delivering the required fire flow shall be provided on the public street or on the site of the premises or both to be protected as required and approved by the chief. Fire hydrants shall be accessible to the fire department apparatus by roads meeting the requirements of Division II.

For fire safety during construction, alteration or demolition of a building, see Section 87.103 (c).

Division V

INSTALLATION AND MAINTENANCE OF FIRE-PROTECTION AND LIFE-SAFETY SYSTEMS

General

Sec. 10.501. (a) **Type Required.** The chief is authorized to designate the type and number of fire appliances to be installed and maintained in and upon all buildings and premises in the jurisdiction other than private dwellings. This designation shall be based upon the relative severity of probable fire, including the rapidity with which it may spread. Such appliances shall be of a type suitable for the probable class of fire associated with such building or premises and shall have approval of the chief.

(b) **Special Hazards.** For occupancies of an especially hazardous nature or where special hazards exist in addition to the normal hazard of the occupancy, or where access for fire apparatus is unduly difficult, the chief is authorized to require additional safeguards consisting of additional fire appliance units, more than one type of appliance, or special systems suitable for the protection of the hazard involved. Such devices or appliances may consist of automatic fire alarm systems, automatic sprinkler or water spray systems, standpipe and hose, fixed or portable fire extinguishers, suitable fire blankets, breathing apparatus, manual or automatic covers, carbon dioxide, foam, halogenated or dry chemical or other special fire-extinguishing systems. Where such systems are provided, they shall be designed and installed in accordance with the applicable Uniform Fire Code Standards.

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Carrollton, Texas 75006
Phone (214) 245-0252 Fax (214) 242-8203

JULY 23, 1996

JOHN BAUMGARTNER
CITY OF ADDISON
BOX 144
ADDISON, TEXAS 75001

DEAR JOHN:

PER YOUR REQUEST AS ADVISED BY LYNN CHANDLER, BELOW YOU WILL FIND OUR CURRENT STATUS REGARDING VARIOUS SUBJECTS REQUIRED TO GET A TEMPORARY CERTIFICATE OF OCCUPANCY FOR MY PROPERTY AT 16400 MIDWAY ROAD.

LANDSCAPE

SLADE STRICKLAND HAS GIVEN ME THE MONTH OF AUGUST TO COMPLETE A SUBSTANTIAL PORTION OF OUR LANDSCAPING. AS WE ALL KNOW, AUGUST IS NOT A GOOD MONTH TO PLANT AND GOOD PLANTS ARE SCARCE, HOWEVER, WE WILL DO THE VERY BEST WE CAN.

FIRE DEPARTMENT

WE ARE CLEARED AND APPROVED. BRUCE MUELLER REQUESTED TODAY THAT WE DIG A THREE FOOT PERIMETER AROUND AND THREE INCHES BELOW THE FOUR (4) FIRE HYDRANTS ON THE PROPERTY TO MAKE OPENING THE WATER VALVES SIMPLE. THIS HAS ALREADY BEEN ACCOMPLISHED.

UTILITIES

BRUCE ELLIS NEEDS A MAINTENANCE BOND FROM OUR CONTRACTOR,TRIDALE COMPANY. BRUCE WAS PROMISED BY STEVE WHITE OF SUBJECT COMPANY TO HAVE THIS DONE BY THURSDAY OF THIS WEEK.

BRUCE ALSO REQUESTED A CONCRETE 2X2 LOCATOR PAD CONTOURED TO FINISHED GRADE AROUND ALL FIRE HYDRANTS. THIS HAS ALREADY BEEN ACCOMPLISHED.

JOHN, I THINK THIS COVERS OUR TEMPORARY C.O. REQUIREMENTS. PLEASE LET ME KNOW IF YOU NEED ANYTHING ELSE.

REGARDS,

V. A. SAHM

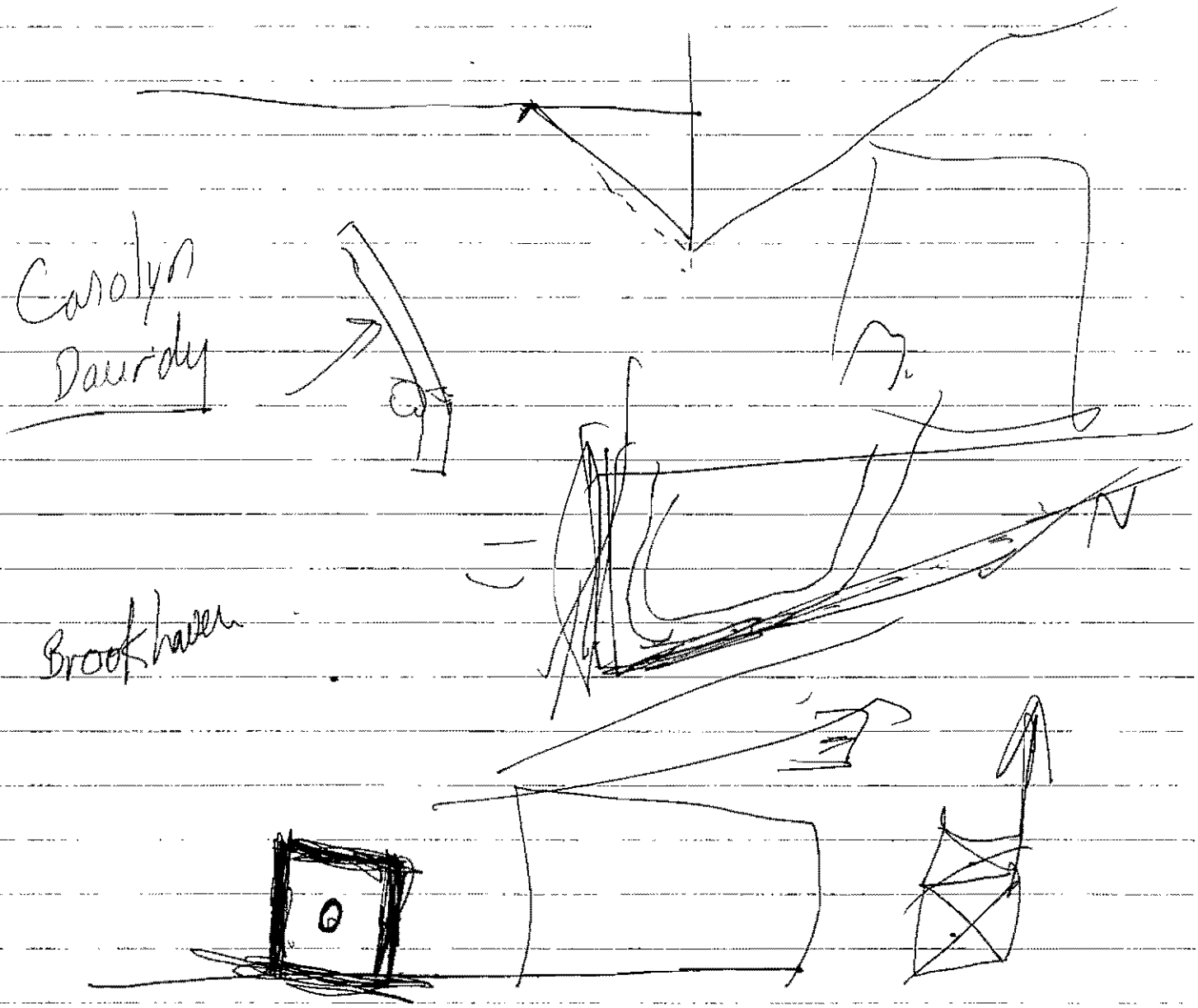
Drainage

Paula James

Bob Pearce
Vic Sahm
Darrell Thompson
Tracy Terrell
John Baumgartner

Town Hall Meeting
2-20-95
March 1, 1995

Air

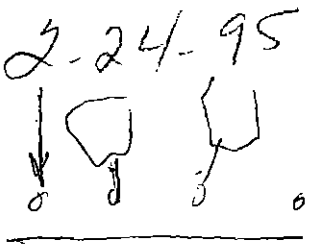


John,

FYI.

Michele

2-24-95



BAS REALITY LTD.
1233 CROWLEY DRIVE
CARROLLTON, TEXAS 75006
(214) 245-2542
FAX (214) 242-8203

FEBRUARY 23, 1995

MR. RON WHITEHEAD, CITY MANAGER
TOWN OF ADDISON
BOX 144
ADDISON, TEXAS 75001

DEAR RON,

I KNOW YOU ARE AWARE OF MY PROBLEM BRINGING AN ELECTRICAL POWER LINE OVER THE DITCH FOR MY FORTHCOMING BUILDING ON MIDWAY. JOHN AND CARMEN SUGGESTED I WRITE TO YOU REQUESTING APPROVAL FROM YOU TO ALLOW ME TO PLEAD MY CASE TO THE CITY COUNCIL AT THE TUESDAY, MARCH 28, 1995 MEETING. I WILL SUMMARIZE THE PROBLEM BELOW SHOULD ANYONE LIKE TO REVIEW THIS MATTER PRIOR TO THE REQUESTED MEETING.

THE TOWN OF ADDISON, APPENDIX B, SUBDIVISIONS, ORDINANCE #261 PAGES 2111 AND 2112 PROHIBITS THE USE OF INSTALLING ELECTRICAL POLES FOR OVERHEAD POWER USES. I THINK THIS ORDINANCE WAS MAINLY AIMED AT RESIDENTIAL DEVELOPMENTS OF WHICH I HEARTILY AGREE. HOWEVER, THIS ORDINANCE IF ENFORCED AGAINST MY MANUFACTURING FACILITY WOULD BE EXTREMELY COST PROHIBITIVE TO ME.

