PROPOSED CODE CHANGES

As the result of a thorough review of current City of Dallas codes and ordinances, 56 code and ordinance changes are proposed. The changes developed subsequent to this review are aimed at providing an improved level of safety through the increased use of automatic sprinklers, while minimizing the financial impact of such a requirement upon the community by eliminating or minimizing overly redundant requirements.

Of the 56 code changes, 48 are proposed to the Dallas Building Code, 6 are proposed to the Dallas Fire Code and 2 are proposed to the Waterworks Ordinances. The actual changes -- including existing code wording, proposed new wording and deleted wording -- are presented in Appendix A in succession by numerical code section.

Each of the proposed code changes can be classified into one of two basic types. The first type of code change concerns those changes which mandate automatic sprinkler installations. These changes are few in number but wide in scope. The second type of change is that which eliminates, reduces or modifies other fire protection or life safety requirements in lieu of mandatory automatic sprinklers. These eliminations, reductions and modifications will help off-set the cost of mandatory sprinkler protection.

The identification and development of the proposed code changes was dependent upon several concerns and considerations. Understanding the development of codes was important in order to realize how current requirements came to exist and how they interface with other code requirements. A knowledge of fire department operations was important in evaluating the impact that code requirements have on effective and safe fire fighting. Understanding the performance and application of automatic sprinklers is essential since sprinklers become the premise for the reduction, elimination and modification of some current code requirements. An understanding of the interrelation of building fire safety features is most important to insure that code requirements provide fire safety redundancy. Coupling the above considerations with supportive technical information, requirements of other recognized codes and standards, fire experience data, along with experience and engineering judgment provides the basis for the proposed code changes.

The supporting rationale for the proposed code changes is discussed below with accompanying explanations of the code changes. The following text does not necessarily represent an exhaustive critical analysis of any particular code section or topic, but is intended to provide the supportive reasoning and technical basis behind the proposed changes. Certain issues involved in the proposed code changes have themselves been the subject of intensive studies and analyses.

BUILDING CODE CHANGES

Subchapter 5

Subchapter 5 of the Dallas Building Code addresses general requirements for the various occupancies -- hospitals, offices, dwellings, factories, schools, restaurants, etc. -- which are categorized in the code. Among the general requirements are limitations on the allowable height and floor size (area) of a building, the degree of fire resistance required for structural members of a building, and requirements for buildings that house more than one occupancy.

The first code change, B-1, allows a doubling of the area for a minor accessory use in a building. Code Section 503 allows occupancies which do not occupy a large floor area to be considered accessory to the major occupancy of the building without subjecting the building to a more stringent area limitation requirement or requiring a fire-resistive separation between the occupancies. Currently, the code permits occupancies to be considered accessory use for up to 10 percent of the area of the floor. With the provision of automatic sprinkler protection, the proposed change will permit accessory uses up to 20 percent of a floor area. Regardless of the provision of automatic sprinklers, the basic area permitted for accessory use will still be limited to the basic areas found in Table 5-C of the Dallas Building Code. The additional risk introduced by allowing greater area for accessory use will be compensated for by the provision of automatic sprinkler systems. The current provision allowing 10 percent is essentially founded on a subjective basis. Since most codes allow increases in the total allowable building area of up to three times the basic area, a 100 percent increase in the allowed accessory use is consistent with currently accepted fire protection practice.

Proposed code changes B-4, B-5, B-6, B-7 and B-8 address the topic of maximum allowable building heights and areas. The Dallas Building Code, as other building codes,

prescribes basic height and area limitations for buildings of a particular occupancy and type of construction. These limitations, which were primarily developed out of a concern for property protection and manual fire fighting capabilities, have been based upon experience, judgment and applied assumptions.

Height and area limitations help to reduce or eliminate the possibility of large, disasterous fires and limit the number of persons exposed to a single fire. The potential for total building involvement and possible conflagration depends upon the amount and arrangement of a building's combustible contents, the ability of a building structure to resist the effects of a fire involving the contents, and the success of suppression efforts. This threat of unrestricted fire spread and the experience of unsuccessful, hazardous manual fire fighting are primary reasons for height and area limitations. The greater the area and height of a building, the greater will be the amount of combustible materials which can contribute to the development and spread of a fire. As a fire spreads and involves larger portions of a building, there will be an increasing demand upon fire department suppression efforts, decreased possibility of successful manual extinguishment or containment, and an increased risk of fire spread to adjacent properties. Larger buildings also increase the hazard to fire fighters due to the greater distances of travel required to reach the fire.

Although limiting the number of persons exposed to fire is not a primary reason for area limits, it is a consideration for height limits. The National Fire Protection Association's "Guide on Building Areas and Heights (NFPA 206M)," does not identify the prevention of loss of life and personal injury as a reason for the limitation of building areas and heights. Such provisions for the prevention of life loss and personal injury are generally addressed by other code regulations. A primary example of such life safety regulations can be found in the Dallas Building Code in the form of exit requirements. Since the number and location of exits are required to adequately accommodate any building, regardless of size, the necessity to limit the area of a building becomes less important from a life safety standpoint. The height of a building, however, does increase the required time and travel distance necessary for evacuation. The concept of not limiting the area, but only the height of buildings for life safety purposes, is exemplified by the National Fire Protection Association's Life Safety Code (NFPA 101) which restricts the allowable height of various construction types for some occupancies, but does not restrict the area of the buildings.

Although limiting the height and area of buildings is a fundamental principle of building codes to the problems of conflagration, fire fighting and evacuation of buildings, there is another solution which is widely recognized by building codes for effective fire control. This solution considers the use of automatic fire extinguishing systems. Typically, building codes will allow a 100 to 300 percent increase in the allowable building area and/or an increase in the allowable height when a building is protected by an automatic fire extinguishing system. Proposed changes to Sections 506(b), 506(c) and 507 of the Dallas Building Code are an expansion of this principle.

The provision of automatic sprinker protection essentially minimizes the problems of conflagration, manual fire fighting and evacuation. Automatic sprinkler systems are designed to limit fires to the area of fire origin and have proven to accomplish this function as demonstrated by sprinkler performance statistics. The ability of a sprinkler system to control a building fire is not dependent upon the floor area protected. The significance of this method of fire control is simply stated by NFPA's "Guide on Building Areas and Heights:"

> The total fire area of a building is irrelevant when a fire is controlled or extinguished at the point of origin.

Automatic sprinkler systems have proven to be a much more effective method of suppression than manual methods and will prevent excessive demands on the fire department and water supplies. Automatic sprinklers will also greatly reduce or eliminate potential risks to fire fighters.

The current Dallas Building Code allows a 200 percent increase in area for one-story buildings and either a 100 percent increase in area or a one-story height increase in multi-story buildings protected by automatic sprinklers. The Dallas Building Code does not permit simultaneous increases for both height and area. However, proposed modifications to sections 506(c) and 507 of the Dallas Building Code will allow height increases and area increases to be taken together. Simultaneous increases are permissible since the area of a building is not a significant life safety consideration. Also, the area is an irrelevant consideration for buildings with dependable automatic suppression capability. This change is consistent with the Basic Building Code which permits simultaneous height and area increases. The prohibition of height and area increases for Group H, Division 1 and 2 occupancies remains applicable.

"Unlimited area" buildings are currently permitted by the Dallas Building Code for one- and two-story buildings of Group B and Group H, Division 5 occupancies that are provided with automatic sprinklers and/or surrounded by a 60 foot clear space, and Type I fire-resistive structures. These unlimited area provisions will remain applicable. Additional unlimited area provisions are proposed for occupancies housed in Type II or Type IV construction. Current exclusion of Group H, Division 1 and 2 occupancies (occupancies used for the storage and handling of flammable or explosive materials) from the unlimited area provisions will remain in the code.

Unlimited area will be permitted for Type II fire-resistive buildings protected by automatic sprinkler systems. This construction type will also be permitted to be unlimited in height as proposed in Code Change B-8. The basic minimum fire resistance required for Type II fire-resistive structures is two hours and is considered to provide sufficient fire limiting redundancy between floors. The 1981 edition of the NFPA Life Safety Code recognizes buildings having two hours of fire resistance as providing adequate structural fire integrity without the supplemental use of sprinklers and does not limit the height of such buildings.

Type II construction having one-hour fire-resistive structural elements (Type II-1 hour) and protected by automatic sprinkler systems will also be allowed unlimited area. The fire-resistance capability of one-hour structures also provides fire-limiting redundancy but is not comparable to that provided for structures having two hours of fire resistance. Therefore, the heights for one-hour structures are restricted to the currently specified tabular quantities with a permissible one-story increase for automatic sprinklers.