HERE IN LIES THE PROBLEM. BELOW ARE OUR THREE OPTIONS:

1) TEXAS UTILITIES WOULD UTILIZE AN EXISTING POLE AT THE SOUTH SIDE OF THE DITCH AND RUN THE POWER OVER THE DITCH TO (1) INSTALLED POLE ON THE EAST END OF MY PROPERTY AND AS CLOSE TO MY TRANSFORMER AS POSSIBLE. WE WOULD THEN GO UNDERGROUND FROM THE POLE TO THE TRANSFORMER TO MY BUILDING. SIMPLE FOR TEXAS UTILITIES. VERY LITTLE COST TO ME. ONLY PROBLEM IS WE NEED A VARIANCE TO INSTALL (1) POLE AT THE REAR OF MY PROPERTY.

2) IF WE CANNOT GO OVER THE DITCH, WE HAVE TO GO UNDER THE DITCH. THIS WOULD ENTAIL BLASTING AND DRILLING A TRENCH APPROXIMATELY 3 FEET DEEP AND 2 FEET WIDE UNDERNEATH THE LIMESTONE DITCH. SECONDLY, SINCE THIS TRENCH IS SOMETIME UNDER WATER, SPECIAL CABLE, WIRING, AND CONCRETE ENCASEMENT WOULD BE REQUIRED BY CODE. THIRDLY, WE WOULD THEN HAVE TO GO FROM THE DITCH TO MY TRANSFORMER (APPROXIMATELY 150') UNDERGROUND IN ANOTHER CONCRETE ENCASEMENT TO HOUSE THE HIGH POWER WIRING. FOURTHLY, WE WOULD HAVE TO BUILD A MAN HOLE ON MY SIDE OF THE PROPERTY, SO TEXAS UTILITIES COULD INSPECT THE WIRING NEXT TO THE DITCH. COST ARE BEING

TABULATED AT THIS MOMMENT FOR THIS OPTION. I HAVE BEEN TOLD THE COST WILL BE ASTRONOMICAL COMPARED TO RUNNING A SIMPLE POWER LINE OVER THE DITCH.

3] THE ONLY OTHER OPTION IS TO RUN THE HEAVY POWER LINES FROM THE CURRENT POLES ON MIDWAY TO THE REAR OF MY BUILDING WHERE THE PLANT IS LOCATED REQUIRING THE HEAVY ELECTRICAL USES. THE LENGTH IS ABOUT 700 FEET, WHICH AGAIN, THE HEAVY WIRING WOULD HAVE TO BE PLACED IN A SPECIAL CONSTRUCTED CONCRETE ENCASEMENT. THIS WOULD HAVE TO RUN THESE DISTANCES. AGAIN, COST FIGURES ARE BEING TABULATED BY TEXAS UTILITIES.

THAT IS ABOUT THE SIZE OF IT. MY ONLY OTHER ALTERNATIVE WOULD BE TO PUT THE PLANT, SILO'S, ETC. IN THE FRONT OF THE BUILDING FACING MIDWAY WHERE THE POWER IS. THIS WOULD THEN PUT THE BEAUTIFUL FRONT OF MY BUILDING IN THE REAR FACING THE DITCHES AND CULVERTS. THAT CERTAINLY DOES NOT MAKE ANY SENSE FOR ME OR THE CITY OF ADDISON.

RON, WE BOTH KNOW THAT IT IS VERY DIFFICULT FOR ANY ONE LAW OR ORDINANCE TO COVER ALL VARIABLES. I FIRMLY FEEL IT WAS NOT THE INTENT OF THE CITY COUNCIL, THROUGH PASSING ORDINANCE #261, TO BRING THIS TYPE OF HARDSHIP ON A NEW BUSINESS THAT HAS SELECTED THE TOWN OF ADDISON AS ITS PERMANENT FUTURE HOME.

THANKS AGAIN.

REGARDS,

BAS REALITY LTD.

V. A. Sahm

V. A. SAHM
GENERAL PARTNER

VAS/mh

Copy keyed to cross-section numbers

Summary
Water Surface Calculations
Entrance to 72" RCP
February 8, 1995

The flow characteristics have been analyzed using the THYSYS computer program developed by the Texas Department of Transportation. The flows were taken from the Design Engineer's Report for the Addison Airport Drainage Improvements Project.

The initial task was to determine the water surface elevation at the entrance to the 72" RCP prior to construction. Based on the survey data from the Addison Airport Drainage Improvement Project and on the topographic maps provided by the Town of Addison, a cross section at station 59+17 (the entrance to the 72" RCP) was established. The western limit of the section is at elevation 614.9 approximately 85 feet west of the fence.

The initial analysis included only the flow from the drainage area north of the section. This analysis considered only the slope of the channel and the flow characteristics of the channel to compute the water surface elevation. This yielded the following:

#1

Q25 = 335 CFS	Water surface = 614.69
Q100 = 411 CFS	Water surface = 614.84

Examination of the topographic map indicated that this section carried not only the flow from the north, but also the flow from the east that crosses under the runway. Therefore, the initial analysis is not a realistic scenario.

An analysis was made using the combined flows and the same section. Again, no backwater effects from downstream were considered. The initial computer simulations indicated that the high point to the west at elevation 614.9 was not high enough to contain the water. Therefore, an imaginary wall was inserted at the high point with a very small roughness coefficient to simulate standing water at the edge of the section. The resulting water surface elevations are as follows:

#2

Q25 = 693 CFS	Water surface = 615.21
Q100 = 853 CFS	Water surface = 615.37

This indicates that even with no backwater effects from downstream, the water was not contained within the channel, but flowed overland across the adjacent property.

After reviewing the initial results, John Baumgartner requested that the water surface elevation prior to construction be evaluated using a section downstream from the entrance to the 72" RCP that appeared to be a constricting section on the topographic map.

Using survey information from the Drainage Improvements project, a section was evaluated at 280 feet downstream from the 72" RCP

entrance. This section was evaluated as a constricting section using the slope of the channel and the flow characteristics of the section to calculate the water surface elevation at the downstream section. The water surface was then projected upstream to the 72" RCP entrance at the channel slope. This method shows the following:

#6

Q25 = 693 CFS	HW25 @ section 280' dwnstm. = 613.22
	HW25 @ 72" RCP entrance = 617.45
Q100 = 853 CFS	HW100 @ section 280' dwnstm. = 613.62
	HW100 @ 72" RCP entrance = 617.85

This water surface elevation is also above the 614.9 high point elevation on the property to the west, indicating flow over this property.

Of the three scenarios examined above, the last probably gives the most reliable information regarding the water flow characteristics prior to construction. This section is very close to a surveyed section, contains all of the 100 year flow within the section for analysis, and represents a constricting section downstream from the 72" RCP entrance. The projection of a 100 year water surface elevation of 617.85 at the 72" RCP entrance indicates a significant backwater effect and shows that a significant amount of water flowed over the adjacent property to the west prior to the construction of the storm drain system. Determination of the exact elevation of the water surface and the split of flow between the channel and the overland flow would require a more complex hydraulic modeling effort and more information regarding the topography of the property west of the airport.

The water surface elevation at the 72" RCP entrance has also been analyzed for the configuration after construction. The system was designed for the 25 year and included overland flow as a part of the design.

The first constructed scenario assumed that the 72" RCP is in place and no fill was placed on the adjacent property. The water surface elevations with overland flow taken into account are as follows:

#3

Q25 = 335 CFS	Water surface = 615.86
Q100 = 411 CFS	Water surface = 618.74

The second constructed scenario was done assuming the 72" culvert is constructed and fill is placed on the adjacent property to the west. This is the existing condition. This analysis showed the following water surface elevations:

#4

Q25 = 335 CFS	Water surface = 617.28
Q100 = 411 CFS	Water surface = 618.99

The third scenario was done assuming 72" culvert is constructed and a retaining wall is placed 10' behind the fence. The water surface elevations are summarized as follows:

#5 Q25 = 335 CFS Water surface = 616.47
Q100 = 411 CFS Water surface = 618.86

It should be noted that all of the water surfaces were projected with the tailwater for the 72" RCP taken from the initial Engineer's Report and the tailwaters were calculated assuming that all of the flow is confined to the 2-7'x6' reinforced concrete box (RCB) downstream. With part of the flow being routed overland, the flow within the RCB would be reduced with a corresponding decrease in the tailwater elevation for the 72" RCP. All of the above scenarios show that some water would continue to flow overland as it did before the drainage system was constructed.

After initial review of these three scenarios, John Baumgartner suggested that the water surface be evaluated using the 100 year tailwater calculated by the developer after the channel improvements were constructed. This tailwater was routed back through the drainage system and included the overflow area in the existing condition (fill has been placed on the adjacent property). The calculated water surfaces are as follows:

#4 Q100 = 411 CFS Water Surface = 618.57

The 25 year flow was not evaluated because no 25 year water surface elevation was provided by the developer's plans.

All of the constructed scenarios indicate that the water flows overland around the pipe as it did prior to the construction of the drainage system.

TOWN OF
ADDISON

PUBLIC WORKS

To: Bob Pearce

Company: Pearce & Assoc.

FAX #: 247-2690

Date: 3-3-95

# of pages (including cover): 4

From: John Baumgartner, P.E.
Director
Phone: 214/450-2886
FAX: 214/931-6643

16801 Westgrove
P.O. Box 144
Addison, TX 75001

☐ Original in mail ☒ Per your request ☐ FYI ☐ Call me

Comments:

TRANSACTION REPORT

MAR- 3-95 FRI 11:51

SEND

#	DATE	S. T.	NAME	TIME	PGS	NOTE	DP
01	MAR- 3	11:48	2472690	2'25"	4	OK	

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Water Surface Calculations
Entrance to 72" RCP
February 8, 1995

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John Baumgartner FAX 214-931-6643

PEARCE AND ASSOCIATES, INC.
Consulting Engineers

January 13, 1995

John —
call me.
Vic
247-2112

Vic Sahm
S & B Investments
1223 Crowley Road
Carrollton, Texas 75006

RE: Concrete Channel Lining
Midway Road, Addison

Dear Mr. Sahm:

I have received a copy of a study performed by Tracy L. Terrill, P.E., relating his findings concerning the conditions which may have caused or contributed to the concrete channel lining failure at the referenced location, and presenting possible solutions to prevent recurrence. The following is my review of his study:

As we have discussed earlier, and as Mr. Terrill stated in his report, the damage was caused by water bypassing an existing storm sewer pipe located on airport property and flowing South along the West property line of the airport, (also being along your East property line.) In describing the conditions which were previously existing at that location, Mr. Terrill states in his report that the top of the bank "when the pipe was installed was a few feet lower" than the design headwater elevation, "allowing water to flow overland west of the pipe."

If this was indeed the case, it was a serious error, either of design or construction.

Mr. Terrill further states that the certainty of overflow by the design 25 year year storm "did not create a major problem", and that the larger flows for the 50 year and 100 year design storms would also cause "little damage". This was certainly not at the time of construction, because the land to the West was undeveloped; however, it would become most emphatically false following development of the land.

As you may recall, at our December meeting at the City of Addison, City Engineer John Baumgartner stated that he was also of the opinion that the west bank had been left low at the time the pipe was installed. When I told him that would have been either a design or construction error, his explanation was that it was done with the intention that it would be corrected when the adjacent property was developed. However, as you know, Mr. Baumgartner not only didn't notify you of such a necessity when you began to develop the adjacent property, but had previously insisted that the fill dirt required for development of the adjacent property be placed a minimum of three feet to the West of the property line, thereby preventing even the possibility of fill being placed where it might provide any assistance in correcting the deficiency adjacent to the headwall. Also, I understand that at no time during the review process nor during construction of the channel lining did he indicate a need to correct inadequate bank height on the airport property.

3321 TOWERWOOD DR. • SUITE 100 • FARMERS BRANCH, TX 75234 • 214/247-1353 • FAX 214/247-2660

As I pointed out at our meeting at the City, it is impossible to construct a drainage structure that provides a guarantee that it will never rain hard enough to flood it. Therefore, the fact that a drainage facility overflows, does not necessarily indicate inadequate design. There are, however, certain accepted design criteria established to provide protection from frequent flooding and to achieve a cost effective balance between cost of construction and the cost of possible damage due to the probability of flooding.

Among the most basic of these design parameters is that the bank of a drainage channel must be at least as high as the 100 year water surface. Otherwise, by definition, the design is inadequate.

It must be concluded, based on Mr. Terrill's report and Mr. Baumgartner's statement, that the damage to the concrete headwall is the direct result of an improperly constructed drainage structure. Whether the error was one of design or of construction, in either case the responsibility lies with the City of Addison.

Concerning correction of the existing situation, in his report Mr. Terrill presents two possible methods of preventing a recurrence of the problem, neither of which do I feel would be acceptable to you as the owner. Both options include relocating a portion of the drainage flow onto your property, and constructing a parallel drainage course on your property (lined channel or storm sewer pipe) in order to relieve the existing pipe and box culvert located on airport property.

If the existing pipe is adequately sized, there should be no need to construct a parallel drainage facility in order to relieve it. The 100 year design water surface, utilizing only the existing 72-inch pipe, is indicated by Mr. Terrill as being elevation 620.74. The placement of fill around the headwall to an elevation exceeding that height will effectively prevent recurrence, at a considerable lower cost and without requiring the loss of additional land. The fill would be almost exclusively on airport property, but would require the removal and replacement of the airport boundary fence. All fill should receive adequate compaction and be placed under the direction of a registered soils engineer.

If the City should feel that elevation 620.74 would be too high to allow water to back up on airport property, an alternative solution would be to install a second storm sewer pipe parallel to the existing 72-inch pipe, in order to lower the design backwater elevation. This construction would take place on airport property, and would be a much shorter distance than would be required by relocating the flow onto your property (approximately 65 feet rather that 400 feet).

I am enclosing a copy of Mr. Terrill's study for your information. If I may be of any further assistence in this matter, please do not hesitate to call.

Sincerely,

Robert L. Pearce, P.E.

Robert L. Pearce, P.E.

Greiner

Greiner, Inc.
4100 Amon Carter Blvd., Suite 108
Fort Worth, Texas 76155
(817) 545-0891
FAX: (817) 545-0534

December 15, 1994
Y8024.62

Mr. John Baumgartner, P.E.
Director of Public Works
Town of Addison
P.O. Box 144
Addison, TX 75001

Reference: **Addison Airport**
Drainage Summary - West Side Outfall

Dear Mr. Baumgartner:

Enclosed is a copy of the Drainage Summary and some exhibits concerning the riprap failure and the drainage in the area we discussed last week. Please review it and let us know if you need further information for this area.

If any questions or need further information, please call.

Sincerely,

GREINER, INC.

Tracy L. Terrill, P.E.

Tracy L. Terrill, P.E.
Project Engineer

Addison Airport
Drainage Summary
West Side Outfall Riprap Failure
December 9, 1994

The area in question is on the west side of the airport from the outfall of the double 7'x6' RCB north to the end of the 72" RCP and the area of riprap that was overturned in the open channel adjacent to the storm drain outfall.

The land west of the airport property has been filled and raised significantly within the last few years.

The riprap failure was probably caused by a high water level behind the riprap that was not balanced by an equal water level in the channel. This resulted in the riprap being overturned. In addition, erosion has occurred along the fence line. Some fence post foundations have been undermined and others are exposed to a significant depth.

The water causing the damage is flowing around the 72" RCP running north of the double 7'x6' RCB along the west property line of the airport.

This system was designed for a 25 year rainfall event. According to the Design Engineer's Report for the Runway and Taxiway Drainage Improvements, the headwater elevation at the upstream end of the pipe is 617.16 feet if the 25 year peak flow is confined to the pipe. The ground elevation directly over the pipe is approximately the same as the 25 year headwater. The existing elevation of the ground at the fence line and on the adjacent property when the pipe was installed was a few feet lower allowing water to flow overland west of the pipe in the existing overflow area during high flow periods. This did not create a major problem because the water had a large area to flow through and therefore flowed at low velocity. The larger flows for the 50 and 100 year events were similarly spread over a large area with little damage.

When the land within this overflow area was filled, the area available for flow was reduced resulting in higher headwaters and velocities. In addition, the toe of the fill slope is very close to the fence. This directs the flow along the fence line where erosion damage is least tolerable. Also, when the riprap was placed on the north bank of the open channel by the developer, no provision was made to accommodate the flow from the existing overflow area west of the pipe. As a result, the water from the overflow area gathered behind the riprap and pushed it over.

The problem may be solved by removing the fill in the area adjacent to the fence to allow the water to flow as it did previously with an outfall built to direct the water into the open channel. Another alternative is to add another pipe from the headwall to the open channel. In either case the outfall at the open channel should be designed to direct the flow in the same direction as the

normal flow in the channel or the opposite bank improved to protect against erosion.