Both Type IV (commonly known as heavy timber construction which consists of large solid wood members) and Type II noncombustible (Type II-N) construction (commonly known as unprotected noncombustible construction) are proposed to be allowed unlimited area for buildings permitted up to three stories in height. Although both Type IV and Type II-noncombustible construction technically have no test-qualified fire resistance, they both exhibit inherent fire-resistive characteristics that is attributed to the size and mass of the structural members involved in their construction. The sprinkler system protection required for unlimited area buildings will supplement the

inherent structural fire resistance of these construction types. The ability of automatic sprinklers to provide structural protection and substitute for other methods of fire resistance such as tested fire assemblies, sprayed-on fireproofing, and plaster, gypsum or concrete coverings is well substantiated.

The basic criteria used for determining the relative fire resistance of structural elements is the American Society for Testing Materials (ASTM) E119 standard time temperature furnace test. A fire-resistance rating is the time period a building element (e.g., column, beam) can withstand a fire exposure of the standard time temperature furnace test without failure. The use of the ASTM E119 fire exposure is based upon a representative fire exposure a building can be expected to endure which has been correlated to full-scale burnout tests. The premise of the application of the test, however, is that the structure only provides passive resistance to the fire. No suppression, manual or automatic, is considered.

The temperature-limiting capability of automatic sprinklers is graphically compared to the ASTM E119 temperature curve in Figure 13. The sprinkler test represented in the graph is one of a multitude of tests used by Underwriters Laboratories, Inc. and Factory Mutual Research for sprinkler listing and approval. The test uses a 300-pound wood crib centered under four open sprinklers. The wood crib is allowed to burn above a combustible liquid spray of n-heptane. After approximately one minute or after ceiling temperatures reach 1,400^{o}F, water is supplied to the four open sprinklers. Within five minutes and throughout the duration of the test, the sprinklers must bring ceiling temperatures back below 600^{o}F. Steel without fireproofing is considered to be threatened if it is exposed to temperatures over 1,000^{o}F for over 10 minutes. Obviously, the test criteria are below this threatening limit.

Another example of the ability of sprinklers to limit temperature and provide structural protection is illustrated in Figure 14. Developed in 1965 by Factory Mutual Research, the curves shown in Figure 14 indicate that a bare steel H-column, subjected to a fire exposure similar to that encountered by the ASTM E119 test, could be expected to maintain its strength indefinitely with the use of automatic sprinkler protection. The steel column would otherwise be expected to fail in less than 15 minutes.

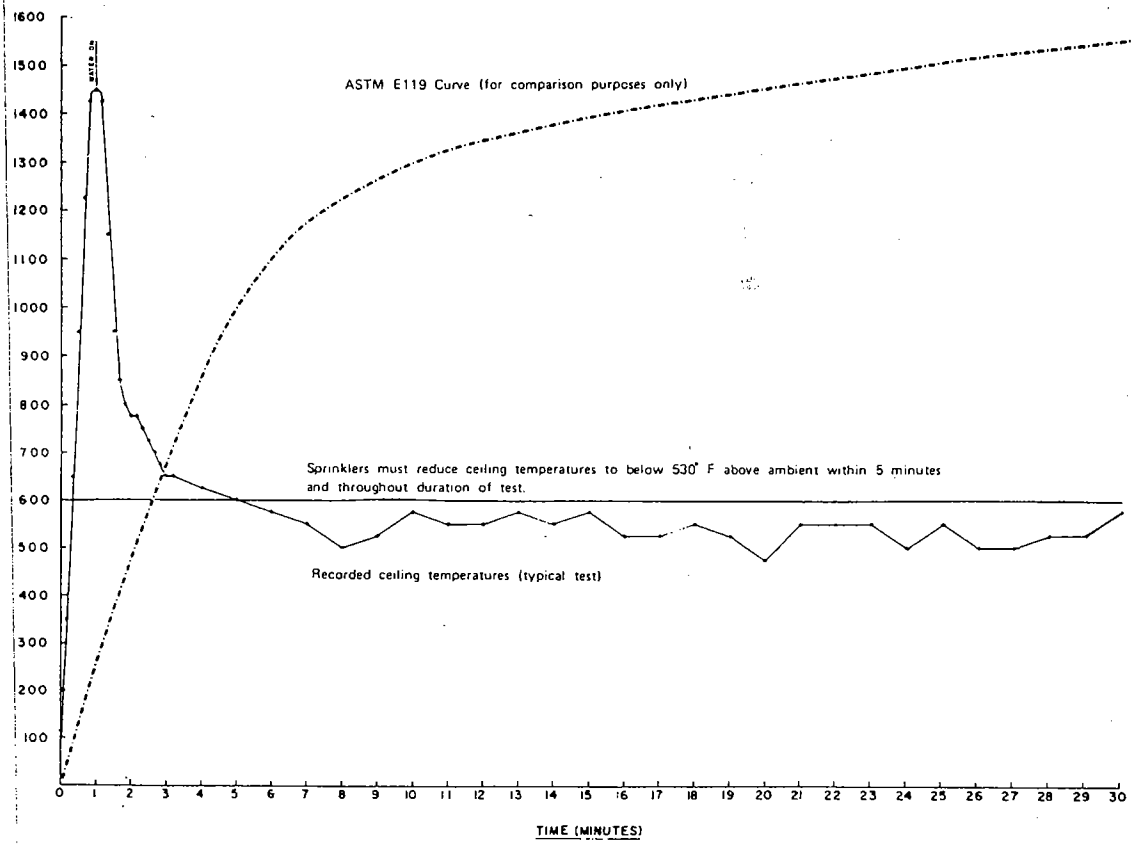


FIGURE 13
TYPICAL SPRINKLER FIRE TEST PERFORMANCE

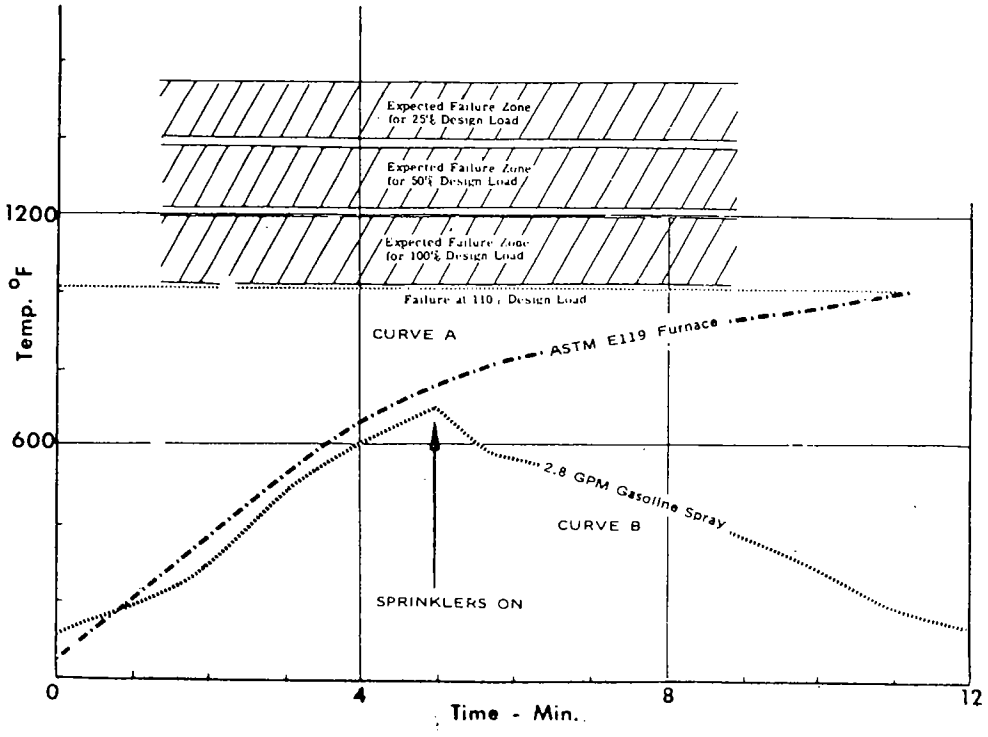


FIGURE 14
COLUMN TEMPERATURES DURING EXPOSURE TO ASTM E-119 STANDARD FURNACE AND SIMULATED EXPOSURE WITH SPRINKLER PROTECTION
Source: Fire Sprinkler Laws, NAS & FCA.

Further substantiation of the ability of sprinklers to provide primary structural protection, particularly for light steel members, is based on large scale fire tests conducted at the Factory Mutual Research Center in Rhode Island. The tests that were conducted used a heavy fire loading consisting of combustibles in a rack storage arrangement. The sprinkler densities which were used are those from NFPA 231C, "Rack Storage of Materials." None of the tests conducted produced critical temperatures in bar joists 12 feet, 6 inches away from the ignition source and roof steel never exceeded critical temperatures, even with sprinkler densities less than the quantities specified by NFPA 231C. Likewise, tests with polyurethane buns conducted by Factory Mutual confirmed the ability of sprinklers to control column temperatures under very severe fire conditions.

The above cited substantiation provides a strong basis for allowing active protection systems to substitute for traditional passive fire resistance in certain limited height structures, such as proposed for three-story Type II-noncombustible structures. Tests also confirm the ability of sprinklers to provide structural protection for wood construction and, therefore, unlimited area, is similarly proposed for Type IV construction (heavy timber) up to 3 stories in height. Development work for the modern-day sprinkler by Factory Mutual Research in the 1940's and 50's showed that sprinklers were able to eliminate active flaming combustion of wood ceilings by preventing the adjacent air temperature from rising substantially above 1,000^{o}F.

A dramatic illustration of sprinkler protection to supplement the fire resistance of wood materials occurred in full-scale fire experiments conducted by the Illinois Institute of Technology Research Institute in 1972. These experiments demonstrated that a hollow-core wood door protected by a simplified sprinkler system, with a water delivery rate much less than required by design standards, could indefinitely withstand the room fire exposure of a heavily fire-loaded residential occupancy.

The previously discussed code changes for unlimited area allowances are instituted only for noncombustible and heavy timber construction types. The existing code allowances for increased area of other combustible construction types remains unchanged. Again, however, simultaneous height increases are proposed to be permitted.

In addition to the across-the-board height and area changes proposed to the Dallas Building Code, there is a specific change proposed for Tables 5-C and 5-D of the

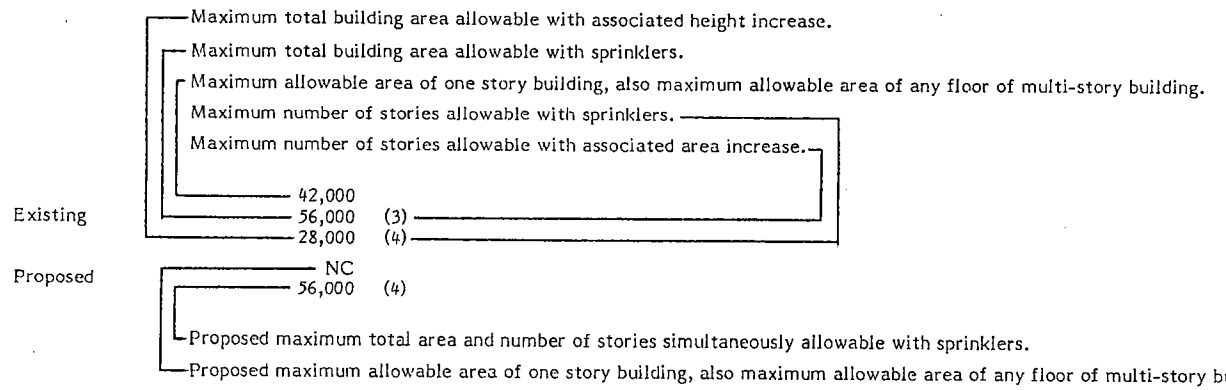
building code. These tables, which provide the basic areas and heights from which increases are derived, are proposed to remain unchanged with the following exception. Currently, Group I, Division 1 and 2 occupancies (nursing homes, nurseries and hospitals) are not permitted to be built of Type II-N (unprotected noncombustible) construction. A note added to both these tables (Proposed Changes B-4 and B-5) permits an exception by allowing Type II-N construction to a maximum height of one story with unlimited area if the building is protected by automatic sprinklers. All other "Not Permitted" categories will remain as found in the code. Permissible use of sprinklered, one-story, unprotected noncombustible construction for hospitals and nursing homes is consistent with the Basic Building Code, the Standard Building Code and the NFPA Life Safety Code.

All the ramifications and interrelations of the height and area limit changes are not directly apparent from reading the actual proposed code change wording in Appendix A. In order to clarify the intent of these changes and to assist the reader in understanding the extent of the changes, Table 10 has been prepared. This table allows the comparison of existing maximum height and areas allowed for sprinklered buildings and the maximum height and areas that are possible as a result of the code changes. The maximum areas shown are based on the increases permitted only for automatic sprinklers and do not consider increases permitted for clear space separation around buildings. The cumulative corresponding maximum allowable area with sprinkler increases and clear space separation increases, however, can be determined by multiplying the area figures shown in the chart by a factor of two.

The final change proposed to Subchapter 5, Change B-9, involves the deletion and rewrite of Section 508. The existing Section 508 allows the substitution of an approved automatic fire extinguishing system for construction required to have one hour of fire resistance, when the extinguishing system is not otherwise required. This permitted reduction in fire resistance is strongly supported by tests and other technical data which was previously discussed. However, by means of an existing exception to Section 508, application of this substitution principle is disallowed for occupancy separations, exterior wall protection, area separation walls, shaft enclosures, corridor wall construction, exit enclosures and construction separations.

TABLE 10
COMPARISON OF MAXIMUM ALLOWABLE HEIGHTS AND AREAS OF SPRINKLERED ONE-STORY AND MULTIPLE STORY BUILDINGS
EXISTING REQUIREMENTS VS. PROPOSED REQUIRMENTS

Explanation of Table: Each grouping of numbers provides the following information:



Occupancy		Type I Fire Resistive	Type II Fire Resistive	Type II 1-Hour	Type II N	Type III 1-Hour	Type III N	Type IV	Type V 1-Hour	Type V N
A-1	Existing	UL UL (UL)	89,700 119,600 (4) 59,800 (5)	NP	NP	NP	NP	NP	NP	NP
	Proposed	NC NC (NC)	UL UL (UL)	NC	NC	NC	NC	NC	NC	NC
A) 2-2.1	Existing	UL UL (UL)	89,700 119,600 (4) 59,800 (5)	40,500 54,000 (2) 27,000 (3)	NP x	40,500 54,000 (2) 27,000 (3)	NP x	40,500 54,000 (2) 27,000 (3)	31,500 42,000 (2) 21,000 (3)	NP x
	Proposed	NC NC (NC)	UL UL (UL)	UL UL (3)	NC x	NC 54,000 (3)	NC x	UL UL (3)	NC 42,000 (3)	NC x
A) 3-4	Existing	UL UL (UL)	89,700 119,600 (12) 59,800 (13)	40,500 54,000 (2) 27,000 (3)	27,300 18,200 (2) NA	40,500 54,000 (2) 27,000 (3)	27,300 18,200 (2) NA	40,500 54,000 (2) 27,000 (3)	31,500 42,000 (2) 21,000 (3)	18,000 12,000 (2) NA
	Proposed	NC NC (NC)	UL UL (UL)	UL UL (3)	UL UL (2)	NC 54,000 (3)	NC 36,400 (2)	NC UL (3)	NC 42,000 (3)	NC 24,000 (2)
B) 1-2-3	Existing	UL UL (UL)	119,700 159,600 (12)* 79,800 (13)	54,000 72,000 (4)* 36,000 (5)	36,000 48,000 (2)* 24,000 (3)	54,000 72,000 (4)* 36,000 (5)	36,000 48,000 (2)* 24,000 (3)	54,000 72,000 (4)* 36,000 (5)	42,000 56,000 (3)* 28,000 (4)	24,000 32,000 (2)* 16,000 (3)
	Proposed	NC NC (NC)	UL UL (UL)	UL UL (5)	UL UL (3)	NC 72,000 (5)*	NC 48,000 (3)*	UL UL (3) 72,000 (5)	NC 56,000 (4)*	NC 32,000 (3)*

TABLE 10
COMPARISON OF MAXIMUM ALLOWABLE HEIGHTS AND AREAS OF SPRINKLERED ONE-STORY AND MULTIPLE STORY BUILDINGS
EXISTING REQUIREMENTS VS. PROPOSED REQUIRMENTS
(CONTINUED)