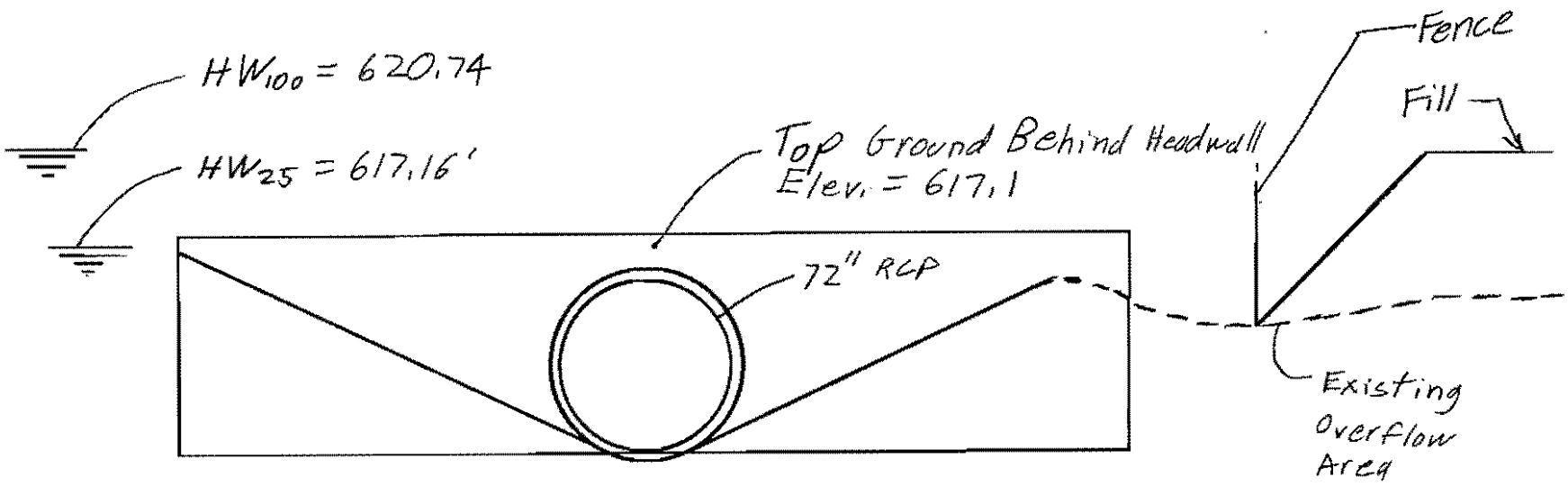
Greiner

Job Addison Airport Project No. Sheet of

Description Computed By Date

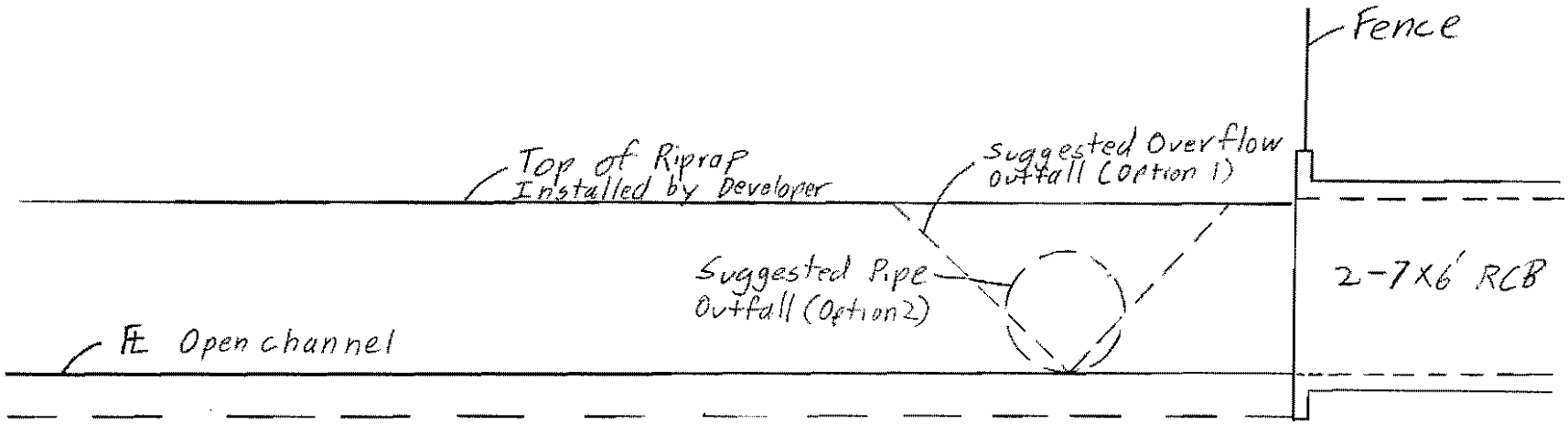
Checked By Date

Section at 72" RCP HEADWALL Facing South



Note: Elevations for Existing Ground lines are approximate.

Profile along Channel at 2-7'X6' RCB Outfall
Facing North



Greiner

Job _____ Project No. _____

Description _____ Sheet _____ of _____

Computed By _____ Date _____

Checked By _____ Date _____

Improve opposite bank or
Redirect flow in direction
of flow in channel.

℄ of suggested pipe or channel

30"RCP

TOP BANK EXIST. DITCH

EXIST.
2 - 42" RCP

S-45

S-49

S-48

S-47

EXIST.

BERM

LINE "I"

66" R.C.P.

72" R.C.P.

LINE "J"

TOP BANK EXIST. DITCH

2- 7' X 6'
CONC. BOX
CULVERT
(SEE SHEETS 23-24)

DOOLEY ROAD

54" R.C.P.

NOTE:SEE SHEET 15 FOR
GRADING DETAILS IN
THIS AREA.

S-44

2- 7' X 5'
CONC. BOX
CULVERT
(SEE SHEET 22)

S-46

EXIST. CONC.
HEADWALL

CONST. 8 L.F. OF 30" R.C.P.
@1.00% (CAP END W/CONC. PLUG)

EXIST. HEADWALL
(TO BE REMOVED)

EXIST.
3' X 6' BOX CULVERT

8" SS

EXIST. 54" R.C.P.

EXIST. 2-66" R.C.P.

66" R.C.P.

VASI

LINE "G"

VASI

N 20° 23' W

REMOVE & REPLACE
~~278~~ 269 S.Y. PAVEMENT

1

Greiner

Greiner, Inc.
4100 Amon Carter Blvd., Suite 100
Fort Worth, Texas 76155
(817) 545-0891
FAX: (817) 545-0534

December 15, 1994
Y8024.62

Post-it™ Fax Note 7671 | Date 1-5-95 | # of pages ▶ 8
To John Baumgartner | From Tracy Terrill
Co./Dept. | Co.
Phone # | Phone #
Fax # | Fax #

Mr. John Baumgartner, P.E.
Director of Public Works
Town of Addison
P.O. Box 144
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Tracy L. Terrill, P.E.
Project Engineer

Addison Airport
Drainage Summary
West Side Outfall Riprap Failure
December 9, 1994

The area in question is on the west side of the airport from the outfall of the double 7'x6' RCB north to the end of the 72" RCP and the area of riprap that was overturned in the open channel adjacent to the storm drain outfall.

The land west of the airport property has been filled and raised significantly within the last few years.

The riprap failure was probably caused by a high water level behind the riprap that was not balanced by an equal water level in the channel. This resulted in the riprap being overturned. In addition, erosion has occurred along the fence line. Some fence post foundations have been undermined and others are exposed to a significant depth.

The water causing the damage is flowing around the 72" RCP running north of the double 7'x6' RCB along the west property line of the airport.

This system was designed for a 25 year rainfall event. According to the Design Engineer's Report for the Runway and Taxiway Drainage Improvements, the headwater elevation at the upstream end of the pipe is 617.16 feet if the 25 year peak flow is confined to the pipe. The ground elevation directly over the pipe is approximately the same as the 25 year headwater. The existing elevation of the ground at the fence line and on the adjacent property when the pipe was installed was a few feet lower allowing water to flow overland west of the pipe in the existing overflow area during high flow periods. This did not create a major problem because the water had a large area to flow through and therefore flowed at low velocity. The larger flows for the 50 and 100 year events were similarly spread over a large area with little damage.

When the land within this overflow area was filled, the area available for flow was reduced resulting in higher headwaters and velocities. In addition, the toe of the fill slope is very close to the fence. This directs the flow along the fence line where erosion damage is least tolerable. Also, when the riprap was placed on the north bank of the open channel by the developer, no provision was made to accommodate the flow from the existing overflow area west of the pipe. As a result, the water from the overflow area gathered behind the riprap and pushed it over.

The problem may be solved by removing the fill in the area adjacent to the fence to allow the water to flow as it did previously with an outfall built to direct the water into the open channel. Another alternative is to add another pipe from the headwall to the open channel. In either case the outfall at the open channel should be designed to direct the flow in the same direction as the

normal flow in the channel or the opposite bank improved to protect against erosion.

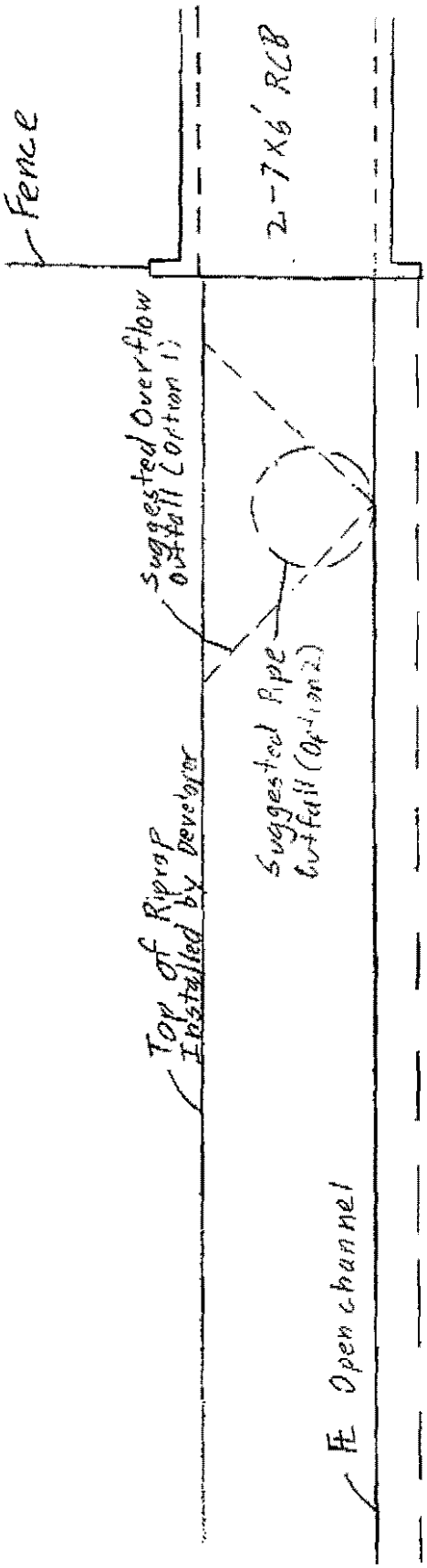
Greiner

Job _____ Project No. _____ Sheet ____ of ____

Description _____ Computed By _____ Date _____

_____ Checked By _____ Date _____

Profile along Channel at 2-7'x6' RCB Outfall Facing North

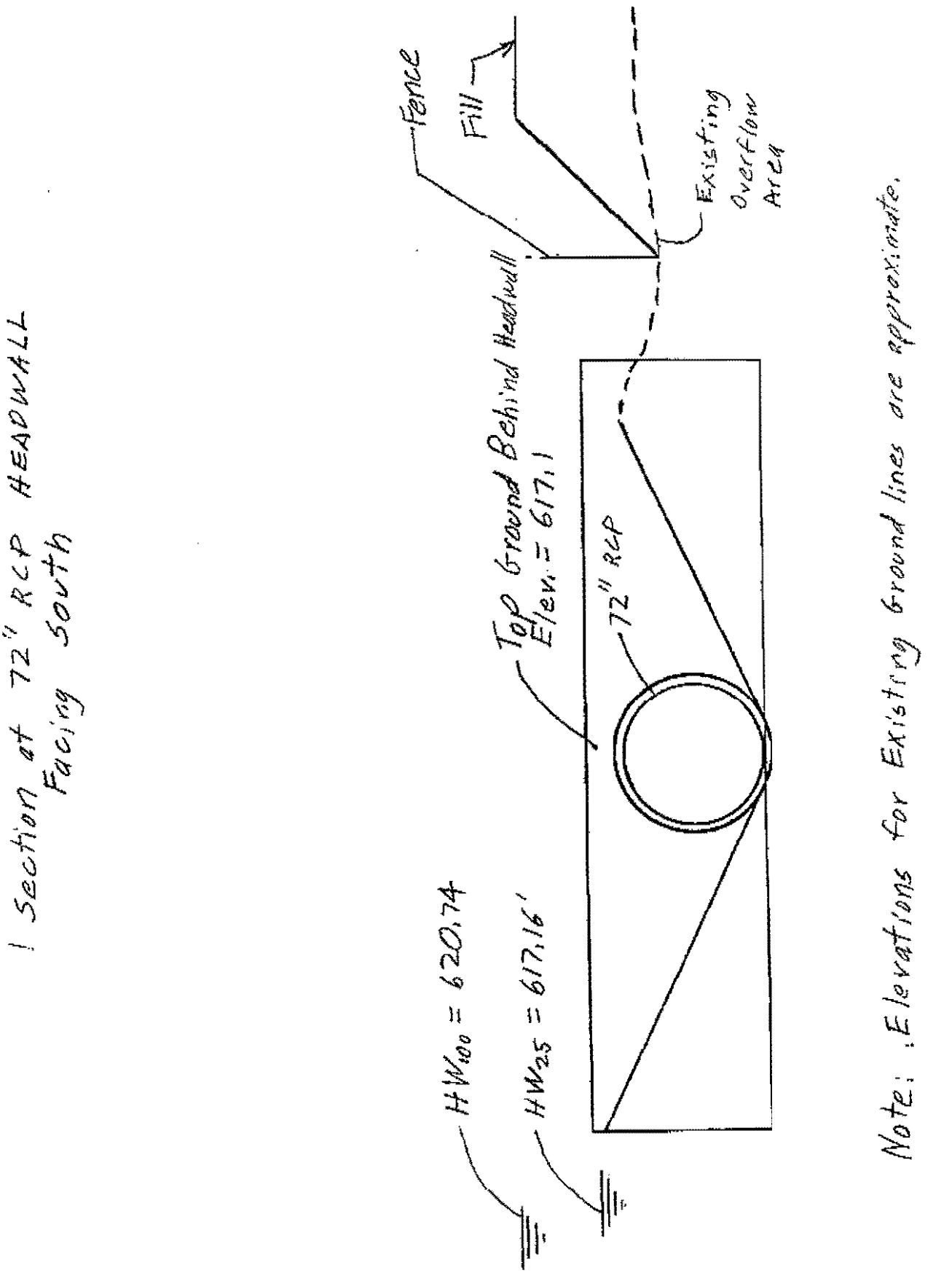


Greiner

Job Addison Airport | Project No. | Sheet ___ of ___

Description | Computed By | Date

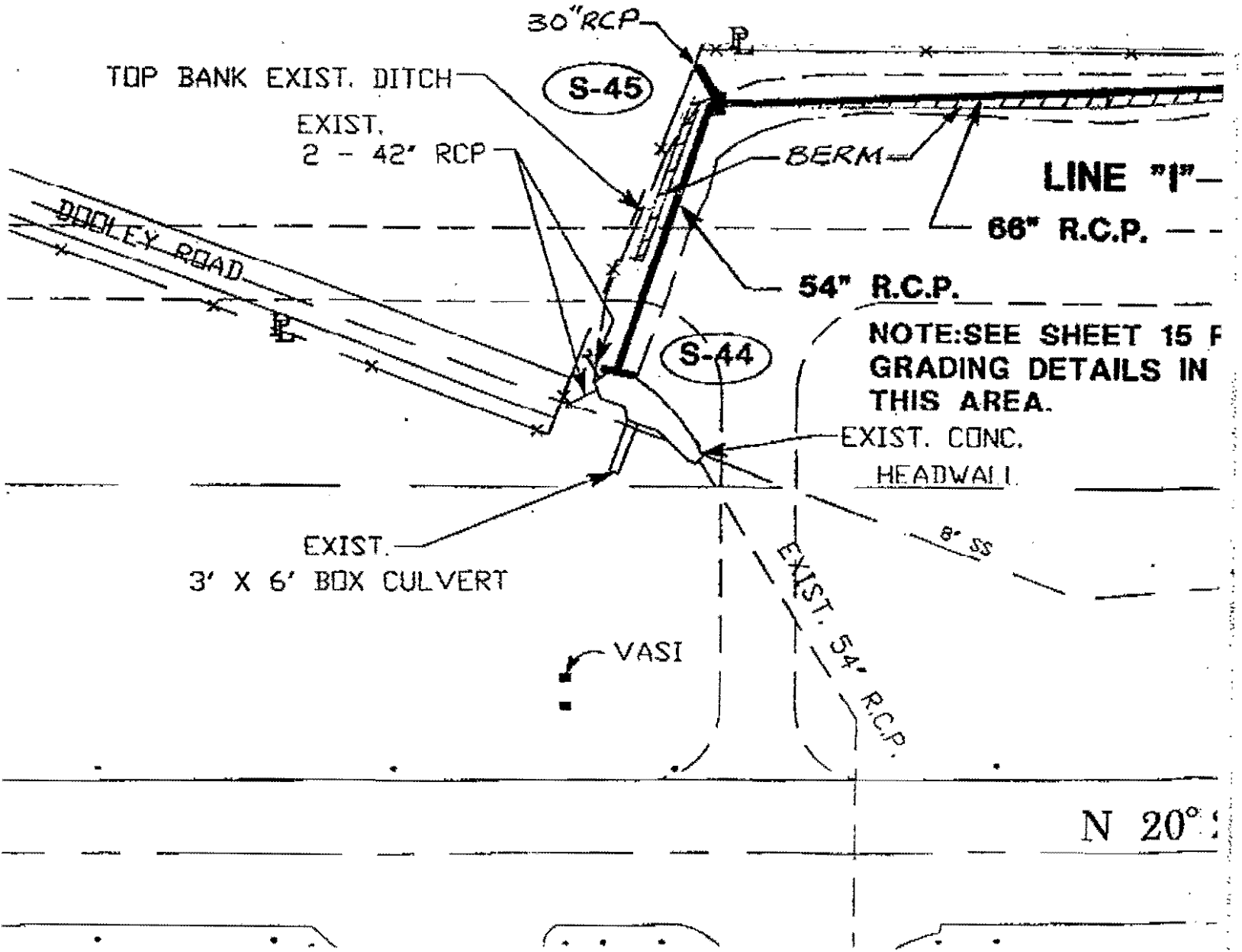
Checked By | Date

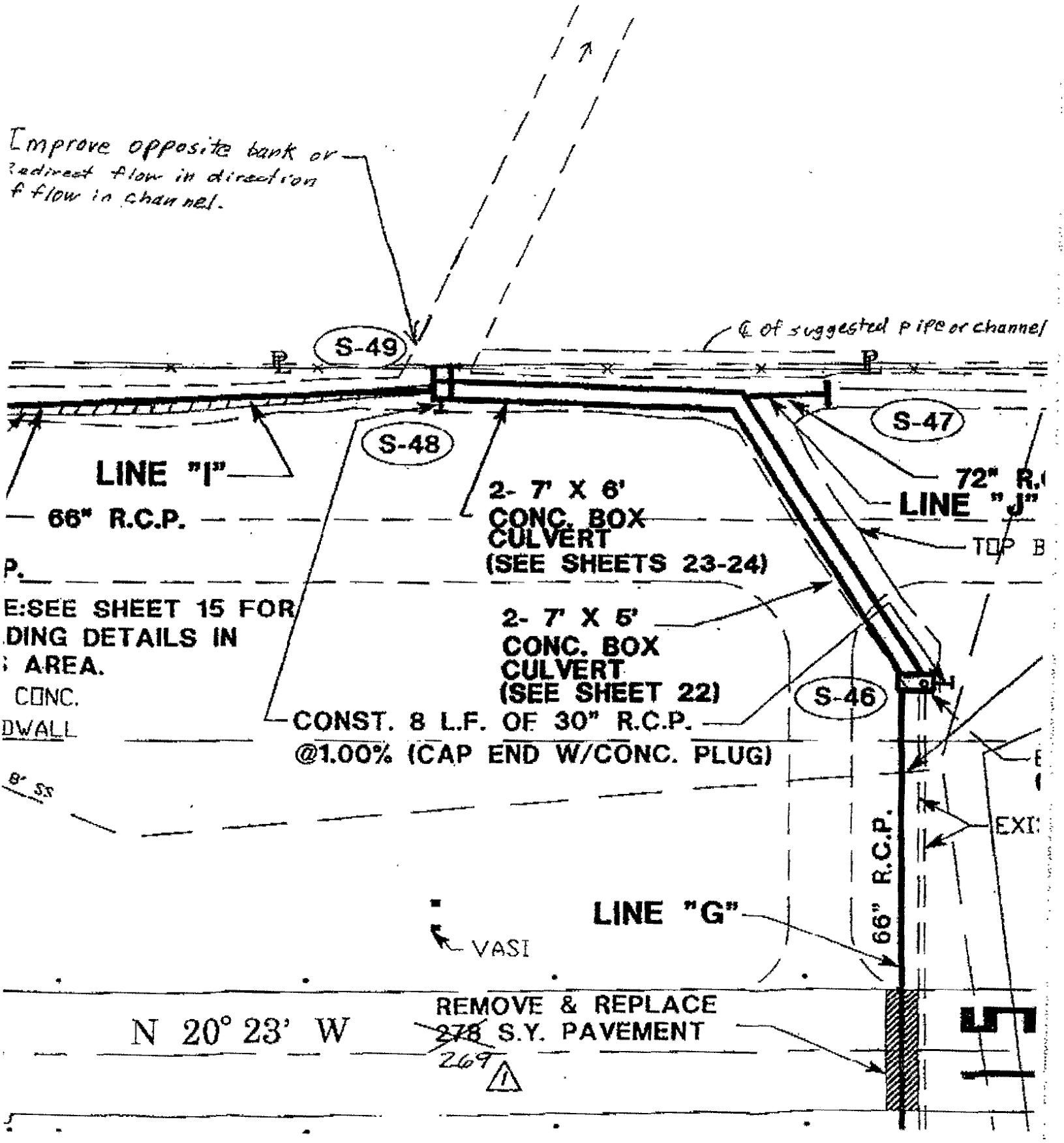


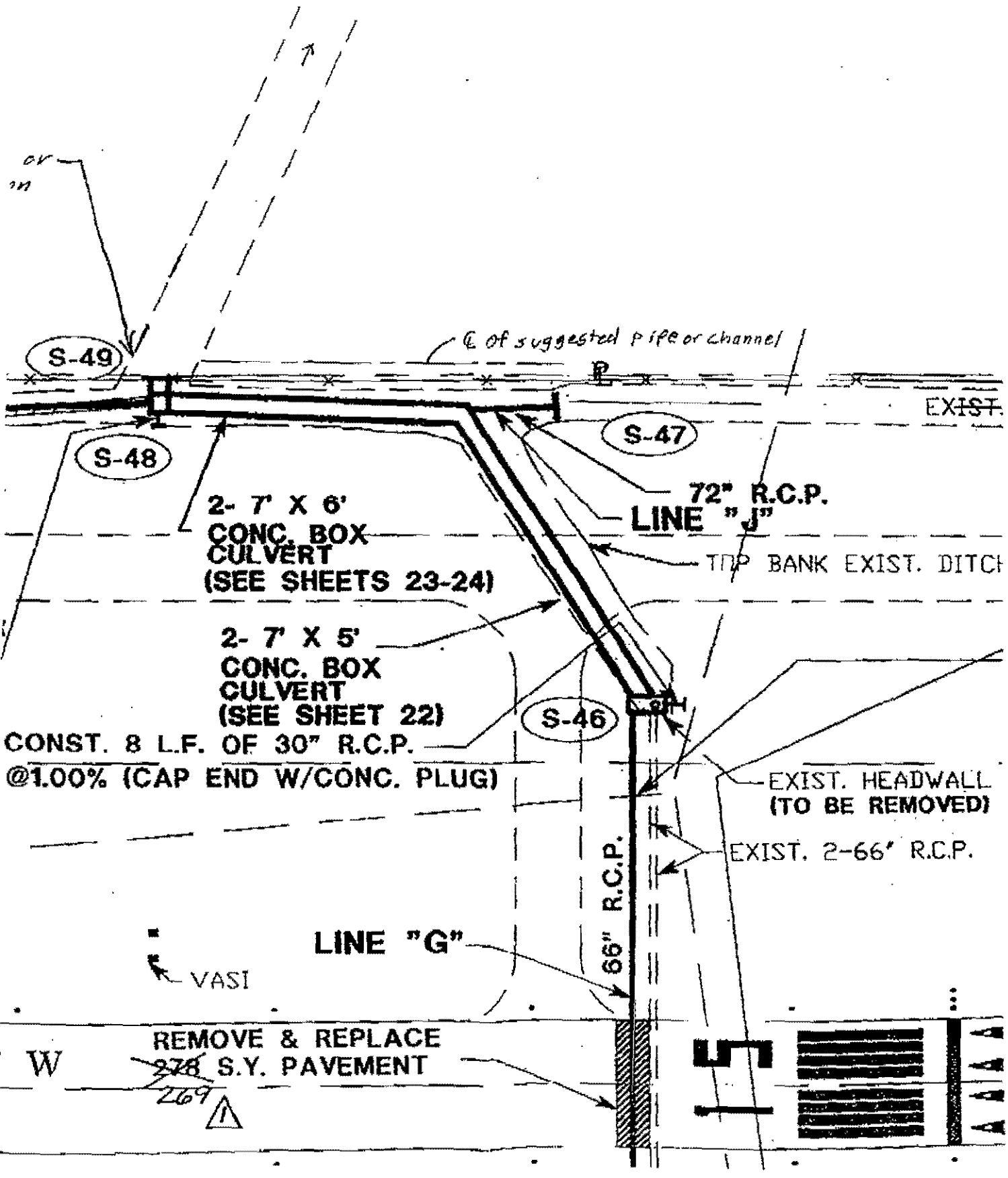
1 Section at 72" RCP HEADWALL Facing South

Note: Elevations for Existing Ground lines are approximate.

Improve opposite s
Redirect flow in dire
of flow in channel.




Improve opposite bank or redirect flow in direction of flow in channel.
℄ of suggested pipe or channel
S-49
S-48
S-47
S-46
LINE "I"
66" R.C.P.
2- 7' X 6' CONC. BOX CULVERT (SEE SHEETS 23-24)
2- 7' X 5' CONC. BOX CULVERT (SEE SHEET 22)
CONST. 8 L.F. OF 30" R.C.P. @1.00% (CAP END W/CONC. PLUG)
72" R.
LINE "J"
TOP B
E:SEE SHEET 15 FOR
DING DETAILS IN
AREA.
CONC.
DWALL
EXI
66" R.C.P.
LINE "G"
VASI
REMOVE & REPLACE
278 269 S.Y. PAVEMENT
N 20° 23' W


S-49
℄ of suggested pipe or channel
EXIST.
S-48
S-47
72" R.C.P.
LINE "J"
2- 7' X 6'
CONC. BOX
CULVERT
(SEE SHEETS 23-24)
TOP BANK EXIST. DITCH
2- 7' X 5'
CONC. BOX
CULVERT
(SEE SHEET 22)
S-46
CONST. 8 L.F. OF 30" R.C.P.
@1.00% (CAP END W/CONC. PLUG)
EXIST. HEADWALL
(TO BE REMOVED)
EXIST. 2-66' R.C.P.
66" R.C.P.
LINE "G"
VASI
REMOVE & REPLACE
~~278~~ 269 S.Y. PAVEMENT
1

MAXI LIFT
December 9, 1994

John Baumgartner	450-2871
~~Bob~~ Walkup/Ford	7203
Lynn Chandler	450 2889
Bruce Mueller	450-7221
Jim STEPHENS	450-7220
Jim IZZARELLI - IZZ-HISAW CONST.	556-1333