Occupancy		Type I	Type II			Type III		Type IV	Type V	
		Fire Resistive	Fire Resistive	1-Hour	N	1-Hour	N		1-Hour	N
B-4	Existing	UL UL (UL)	179,700 ** 239,600 (12)* 119,800 (13)	81,000 ** 108,000 (4)* 54,000 (5)	54,000 ** 72,000 (2)* 36,000 (3)	81,000 ** 108,000 (4)* 54,000 (5)	54,000 72,000 (2)* 36,000 (3)	81,000 ** 108,000 (4)* 54,000 (5)	63,000 84,000 (3)* 42,000 (4)	36,000 48,000 (2)* 24,000 (3)
	Proposed	NC NC (NC)	UL ** UL (UL)	UL ** UL (5)	UL ** UL (3)	NC ** 108,000 (5)*	NC 74,000 (3)*	UL UL (3) 108,000 (5)	NC 84,000 (4)	NC 48,000 (3)
E	Existing***	UL UL (UL)	135,600 180,800 (4) 90,400 (5)	60,600 80,800 (2)+ 40,400 (3)	40,500 27,000 (2) NA	60,600 80,800 (2)+ 40,400 (3)	40,500 27,000 (2) NA	60,600 80,800 (2)+ 40,400 (3)	47,100 62,800 (2)+ 31,400 (3)	27,300 18,200 (2) NA
	Proposed***	NC NC (NC)	UL UL (UL)	UL UL (3)+	UL UL (2)+	NC 80,800 (3)+	NC 54,000 (3)+	UL UL (3)+	NC 62,800 (3)+	NC 36,400 (2)+
H) 1	Existing	15,000 30,000 (UL) NA	12,400 24,800 (2) 1,500 (3)	5,600 1,500 (2) NA	3,700 1,500 (2) NA	5,600 1,500 (2) NA	3,700 1,500 (2) NA	5,600 1,500 (2) NA	4,400 1,500 (2) NA	2,500 1,500 (2) NA
	Proposed	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)
H) 2	Existing	15,000 30,000 (UL) NA	12,400 24,800 (5) 1,500 (6)	5,600 11,200 (2) 1,500 (3)	3,700 1,500 (2) NA	5,600 11,200 (2) 1,500 (3)	3,700 1,500 (2) NA	5,600 11,200 (2) 1,500 (3)	4,400 8,800 (2) 1,500 (3)	2,500 1,500 (2) NA
	Proposed	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)	NC NC (NC)
H) 3-4-5	Existing	UL UL (UL)	74,400 99,200 (5)* 49,600 (6)	33,600 44,800 (2)* 22,400 (3)	22,500 15,000 (2)* NA	33,600 44,800 (2)* 22,400 (3)	22,500 15,000 (2)* NA	33,600 44,800 (2) 22,400 (3)	26,400 35,200 (2) 17,600 (3)	15,300 10,200 (2)* NA
	Proposed	NC NC (NC)	UL UL (5)	UL UL (2)	UL UL (2)	NC 44,800 (2)*	NC 30,000 (2)*	NC UL (3)*	NC 35.200 (2)*	NC 20,400 (2)*
I-1	Existing	UL UL (UL)	45,300 60,400 (3) 30,200 (4)	20,400 13,600 (2) NA	NP	20,400 13,600 (2) NA	NP	20,400 13,600 (2) NA	15,600 10,400 (2) NA	NP
	Proposed	NC NC (NC)	UL UL (UL)	UL UL (2)	UL (1)	NC 27,200 (2)	NC UL (1)	NC UL (2)	NC 20,800 (2)	NC
I-2	Existing	UL UL (UL)	45,300 60,400 (3) 30,200 (4)	20,400 27,200 (2) 13,600 (3)	NP	20,400 27,200 (2) 13,600 (3)	NP	20,400 27,200 (2) 13,600 (3)	15,600 20,800 (2) 10.400 (3)	NP
	Proposed	NC NC (NC)	UL UL (UL)	UL UL (3)	UL (1)	NC 27,200 (3)	NC UL (1)	NC UL (3)	NC 20.800 (3)	NC

TABLE 10
COMPARISON OF MAXIMUM ALLOWABLE HEIGHTS AND AREAS OF SPRINKLERED ONE-STORY AND MULTIPLE STORY BUILDINGS
EXISTING REQUIREMENTS VS. PROPOSED REQUIRMENTS
(CONTINUED)

Occupancy		Type I Fire Resistive	Type II Fire Resistive	Type II 1-Hour	Type II N	Type III 1-Hour	Type III N	Type IV	Type V 1-Hour	Type V N
I-3	Existing	UL UL (UL)	45,300 60,400 (2) 30,200 (3)	NP	NP	NP	NP	NP	NP	NP
	Proposed	NC NC (NC)	UL UL (3)	NC	NC	NC	NC	NC	NC	NC
M	Existing	Special Provisions of Chapter 11 are Applicable								
	Proposed	No Change								
R-1	Existing	UL UL (UL)	89,700 119,600 (12) 59,800 (13)	40,500 54,000 (4) 27,000 (5)	27,300 36,400 (2)++ NA	40,500 54,000 (4) 27,000 (5)	27,300 36,400 (2)++ NA	40,500 54,000 (4) 27,000 (5)	31,500 42,000 (3) 21,000 (4)	18,000 24,000 (2)++ NA
	Proposed	NC NC (NC)	UL UL (UL)	UL UL (5)	UL UL (2)++	NC 54,000 (5)	NC NC(NC)++	NC UL (3) 54,000 (5)	NC NC (4)	NC NC(NC)++
R-3	Existing	UL UL (UL)	UL UL (3)	UL UL (3)	UL UL (3)	UL UL (3)	UL UL (3)	UL UL (3)	UL UL (3)	UL UL (3)
	Proposed	NC NC (NC)	NC NC (4)	NC NC (4)	NC NC (4)	NC NC (4)	NC NC (4)	NC NC (4)	NC NC (4)	NC NC (4)

Notes:

NA - Not Applicable
NP - Not Permitted
NC - No Change
UL - Unlimited

x Permitted by Section 508, which allows one-hour construction to be reduced to unprotected construction. Height and area may not exceed maximum unsprinklered height and area for one-hour protected construction.

* The area of a sprinklered one- or two-story Group B or Group H, Division 5 occupancy of this construction type is not limited if the building is entirely surrounded by clear space of 60 feet in width.

** The existing code provisions allow unlimited area for a sprinklered or unsprinklered building of this construction type if the building is entirely surrounded by clear space of 60 feet in width. Proposed provisions will also permit unlimited area; however, such buildings are required to be sprinklered by the proposed provisions.

*** Section 802(a) allows areas to be increased by 50 percent when the maximum travel distance specified in Section 3302(d) is reduced by 50 percent.

+ Rooms in Divisions 1 and 2 occupancies used for day care purposes, kindergarten, first or second grade pupils and Division 3 occupancies are not permitted above the first story.

++ Group R, Division 1 occupancies more than two stories in height or having more than 3,000 square feet of floor area above the first story, are required to be not less than one-hour fire-resistive construction.

The proposed rewritten version of Section 508 will allow the substitution of automatic sprinklers for several of these fire safety features. Crediting automatic extinguishing systems, such as sprinkler systems, for otherwise necessary fire safety features is a basic consideration of the NFPA Systems Concept. This consideration of the Systems Concept is currently being applied nationally via the "Fire Safety Evaluation System" (FSES) for health care facilities. The FSES which was developed by the National Bureau of Standards and is formally recognized by the NFPA Life Safety Code, allows the use of one or more fire safety features to compensate for the lack of other features. The FSES recognizes automatic sprinklers as the only fire safety feature which can compensate for any of the other required fire safety features, such as fire resistance, compartmentation, smoke control, exits, etc.

The fire-resistance requirements for occupancy separations is the first item of the rewritten Section 508 for which sprinklers may be substituted. This change will effectively eliminate one-hour occupancy separations required by Table 5-B of the Dallas Building Code and will allow a one hour reduction in the fire resistance for occupancy separations required to have two or more hours of fire resistance. It should be noted that the fire-resistive reductions will not be permitted for Group B, Division 1 occupancies (gas stations and vehicle storage garages) or Group H occupancies (occupancies used for storage and handling of flammable or explosive materials). These occupancies have characteristics where materials having an explosive nature are frequently encountered. Since these hazards may represent non-traditional fire growth scenarios upon which sprinklers can reasonably be expected to perform, an additional degree of redundancy is considered necessary.

The fire resistance and opening protection requirements for exterior walls is the second item for which sprinkler protection is allowed to substitute. This allowed substitution is applicable only to the wall requirements governed by Section 504(b) and Table 5-A of the Dallas Code, but does not apply to the wall requirements governed by Table 17-A for types of construction.

The prevention of the spread of fire between buildings and potential damage from fire in an exposing building are the main fire protection functions of rated exterior building walls. The exterior wall requirements of the Dallas Building Code are dependent upon the the fire load of the occupancy and distance of walls from the property line (or an assumed property line for buildings located on the same property). The risk of fire

spread from exposing buildings is increased as buildings are located closer together. Depending upon the occupancy and separation distance between adjoining properties, the requirement for exterior walls can vary from a required four-hour fire-resistive wall with no allowed openings, to one-hour walls with unprotected openings or openings protected by fire doors and fire windows. These current exterior wall protection requirements of the Dallas Building Code which reduce the risk of fire spread can be reduced for the provision of automatic sprinklers, which will greatly diminish or eliminate the risk of building-to-building fire spread. The 1980 edition of NFPA 80A, "Recommended Practice for Protection of Buildings from Exterior Fire Exposures," recognizes automatic sprinkler protection as a solution to the problem of fire exposure, as follows:

> Where the exposing building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, no exposure hazard is considered to exist.

Also,

> Where the exposed building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, the exposure hazard to the total exposed building and its contents is materially reduced.