Tim Walsh Grimmell	721-9129
BILL DUKE - IZZARELLI - HISAW	556-1333
Gary Lumbaugh - Reibenstein Assoc.	521-7147
VIC SAHM - OWNER	245-2542

TOWN OF ADDISON

FIRE DEPARTMENT

Post Office Box 144 Addison, Texas 75001

(214) 450-7200 FAX (214) 450-7208

4798 Airport Parkway

MEMORANDUM

October 31, 1994

TO: ***Ron Whitehead, City Manager***
FROM: ***Bob Wallingford, Fire Chief***
SUBJECT: ***Progress Report - Maxi-Lift Inc. Project (Vic Sahm)***

Attached herewith please find a copy of a letter received from Carter Burgess. If you'll recall, this was the architect appointed by Mr. Sahm to interpret the fire code as it pertained to the proposed structure on north Midway Road. I believe the letter is self-explanatory and is an acceptable compromise from the original proposal.

All parties were present at the meeting on October 10, 1994 and it should be noted that we still do not have a definite action plan from Mr. Sahm. John Baumgartner and myself both feel comfortable with the response from Carter Burgess and are awaiting further communication from Mr. Sahm.

If I can provide you with additional information on this item, please do not hesitate to contact me.

REW/le
Attachment (1)
cc: John Baumgartner, City Engineer

Carter : Burgess

Consultants in Engineering, Architecture,
Planning and the Environment

October 24, 1994

Mr. Vic Sahm
Maxi-Lift, Inc.
P.O. Box 518
Carrollton, TX 75011-0244

Reference: Manufacturing/Warehouse Facility
Addison, Texas

Dear Mr. Sahm:

This letter is intended to outline the discussion held at the City of Addison on October 10, 1994. The concern outlined by Chief Wallingford was based on the lack of a definitive action plan.