If all buildings of any particular community were protected by automatic sprinkler systems, no exposure hazard would be present and fire-resistive requirements for exterior walls could be eliminated, except as would be necessary to comply with construction type requirements. However, new buildings protected by automatic sprinkler systems are considered to have the exposure risk and potential for fire spread significantly reduced. Therefore, Section 508, although not permitting an elimination of the fire resistance of exterior walls, does permit a reduction in the required fire protection rating of the walls. Four-hour required exterior walls will be allowed to be reduced to two-hour walls and two-hour walls will similarly be allowed a reduction to one hour of fire resistance. Where one-hour walls and opening protectives are required, the opening protectives may be eliminated with the provision of automatic sprinklers, however, the required fire resistance of the walls shall not be reduced.

The fire-resistive reduction allowed for four-hour exterior walls by the proposed Section 508 will also be permitted for walls used to separate buildings of the same or

different construction type. This change will allow separation walls constructed in accordance with the code provisions for two-hour area separation walls to define the boundaries of a building for all occupancies, except Group H.

Current Sections 3304(g) and 3304(h) of the Dallas Building Code require corridors serving greater than thirty occupants to be constructed with walls and ceilings having a fire resistance of one hour. Penetrations of this corridor envelope created by door openings or duct penetrations are required to be protected by self-closing, 20 minute rated fire doors and fire dampers, respectively. The provision of automatic sprinkler protection will be allowed to substitute for this corridor separation requirement for all occupancy groups except Group H, Division 1, Group I, Division 3 (institutional buildings where inmates are restrained) and Group R (hotels, apartments).

Both the Life Safety Code and the 1981 Basic Building Code allow such reduction for automatic sprinklers. The Life Safety Code allows health care occupancies protected by automatic sprinkler systems to have corridors constructed of nonrated fire partitions that terminate at a ceiling. The Basic Building Code allows buildings with automatic sprinkler systems supervised at a constantly attended location to utilize nonrated fire corridor construction for business, industrial, mercantile, storage and various assembly occupancies. The Basic Building Code also allows a reduction in the fire-resistance rating of corridor walls to one-half hour for hotel and apartment occupancies. The primary reasoning behind such allowances is the ability of automatic sprinklers to control a fire at the area of origin while reducing the "stress" on rated construction components, thereby preventing the spread of fire into or out of a corridor and allowing additional time that may be needed for evacuation by means of a building's corridor system.

Several tests substantiate this rationale. In 1959, the Los Angeles Fire Department undertook a series of fire tests known as "Operation School Burning." The tests, which were conducted in a three-story school facility, concluded that a complete system of automatic sprinklers will maintain low temperatures throughout a building and will reduce build-up of smoke and irritating gases, allowing more time for evacuating occupants. In 1966, tests conducted by the City of Denver at the Parklane Hotel indicated that sprinklers located only in corridors were able to permit egress past an opening of a room involved in fire. This was further confirmed by the National Bureau of Standards in 1977. Testing and research performed by the National Bureau of

Standards and sponsored by the Departments of Housing and Urban Development and Health, Education and Welfare showed that the application of sprinkler spray in the corridor is effective in reducing exit corridor gas temperatures outside of the spray zone to a level low enough for passage. The American Health Care Association sponsored a series of 14 full-scale tests in 1974 which concluded that corridor wall construction having one-hour fire-resistance rating provides no significant fire safety function in buildings provided with automatic sprinkler protection.[21]

The fifth and last item in the proposed Section 508 is very specific in nature and is provided in order to maintain consistency with the existing Section 508. The deletion of the existing provision would disallow unprotected construction types housing Group A, Division 2 and 2.1 occupancies. Table 5-C of the Dallas Building Code does not permit unprotected construction types for these assembly occupancies. However, it permits structures having one hour of fire resistance to be built as structures having no fire-resistance rating when the structures are provided with an automatic sprinkler system. Therefore, the intent of this change to revised Section 508 is made to assure that the allowances previously permitted by this section are not inadvertantly deleted.

Also consistent with the existing Section 508 is the continuation of the exception which prevents the fire-resistive construction requirements for shaft enclosures, stair enclosures and exit passageways from being reduced because of the provision of automatic sprinkler systems. Structural members supporting shaft enclosures or exit passageways are additionally listed as an exception. Redundancy for the exit facilities in a building is considered a necessary feature.

The last exception listed in the revised Section 508 will prevent one-hour corridor separations for unsprinklered hospital rooms from being deleted. In effect, any room in a hospital which is exempt from protection by automatic sprinklers must still comply with the corridor separation requirements stipulated by the Dallas Building Code.

Subchapter 6

Subchapter 6 of the Dallas Building Code contains specific requirements for Group A (assembly) occupancies.

Proposed Code Change B-10, which is the only change proposed to Subchapter 6 of the Dallas Building Code, is a corollary change to Proposed Code Change B-38, which deletes the requirements for smokeproof enclosures. It should be noted that Proposed Code Change B-10 is applicable to five other code sections in addition to Section 604 of Subchapter 6. Commentary regarding Proposed Code Changes B-10 and B-38 can be found in the discussion related to the proposed changes of Subchapter 33.

Subchapter 7

Subchapter 7 of the Dallas Building Code addresses requirements for Group B occupancies. This classification includes gasoline service stations, retail stores, office buildings, factories, aircraft storage hangars, open parking garages, power plants and storage buildings. This occupancy classification within the UBC is unique to that of most other codes in that a broad range of commercial buildings is included. Many other building codes provide distinct occupancy classifications for business buildings, factory buildings, mercantile buildings and storage buildings. The activity within the Board for the Coordination of Model Codes is presently working toward a common occupancy classification system for all model building codes which may ultimately result in more discrete occupancy classifications for the UBC.

The first change (B-11) in Subchapter 7 modifies Section 702(a)2 of the Dallas Building Code. This section currently allows a designer to build a structure housing a Group B, Division 2 occupancy (e.g., office) or a Group R, Division 1 occupancy (e.g., hotel) above a Group B, Division 1 occupancy (e.g., garage) and allow the garage and office or hotel to be considered as separate buildings when four conditions are met. With the four conditions met, a designer can benefit by building the office/hotel portion of the structure of a lesser construction with greater height and area than would otherwise be permitted. One of the four conditions requires a three-hour occupancy separation between the garage and office/hotel. The proposed code change will permit a two-hour fire-resistive separation to be utilized when the entire structure is protected by automatic sprinklers. This reduction is permitted with regard for the ability of automatic sprinklers to offset passive fire-resistance criteria, and the relative low hazard of Group B, Division 1 occupancies. Even with this fire-resistance reduction, an ample degree of fire-resistance redundancy is assured by the requirement for two hours of fire resistance.

Proposed Change B-12 deletes the reference in Section 702(b) to Section 3206. As discussed in a later section of this report, the requirement for smoke and heat venting in fully sprinklered buildings is proposed to be deleted.

Section 709 of the Dallas Building Code addresses special requirements applicable to open-air parking garages, including allowable types of construction as specified in Table 7-A. While the inclusion of an automatic fire extinguishing system is presently considered in Table 7-A, the present requirements are considered more restrictive than that allowed by a national consensus standard specifically dealing with open-air parking garages. NFPA Standard No. 88A-1979, "Standard for Parking Structures," allows a substantial increase both in area and height for open-air parking structures over that presently allowed in the Dallas Building Code. In fact, both larger areas and greater heights are allowed in the NFPA standard for unsprinklered parking garages, as well. Being conservative, however, Proposed Code Change B-13 only allows increased area and height limits for sprinklered open-air parking garages. The resulting code language proposed for the Dallas Building Code remains slightly more conservative than that contained in the NFPA standard.

Additional rationale for the reduction in fire-resistance ratings for sprinklered open-air parking garages beyond that presently allowed by the Dallas Building Code is based upon studies conducted in Europe, Japan and the United States, including full scale tests in open-air parking structures.[22] Fire tests have demonstrated that a fire in an automobile in an open-air parking structure will be limited to the vehicle of origin with a high degree of probability. In addition, even in a parking structure of unprotected noncombustible (Type II-N) construction, the maximum temperature of structural steel remained far below critical levels during the test fire.

Surveys of fire experience in automobile parking structures have also demonstrated that the structures have a low-fire frequency as well as a low fire load (less than two pounds per square foot).[23] Parking structures also have a relatively low occupant load when compared to most other occupancies.

These data, in conjunction with a building configuration that facilitates fire department access and the dissipation of combustion products, form the basis for a liberalization of present code requirements.