In our meeting we tried to investigate the different options necessary to move this project closer to a resolution. Based on this meeting it was decided that:

1. It was not clear whether an ESFR sprinkler system would be acceptable for protection of this commodity.

2. Grinnell was going to investigate the storage arrangement to determine if this is appropriate. If this system is acceptable, the draft curtains would not be required.

3. The Fire Chief is willing to accept a mechanical smoke exhaust/comfort venting system in lieu of smoke and heat vents. The system would require a fire department control station to operate the fans.

4. The areas where high piled storage did not occur would have smoke venting as dictated by Article 32 of the building code. The storage areas with high piled storage would have smoke venting per Article 81 of the fire code.

5. Based on the discussions, the building would be separated into 4 areas by fire walls. The ratings of the walls would be determined by the building official. Non-storage areas under 50,000 sq. ft. would need no smoke venting. The areas over 50,000 sq. ft. would need smoke venting per the building code at a ratio of 1:100.

6. The areas with high piled storage would need smoke and heat vents at a ratio of 1:75 as determined by the fire department. Drop out vents were not acceptable to the fire department. Discussion with the fire department indicated that the code required 300 cfm per sq. ft. of smoke vent. This amount could be reduced if an engineered smoke venting report was performed. However, the total CFM could not be reduced to below 150,000 cfm per storage area. These fans could be used as a combination comfort/smoke venting system.

7. Chief Wallingford determined that the fans would have to be high temperature rated and protected according to Article 81 of the fire code.

If you have any questions please feel free to give me a call at (817) 7235-6011.

Sincerely,

CARTER & BURGESS, INC.

David J. Burkhart, P.E.
Fire Protection Engineer

DJB
94157000.L01

cc: Correspondence
Chief Wallingford - City of Addison
John Burngartner - City of Addison

TOWN OF ADDISON

FIRE DEPARTMENT

Post Office Box 144 Addison, Texas 75001

(214) 450-7200 FAX (214) 450-7208

4798 Airport Parkway

August 23, 1994

Mr. Vic Sahm
Maxi-Lift Inc.
1223 Crowley Drive
Carrollton, Texas
75006

Dear Mr. Sahm:

Further to your meeting of August 19, 1994 with Chief Wallingford, please be advised that the Prevention Division was instructed to further research the smoke and heat vent requirements and ESFR sprinkler systems.

The information was complied and upon further review, the Fire Department's position on this issue remains **unchanged**.

We would certainly welcome your business to Addison but you should understand that the construction of the building **must comply** with Article 81 of the Uniform Fire Code 1991 and in principle, the installation of smoke and heat vents as stated by the code.

The Fire Prevention Division has found nothing to support your request for the waiver and elimination of this requirement but has, in fact, found substantial documentation to contradict your proposal.

Please note that at this time, the water line supplying the required fire hydrants {a minimum of six (6)} will have to remain as a looped system.

However, should you supply this office with proper documentation from a certified, registered engineering firm that states the water flow from a "dead end line", non-looped system, is sufficient to supply an ESFR sprinkler system and support fire fighting efforts, this office would then consider an alternative method. This would require a submittal of hydraulic calculations and drawings on the ESFR sprinkler system and related fire pump capacity.

. . .2/continued

Mr. Vic Sahm
Maxi-Lift Inc.
Carrollton, Texas
August 23, 1994

Also, please be advised of a further requirement which will be necessary for your company to comply with. The Uniform Fire Code, Article 81, Section 81.103, mandates that any building used for high-piled combustible storage is required to have a permit issued by the Fire Prevention Division. A representative of your company will need to make application for this permit after all other Fire Department requirements are met.

Please do not hesitate to contact my office, should you have any questions, comments or concerns regarding this matter.

Yours sincerely,

Jim Stephens
Fire Prevention Officer
ADDISON FIRE DEPARTMENT

JGS/le
cc: Bob Wallingford, Fire Chief
Lynn Chandler, Building Official
Carmen Moran, City Secretary

Maxi-Lift, inc.

FAX NUMBER: (214) 242-6203 FAX COVER LETTER

TO: City of Addison DATE: 7/5/94

ATTENTION: John Baumgardner

FAX NUMBER: (214) 931-6643

NO. OF PAGES: COVER LETTER AND 1

MESSAGE: Information enclosed.

FROM: Brandi L.

Maxi-Lift, Inc./Carrollton, TX.

P.O. BOX 11-0518 • CARROLLTON, TEXAS 75011-0518
1223 CROWLEY DRIVE • CARROLLTON, TEXAS 75006 • (214) 245-2542
U.S. WATS (800) 527-0657 • (800) 233-1081 CANADIAN WATS
FAX NO. (214) 242-6203 • USA TELEX NO. 709760 MAXI LIFT UD

07-05-94 02:32 PM P01/01

Maxi-Lift, inc.

FAX NUMBER: (214) 242-8203 FAX COVER LETTER

TO: City of Addison DATE: 7/5/94

ATTENTION: John Baumgardner

FAX NUMBER: (214) 931-6643

NO. OF PAGES: COVER LETTER AND Ø

MESSAGE: John, I only sent 1 months bill because the months before were identical. If you have any questions please call.

FROM: Brenda Fahn
Maxi-Lift, Inc./Carrollton, TX.

P.O. BOX 11-0518 • CARROLLTON, TEXAS 75011-0518
1223 CROWLEY DRIVE • CARROLLTON, TEXAS 75006 • (214) 245-2542
U.S. WATS (800) 527-0657 • (800) 233-1081 CANADIAN WATS
FAX NO. (214) 242-8203 • USA TELEX NO. 709760 MAXI LIFT UD

ACCOUNT NUMBER	CYCLE	BILL DATE	DUE DATE
366833-29302	14-01	05/24/94	06/13/94

V01700

PAYMENTS	15.29-
ADJUSTMENTS	.00
BALANCE FORWARD	$.00

RATE CLASS COMMERCIAL

SERVICE PERIOD	DAYS	METER NUMBER	UNITS	CURRENT	PREVIOUS	USAGE
04/21/94 05/20/94	29	5838H-V	TGAL	4	4	

Service	Consumption/Rate	Charge
WATER	0	15.29
	Total Amount Due	$15.29

Receiving Report No. _____ Attached

Prices Approved By: 6/2/94

Footed & Extended By: [signature]

#7100-000

Folio _____ Acct. # & Description Utilities

Paid Check # 6990 Dated 5/31/94

Thank you for prompt payment of your April billing.

FOR BILLING INQUIRIES PLEASE CALL 466-3120.
AFTER HOURS AND FOR EMERGENCIES PLEASE CALL 466-3425

THE CITY OF CARROLLTON PROVIDES SPECIAL CUSTOMER ASSISTANCE TO PERSONS WITH DISABILITIES.
FOR MORE INFORMATION, PLEASE CALL 466-3120.

SERVICE ADDRESS 1325 CROWLEY DR

V01700

ACCOUNT NUMBER	CYCLE	BILL DATE	DUE DATE
366833-39301	14-01	05/24/94	06/13/94

LAST BILL AMOUNT	$392.47
PAYMENTS	392.47-
ADJUSTMENTS	.00
BALANCE FORWARD	$.00

RATE CLASS COMMERCIAL

SERVICE PERIOD	DAYS	METER NUMBER	UNITS	CURRENT	PREVIOUS	USAGE
04/21/94 05/20/94	29	80354N	TGAL	5461	5383	78

Service	Consumption/Rate	Charge
WATER	78	212.09
WASTEWATER	78	139.91
	Total Amount Due	$351.00

Receiving Report No. _____ Attached

Prices Approved By: 6/2/94

Footed & Extended By: [signature]

#7100-000

Folio _____ Acct. # & Description Utilities

Paid Check # 6990 Dated 5/31/94

Thank you for prompt payment of your April billing.

FOR BILLING INQUIRIES PLEASE CALL 466-3120.
AFTER HOURS AND FOR EMERGENCIES PLEASE CALL 466-3425

Drawing Log

ADDISON EDR
CCTV & AUDIO
DESIGN

September 9, 1999

AGUIRRE
CORPORATION
BUILDING SOLUTIONS SINCE 1946

12700 PARK CENTRAL DRIVE
DALLAS TEXAS 75251

FAX 972 • 788 1585
TEL 972 • 788 1508

Security Consulting Group
C.H. GUERNSEY & COMPANY
Engineers, Architects & Consultants
Oklahoma City, Oklahoma

Drawing Log

DRAWING INDEX

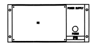
SHT. REF. NO.	TITLE
COVER	GENERAL SPECIFICATIONS PACKAGE
ADD-X0	DRAWING INDEX & SYMBOLS LEGEND
ADD-X1	EQUIPMENT MAKEUP COMMUNICATIONS ROOM
ADD-X2	ONE - LINE DIAGRAM
ADD-X3	FLOOR PLAN

GENERAL NOTES

1. All ESS equipment to be powered from dedicated 120V circuit backed up by UPS/on site generator.

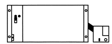
SYMBOLS LEGEND

Sony SSM-20N5U

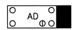


IFS R3 Fiber Optic Rack w/Modules

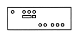
American Dynamics ADTT Touch Tracker Keyboard



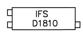
Opticomm Fiber Optic Rack w/Power Module



American Dynamics AD2150TT32-5 w/Touch Tracker



Robot MV77 Color Digital Quad



IFS Fiber Optic Modem

Revisions		
Rev.	Date	Description

ADDISON EDR
CCTV & AUDIO DESIGN
TOWN OF ADDISON, TEXAS

Security Consulting Group

C.H. GUERNSEY & COMPANY
Engineers, Architects & Consultants
Oklahoma City, Oklahoma

AGUIRRE CORPORATION

210 W 6TH STREET SUITE 1404
FORT WORTH TEXAS 76102

FAX 817 877 5261
TEL 817 877 5260

STATE OF TEXAS
RICHARD LAWRENCE DICKERSON
69306
REGISTERED PROFESSIONAL ENGINEER

THE SEAL APPEARING ON THIS DOCUMENT WAS AUTHORIZED BY RICHARD LAWRENCE DICKERSON, P.E. 69306.