As can be seen in Table 7-A of the current Dallas Building Code, unlimited area and height is currently allowed for open-air parking garages of Type I construction, whether or not the garage is sprinklered. The previously referenced studies indicate that the fire-resistance rating afforded by a Type I structure is more than sufficient for the occupancy, as currently reflected in the table. Proposed Change B-13 also allows unlimited area and unlimited height for open-air parking garages of Type II fire-resistive construction if they are fully sprinklered. Again, the fire-resistance rating of the structure would be more than sufficient to accommodate the occupancy, even if the building is not sprinklered. This particular modification, therefore, is considered to be an acceptable liberalization, yet provides the necessary factor of safety for structural integrity. Similarly, the proposed modification for sprinklered Type II one-hour open-air parking structures would provide the redundancy of inherent fire resistance for the structure in conjunction with an automatic fire extinguishing system.

The proposed changes for Type II-N construction are based upon the current requirements of NFPA 88A, in conjunction with engineering judgment and fire experience. Again, the configuration and nature of the occupancy are considered sufficient bases to allow an increase in the square footage and height of open-air parking structures of Type II unprotected noncombustible construction. The present differential in allowable height between sprinklered ramp access garages and sprinklered mechanical access garages will be eliminated. The difference in risk to the general public between these structures, if fully sprinklered, is considered negligible.

An editorial change is included in the heading of Table 7-A, specifically referencing the provision of an automatic sprinkler system as opposed to another type of automatic fire extinguishing system. Fire experience indicates that water-based extinguishing systems are superior to gaseous or chemical-type extinguishing systems in an open-air parking environment. This editorial change is not intended to preclude the use of foam water sprinkler systems, or other extinguishing systems for special hazards which may exist in conjunction with the building.

Proposed Section 710 (Change B-14) would be a new section to the Dallas Building Code applicable to the covered mall buildings. The proposal is based largely upon the requirements contained in Chapter 7 of the Appendix of the 1982 edition of the Uniform Building Code. The amendments to the material contained in the 1982 Uniform Building Code are based upon the requirements of other model codes, fire experience and

engineering judgment. Section 710 begins with definitions specifically applicable to covered mall buildings. For consistency, these definitions may be included in the general definitions section of the Dallas Building Code as an editorial change. As a means of clarification, the term "covered mall building" is intended to include the covered common pedestrian area, associated "tenant" spaces and attached anchor stores.

The allowable types of construction for covered mall buildings have been limited to Type I, Type II or Type IV construction. This is a departure from the requirements contained in the 1982 UBC. The construction of an unlimited area building used as a covered mall shopping center of Type III or Type V construction, two stories in height (as allowed by the 1982 UBC), is not considered good fire protection practice. Sections of UBC Standard 38-1 allow the omission of sprinklers in certain concealed spaces which may be of combustible construction. Fire loss statistics for sprinklered buildings indicate this as a contributing factor leading to unsatisfactory sprinkler performance. (While Type IV construction is combustible, concealed spaces within the structure are not contemplated.)

For buildings of noncombustible construction (Types I and II) and Type IV construction, the allowable height of a covered mall building is three stories. The use of Type II-N construction for a covered mall building up to three stories in height is consistent with Code Change B-6 and represents a liberalization of the requirements contained in UBC Appendix Chapter 7. This liberalization, as with some of the other less stringent provisions in this proposal when compared to the UBC, are largely based upon the exceptionally good fire experience of fully sprinklered covered mall shopping centers constructed in this manner over the last 20 years.

Because covered mall shopping center buildings may have other attached structures of combustible construction, the provision requiring a public space, street or yard not less than 60 feet in width around the covered mall building is in order. This is also consistent with Code Change B-6 dealing with Section 506(b).

The portion of this code change dealing with smoke control is much less detailed than the requirements contained in the UBC. First, the dependence upon a smoke control system for life safety in a three-story, fully sprinklered building is minimal. The configuration of the covered mall building, i.e., a large open space where visual

communication is provided to facilitate retailing, enhances the occupants' awareness of any fire threat. Also, the control of the fire size by automatic sprinkler protection will minimize the quantity of smoke. This, in conjunction with exit facilities conforming to the requirements of the UBC Appendix, will provide a high degree of safety.

As explained in another section of this report, current code provisions in many of the model building codes dealing with smoke control are more specific than necessary and, in many cases, are not based upon any engineering data. Such is the case with the requirements contained in the 1982 UBC for covered malls. The specification for supply air in the vicinity of the fire may inadvertantly produce conditions which can negatively affect the ability of the automatic sprinklers to control the fire. The performance criteria contained in Proposed Change B-14 will allow evaluation of a smoke control system on a case-by-case basis by the building official, as is current practice.

The requirement for standby power for the public address system, exit signs, emergency lighting and smoke control system, specified in the 1982 UBC, is not included in the proposal for the Dallas Building Code. The provision of emergency power for the public address and smoke control systems is not justified on the basis of fire experience or the expected fire severity in this occupancy. Furthermore, emergency power is not economically warranted as a minimum requirement of the building code. The provisions for exit illumination and illumination of exit signs are adequately addressed in Chapter 33.

The exit provisions dealing specifically with covered mall buildings are essentially the same as those specified in UBC.

Section 714 includes an additional paragraph beyond that included in the UBC Appendix Chapter 7. The intent of the paragraph is to allow other buildings to be attached to a covered mall building, provided they are separated from the covered mall building by an occupancy separation as specified in Section 503. The intent of this section is for the code to allow the construction of multi-occupancy "mega-structures" which are becoming more popular in metropolitan areas. These structures may contain a combination of retail, hotel, and business occupancies in one complex. Numerous examples of such complexes exist accross the United States. The provisions of Section 710 govern the specific requirements applicable to the covered mall portion of such a

structure. It is the intent of this report that all contiguous portions of such a facility be fully sprinklered.

Subchapter 8

Subchapter 8 contains special requirements applicable to educational (Group E) occupancies.

The proposed change (B-15) to Section 802(c) will eliminate the requirement currently in the Dallas Building Code for the provision of one-hour fire-resistive construction for storage and janitor closets in educational facilities which are fully sprinklered. The provision of automatic sprinkler protection in the building will eliminate the need for passive segregation of these rooms from the remainder of the building. The provision of this construction in an educational building which is fully sprinklered would be an unnecessary, redundant feature. Recognition of this principle may be found in the NFPA Life Safety Code which allows automatic sprinkler protection to substitute for one-hour construction required for "hazardous" rooms in institutional occupancies. The principle is also included in the current Dallas Building Code, Section 508, which allows automatic sprinkler protection to substitute for one-hour fire-resistive construction.

Subchapter 9

This subchapter outlines special requirements applicable to "Group H" (hazardous) occupancies.

A revision has been proposed to Table 9-A of the Dallas Building Code which deals with exempt amounts of hazardous materials. Table 9-A is utilized as the basis for classification of a building into the Group H category, depending upon quantities of materials in the building. Table 9-A specifies maximum quantities of flammable liquids, combustible liquids, flammable gases, fibers, solids, unstable materials, corrosive liquids, oxidizing materials, highly toxic materials and poisonous gases which may be allowed in a building. Quantities exceeding these amounts will cause the building to be classified as "Group H," therefore subject to more stringent code requirements. The quantities of materials specified in Table 9-A do not have a unit basis. The allowed quantities of materials apply regardless of building size. For example, the presence of 30 gallons of a Class I-A flammable liquid in a 5,000 square foot building will have the

same impact upon building occupancy classification as 30 gallons of Class I-A flammable liquid in a 100,000 square foot building.

Code Change B-16 represents an amendment to allow the quantities of materials specified in Table 9-A to be utilized on the basis of multiples of a building area of 24,000 square feet. This change is intended to relax the method of classifying a building as a Group H occupancy when provided with automatic sprinklers. It is recognized that many "high technology" industries in the Dallas area utilize processes involving flammable liquids and gases. These processes are generally well controlled from the standpoint of minimizing fire ignitions and fire damage potential.

The 24,000 square foot figure is based upon the largest area currently allowed for a B-2 occupancy in a Type II-N building (assumed to be representative of this occupancy type) which may be built without automatic sprinkler protection. In other words, a Type II-N building having a B-2 occupancy may be built to a size of 24,000 square feet without automatic sprinkler protection while having quantities of materials just under those allowed by Table 9-A. The provision of automatic sprinkler protection is considered a significant enhancement of the fire protection features of the building, for which a doubling of the quantities referenced in Table 9-A are presently allowed. The use of multiples of a 24,000 square foot building area is not considered to represent a hazard greater than that currently allowed by the building code, effectively recognizing the hazard on a unit area basis.

It is not the intention of this code change that allowable quantities of materials referenced in Table 9-A be computed on a per square foot basis. The quantities of materials stored in a building may be stored in a single room in a building or may be stored in various places within the same building.

An additional code change is proposed for Section 901. Code Change B-17 would allow the elimination of the one-hour fire-resistive occupancy separation for vocational shops, laboratories and similar areas in eductional buildings which are fully sprinklered. Again, this represents an equivalency of active fire suppression versus the passive fire-resistance requirements of the current code.