ON

Date: 09/15/99

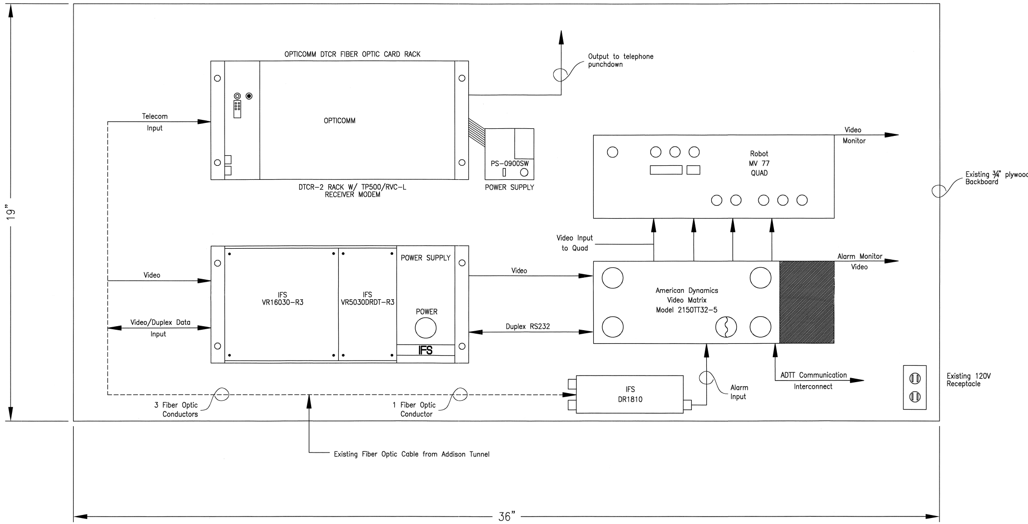
Project No. 1020908900

Drawn By: RLD

Checked By: RLD

Sheet Title: INDEX, LEGEND

Drawing No. E1.0



FIBER OPTIC EQUIPMENT MAKEUP PANEL
COMMUNICATIONS ROOM

Drawing Log

Rev.	Date	Description

Revisions

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CCTV & AUDIO DESIGN
TOWN OF ADDISON, TEXAS

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Engineers, Architects
& Consultants
Oklahoma City, Oklahoma

AGUIRRE
CORPORATION

210 W 6TH STREET SUITE 1404
FORT WORTH TEXAS 76102

FAX 817 877 5261
TEL 817 877 5260

Date:
09/15/99

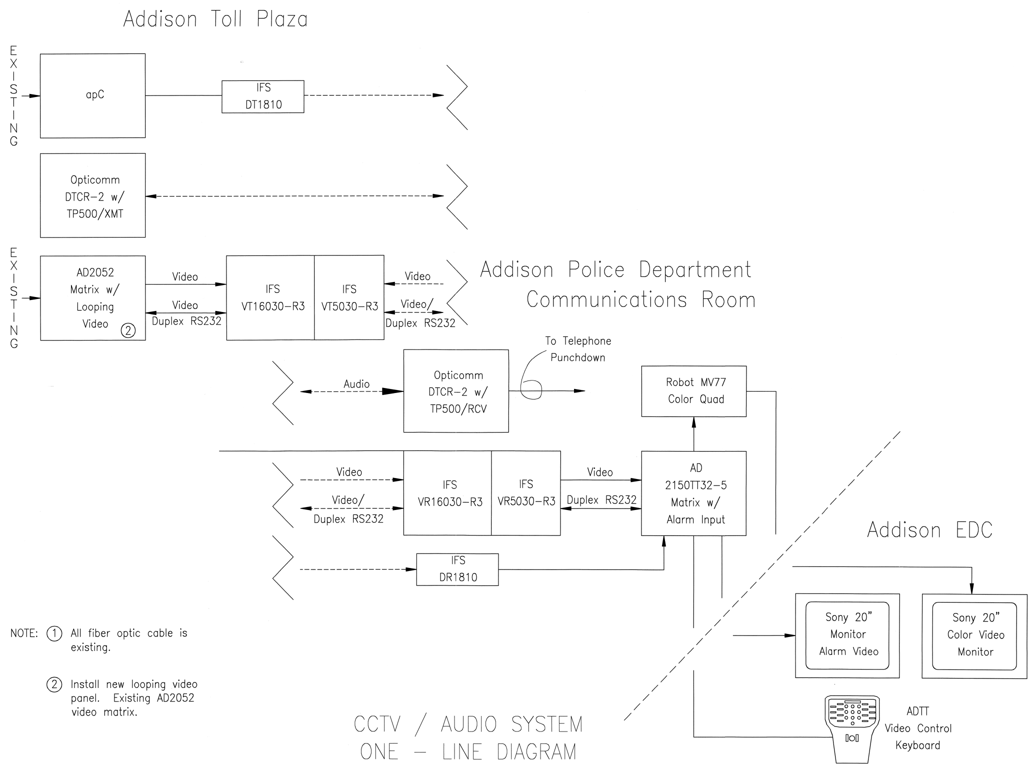
Project No.
1020908900

Drawn By:
RLD

Checked By:
RLD

Sheet Title:
FIBER OPTIC PANEL

Drawing No.
E1.1



Revisions

Rev.	Date	Description

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210 W 6TH STREET SUITE 1404
FORT WORTH TEXAS 76102
FAX 817 877 5261
TEL 817 877 5260

Date: 09/15/99

Project No. 1020908900

Drawn By: RLD

Checked By: RLD

Sheet Title: ONE-LINE DIAGRAM

Drawing No. E1.2

Drawing Log

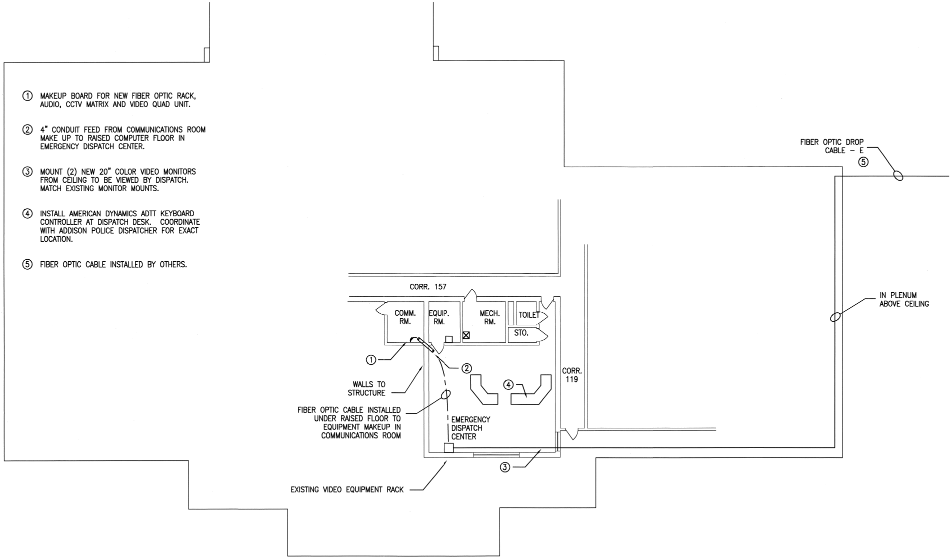
① MAKEUP BOARD FOR NEW FIBER OPTIC RACK, AUDIO, CCTV MATRIX AND VIDEO QUAD UNIT.

② 4" CONDUIT FEED FROM COMMUNICATIONS ROOM MAKE UP TO RAISED COMPUTER FLOOR IN EMERGENCY DISPATCH CENTER.

③ MOUNT (2) NEW 20" COLOR VIDEO MONITORS FROM CEILING TO BE VIEWED BY DISPATCH. MATCH EXISTING MONITOR MOUNTS.

④ INSTALL AMERICAN DYNAMICS ADTT KEYBOARD CONTROLLER AT DISPATCH DESK. COORDINATE WITH ADDISON POLICE DISPATCHER FOR EXACT LOCATION.

⑤ FIBER OPTIC CABLE INSTALLED BY OTHERS.



ADDISON POLICE DEPARTMENT FLOOR PLAN

Drawing Log

Rev.	Date	Description

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CCTV & AUDIO DESIGN
TOWN OF ADDISON, TEXAS

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Oklahoma City, Oklahoma

AGUIRRE CORPORATION
210 W 6TH STREET SUITE 1404
FORT WORTH TEXAS 76102
FAX 817 877 5261
TEL 817 877 5260

Date: 09/15/99
Project No. 1020908900
Drawn By: RLD
Checked By: RLD
Sheet Title: FLOOR PLAN
Drawing No. E1.3