Code Change B-18 is proposed to Section 902(b) which will eliminate the reference to Section 3206 dealing with smoke and heat venting in the Dallas Building Code. As will

be explained later in this report, the current requirements concerning smoke and heat venting are recommended to be deleted from the Dallas Building Code.

Subchapter 12

Subchapter 12 contains specific requirements applicable to residential occupancies. This classification includes hotels, apartment houses and dwellings.

A change (B-19) has been proposed to Section 1204 to allow the elimination of emergency egress window units in buildings of Group R occupancy which are fully sprinklered. Presently, the code requires every sleeping room below the fourth story to have at least one operable window or exterior door approved for emergency egress or rescue. This provision is not required for high-rise buildings and for windows above the fourth floor in low-rise buildings because rescue via windows above the level is either not contemplated or not feasible because of the limitations of fire department equipment. At the present time, this provision applies equally to both sprinklered and unsprinklered buildings. It is interesting to note that the level of safety provided in a high-rise residential building is apparently acceptable for both the sprinklered and unsprinklered conditions, recognizing certain limitations on the number of exits, exit travel distance, corridor protection and building construction, without the availability of emergency escape windows.

The provision of emergency escape windows in buildings less than four stories is an obvious redundancy, mandated because of its feasibility. However, the level of safety in a building less than four stories should be greater than that of a high-rise residential building (all other factors being equal), primarily because of a lesser exit time and the availability of fire department access. The provision of sprinkler protection, in addition to currently required smoke detection for residential facilities, and corridor wall construction, provides the necessary means to ensure, to a high degree, that the conventional exit facilities will be available for egress and provides additional time for exiting.

This code change is not intended to eliminate the requirement for windows in residential buildings, but merely the specially designed windows for emergency egress. The windows themselves represent a further degree of redundancy which is not available in high-rise structures. Fire department access will remain available through

these windows. This change is not intended to allow the provision of bars or grilles on windows which may inhibit such rescue efforts.

The current code provision for the emergency egress windows represents an unnecessary redundancy in the case of residential occupancies which are fully sprinklered.

Subchapter 17

Subchapter 17 of the Dallas Building Code contains general requirements and building construction classification criteria for all building types.

An amendment is proposed to Section 1705(b)5 of the Dallas Building Code (B-20). Section 1705(b)5 presently represents an amendment beyond the requirements of the Uniform Building Code. This section allows the use of nonrated construction for partitions that form a corridor serving an occupant load of 30 or more persons within a single tenant space. Because of the demand for such a relaxation of the requirements of the Uniform Building Code, the City of Dallas has adopted a local amendment to allow nonrated construction under certain conditions. These conditions include allowing nonrated construction if the travel distance in the corridor is less than 75 feet, or, if more than 75 feet, smoke detectors are installed in the corridors arranged to provide an audible alarm within the space. The proposed change to this section would also allow the use of nonrated partitions within a single tenant space if the building is fully sprinklered.

The proposal recognizes the ability of an automatic sprinkler system to extinguish or control fires at their point of origin, greatly minimizing the need for internal building subdivision and the demands upon a building's exiting system. Other code provisions such as exit arrangement, exit travel distance and exit capacity are considered sufficient safeguards to provide redundancy by means of evacuating the fire area in addition to the suppression function provided by automatic sprinklers. This change is consistent with the Basic Building Code and supported by several tests previously discussed in regard to Proposed Code Change B-9.

Code Change B-21 addresses the subject of protection of vertical openings in Section 1706(b). Currently, the Dallas Building Code requires openings into shaft enclosures to be protected by self-closing fire assemblies. An additional exception to Section 1706(b)

is proposed which would allow the omission of fire dampers for openings of shaft enclosures in fully sprinklered buildings (other than Group R, Division 1 or Group I occupancies). This is a proposal based upon the current code text contained in Section 1807(m) which allows the omission of fire dampers (other than those needed to protect floor/ceiling assemblies) in fully sprinklered high-rise business and high-rise residential buildings. This provision is common to all three model building codes for sprinklered high-rise buildings. It has, in some cases, been interpreted to allow the elimination of all fire dampers in a building, other than those which are part of a composite floor/ceiling assembly, i.e., where the ceiling contributes to the fire-resistance rating of the floor.

This concept of omitting dampers from air shaft openings had its origination with the Reconvened International Conference of Fire Safety in High-Rise Buildings, which was sponsored by the General Services Administration in 1971. The concern of fire propagation for a completely sprinklered building was considered insignificant. Also, the physical arrangement of shafts is such that shaft openings on one floor are separated by several feet from openings on the next floor. The possiblitiy of flame propagation even with the remote chance of sprinkler failure through such a mechanism is considered nil.[24] It is also recognized that the use of fire dampers, whose operation will impede air flow, can also be detrimental to the operation of smoke control systems.

Proposed Change B-21 represents a limited extension of this current code provision to other building occupancies for both low-rise and high-rise construction. The provision would not be applicable to Group R, Division 1 or Group I occupancies because of the "defend in place" fire protection approach needed for occupants of such buildings. The provision would allow the elimination of fire dampers in a shaft wall between a rated shaft enclosure and the ductwork serving a particular floor. It does not allow the elimination of fire dampers for floor penetrations of unenclosed ducts, nor is it intended to allow the elimination of fire dampers where ductwork may pass through a rated exit enclosure. (Duct penetrations of exit enclosures are undesirable and should be avoided.)

A proposed amendment to Section 1706(d) concerning elevator shaft venting is presented in Code Change B-22. The requirement for the venting of elevator shafts is also in the ANSI American National Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks (ANSI A-17.1). This proposal will eliminate the requirement to vent elevator shafts to the outside in buildings which are protected throughout

by an automatic sprinkler system. This is an especially useful provision for elevator hoistways which do not extend to the top floor of the building which would require special exterior wall venting by means of fire-resistance rated horizontal extensions of the hoistway.

The venting of elevator shafts has received increased attention in recent years. Attention has focused on the venting of shafts in buildings with respect to their possible influence on the stack effect in a building. Elevator shafts which are vented to the outdoors may contribute to the spread of smoke within a building under certain atmospheric conditions. This possibility has been recognized in the latest edition of the ANSI Elevator Code. Rule 100.4 of the 1981 edition of the ANSI Elevator Code allows hoistways to be provided with a means to prevent the accumulation of smoke and hot gases in case of fire.

The omission of shaft vents is currently allowed by the Standard Building Code for hoistways in certain occupancies which do not extend into the top floor of the building and where the shaft is protected by automatic sprinklers which are arranged to be responsive to both heat and smoke accumulation at the top of the shaft. Such an installation would be considered "partial" sprinkler protection since the remainder of the building need not be sprinklered. The situation involving a fully sprinklered building is obviously more desirable since fires will be controlled at their point of origin, keeping the fire small. In a fully sprinklered building, the quantity and dynamics of smoke is materially reduced, minimizing the need for smoke control in general. In tall buildings where stack effect may be more pronounced, smoke control measures are mandated.

A code change (B-23) concerning atrium buildings has been provided for inclusion in Chapter 17. This verbiage is included as Section 1706(e) for the Dallas Building Code. It is understood that atrium provisions of the 1982 Uniform Building Code have been adopted into the new Dallas Building Code which will be effective January 1, 1983. Nevertheless, this proposed section should be evaluated as an alternate to the language contained in the 1982 Uniform Building Code. The subject of atrium buildings has received considerable attention within the past several years owing to the fact that atrium buildings have become more popular. The requirements contained in the 1982 edition of the Uniform Building Code are, in part, overly redundant, especially when applied to a "low-rise" building containing an atrium. This may be partly the result of the overwhelming influence of the large atrium hotel building upon the building code

community. These buildings are frequently high-rise buildings, and, as a result, many of the provisions applicable to high-rise buildings were included under the section for atrium buildings.

The proposal presented in this report is an amended version of the requirements of Section 1715 of the 1982 Uniform Building Code. Similar to the requirement of the Uniform Building Code, all atrium buildings would be required to be sprinklered in the proposed code change to Section 1706. However, a much broader performance-type statement concerning smoke control is included in the proposal. The Uniform Building Code specifies smoke control requirements for atrium buildings within the body of the code. It is believed that atrium buildings are unique so as to preclude the specification of a particular smoke control system and its operation within the building code. The code change proposal included in this report specifies the need for a smoke control or smoke removal system designed to control the migration of products of combustion. The smoke control or smoke removal system must be "approved" and, therefore, must be acceptable to the building department and fire department on a case-by-case basis. The specification of flow rates, pressure differentials and operating mode within a building code for a complicated building may, in fact, produce undesired results during an actual fire emergency.

The proposal contained in this report does not limit the number of stories which may be open to the atrium space. The requirement contained in the Uniform Building Code, as some of the other model codes, is historically rooted, allowing a maximum number of three stories of communicating floor levels. There is no engineering basis to limit the number of stories of a building which may open onto the atrium space. This architectural feature has been utilized for many years without adverse experience. The atrium sections of at least two current major city codes (Chicago, Illinois and Kansas City, Missouri) do not limit the number of communicating floors in an atrium building.

The proposal specifies a minimum size of floor opening for the atrium building. This minimum size is intended to provide a degree of visual communication between floor levels for occupants of the building as well as to minimize the flue effect of products of combustion which may be transmitted to the upper stories. The larger the floor opening is, the slower the velocity of products of combustion will be through the floor opening. However, an exception is proposed to this requirement which would allow the use of smaller floor openings which can be treated in a more traditional manner. Small floor

openings such as escalator openings have been utilized for many years in fully sprinklered buildings when protected by a draft stop installed around the perimeter of the floor opening at each story in conjunction with close-spaced sprinklers. The draft stop is intended to prevent the rapid movement of products of combustion to the stories above and to facilitate the operation of sprinklers installed around the draft stop, thereby further precluding the transmission of smoke and heat to the story above. This approach is consistent with Section 1706(a) of the 1982 UBC which allows escalator openings for an unlimited number of stories in Group B occupancies to be so protected.

The proposal does not include other specifications contained in Section 1715 of the 1982 Uniform Building Code as they are adequately addressed in the remainder of the code.

A new section is proposed to the Dallas Building Code, tentatively identified as Section 1719, by Code Change B-24. This proposed change would allow limited amounts of low voltage wire to be installed in concealed spaces such as air handling plenums in buildings which are protected throughout with an automatic sprinkler system.

Since 1975, the National Electrical Code has prohibited the installation of low voltage wiring in concealed spaces used for environmental air handling. This requirement was incorporated into many municipal codes because of their reference to the National Electrical Code. The National Electrical Code requires that such wiring be installed in conduit or be of a low smoke producing material. This provision has resulted in a substantially increased cost of installation for these systems. Typically, low voltage wiring in a commercial building would include telephone, data, temperature control, closed circuit television, and fire and security alarm system wiring.

Several municipal codes (e.g., Kansas City, Missouri and Phoenix, Arizona) have adopted local amendments in order to allow limited quantities of low voltage wiring in air handling plenum spaces. The City of Dallas Code, based upon the 1979 edition of UBC, previously allowed limited quantities of low voltage wiring, but this amendment has been lost with the City of Dallas' recent adoption of the 1982 UBC. We believe, however, that this provision of the National Electrical Code presents an unnecessary financial burden on the building community. No significant benefit in the area of improved safety is apparent. Several unpublished fire test reports and studies addressing this subject have demonstrated that the "hazard" created by such installations is negligible.[25]

As a result, we are proposing an amendment to this section to allow limited quantities of low voltage wiring in plenum spaces. The allowable quantity of low voltage wiring would be controlled by the building department on a case-by-case basis. This proposal is consistent with the latest requirement found in the Basic Building Code which allows the building official to permit low voltage cable in sprinklered buildings.[26] As a guide in determining reasonable quantities of allowed material, quantities of material not exceeding a cumulative diameter of four and one-half inches in any given 100 square foot area of the ceiling space should be allowed. (This criteria was included in the earlier edition of the Dallas Building Code.) Additional quantities of the material may be allowed, subject to approval of the building official, when other protective measures are incorporated. This provision can have a substantial impact not only upon new construction, but upon the cost of renovating commercial space on a continuing basis so as to accommodate the relocation of telephones, computer terminals, etc.

Subchapter 18

Subchapter 18 contains requirements for buildings of Type I construction and also includes special requirements applicable to high-rise buildings.

A revision to Section 1806 is proposed in Code Change B-25. This change would allow roof construction and its supporting framing in Type I buildings which are protected throughout by an approved automatic sprinkler system to be of unprotected noncombustible materials. Fire tests have demonstrated that automatic sprinkler protection can provide the necessary fire control, even under the challenging conditions of the Factory Mutual rack storage tests, to prevent unprotected steel from reaching critical temperatures. Since the roof construction does not support an occupied floor above, the need for fire resistance is greatly reduced. Therefore, dependence upon both structural fire resistance and automatic sprinkler protection for that portion of the building is an unnecessary redundant feature.

This philosophy is consistent with the intent of certain code sections which allow the omission of the fire-resistance rating of the roof assembly in Type I and Type II buildings of certain low hazard occupancies when the roof construction is greater than a specified distance above the floor, even in unsprinklered buildings. The philosophy embodied in that code language is in recognition of the larger volume of a space associated with higher ceilings which can dissipate heat and the separation distance

which minimizes the possibility of flame impingement. Automatic sprinkler protection supplements this philosophy by providing an active means of maintaining low temperatures of the air and roof structure and greatly reduces the possibility of flame impingement. Again, the elimination of this fireproofing is only allowed for roof members because of the recognition that structural integrity for the roof of the building is not as critical as construction which supports occupied floors.

Section 1807 of the Dallas Building Code contains special requirements for Group B, Division 2 office buildings and Group R, Division 1 occupancies (hotels and apartment houses) greater than 75 feet in height, otherwise known as "high-rise" buildings. Essentially, this section evolved as a result of several spectacular fires in high-rise buildings occurring in the late 1960's and early 1970's. The fire problem of high-rise buildings constructed since World War II is considered to be greater than that of high-rise buildings constructed prior to this period because of their incorporation of lighter construction materials, the use of exterior curtain wall design, central air handling systems, a diminished degree of internal subdivision and the introduction of certain plastic building construction materials.

The previously referenced fires in these buildings generated a multitude of additional fire protection requirements for high-rise buildings which became cumulative over a period of several years. Most of the additional fire protection features for high-rise buildings can be labeled as "reactive" features as, generally, they do little -- if anything -- to suppress the fire. (The term "reactive" is used since some building systems are not truly passive.) Examples of these requirements include the compartmentation of floors into not less than two areas by fire-resistant partitions, smoke control systems, fire detection systems, voice communication systems, fire department communication systems, public address systems, remote control and status indicators for air handling systems, remote control and status indicators for elevators, standby power, and smokeproof or pressurized enclosures for exit stairways.

Until this year, most model building codes maintained the option of allowing either compartmentation or automatic sprinkler protection for high-rise buildings. Compartmentation may be described as providing, on every floor of a high-rise building, a minimum of two compartments which may be used as areas of refuge should a fire occur in one portion of the floor. These compartments are limited in size, generally between 7,500 and 15,000 square feet in floor area. Presently, buildings which are

equipped throughout with automatic sprinklers are not required to be compartmented. In addition, several of the "reactive" features necessary in compartmented buildings may be eliminated in sprinklered buildings.

Although the design option of "compartmentation" has been included in the model building codes (i.e., Standard Building Code, Uniform Building Code, Basic Building Code) and many locally written codes, there are many communities which mandate automatic sprinklers for high-rise structures and do not recognize any alternative design options. These locally-initiated sprinkler provisions were mandated as a result of several multiple death fires in high-rise buildings and because of the anticipated demands upon the local fire service. Several cities which require sprinkler protection for high-rise office buildings, hotels or apartments are the City of New York, New York; Honolulu, Hawaii; Omaha, Nebraska; Manchester, New Hampshire; Rockford, Illinois; and Denver, Colorado.[27] The membership of the Building Officials and Code Administrators Interntional (BOCA) has recently incorporated a code provision to the Basic Building Code which parallels the sprinkler provisions of the above mentioned cities. This provision to the Basic Building Code recognizes the importance of automatic fire suppression in high-rise structures, other than those of limited height, by eliminating the compartmentation option for "high-rise" buildings greater than 12 stories (or 150 feet). Such buildings are required to be fully sprinklered.

This change to the widely used and recognized Basic Building Code is most notable, but it is not an unprecedented sprinkler mandate by a model code for high-rise structures. The Basic Building Code required automatic sprinkler protection for buildings greater than 12 stories or 150 feet in 1973. This mandatory sprinkler requirement was rescinded in 1978. The code was revised to allow the compartmentation option because, at the time, the membership felt that the compartmentation option represented a reasonable method of providing fire safety. The NFPA Life Safety Code has recognized the problems posed by high-rise buildings, although not discounting alternative design options, specifing only automatic sprinkler protection for high-rise business occupancies since 1976. Similarly, the National Building Code has required automatic sprinkler protection for all buildings greater than 75 feet since the 1976 edition.

As previously stated, the City of Dallas also desires to eliminate the compartmentation option for high-rise buildings. This desire is due to the high demands placed upon the fire service to perform fire suppression and rescue in high-rise buildings as well as a

high probability of failure in the buildings' vertical and horizontal compartmentation (as evidenced by several recent fires). However, since the requirement for automatic sprinkler protection in high-rise buildings was not, until recently, considered a basic element of providing for fire protection, many of the so-called reactive building elements became cumulative and "standard" in high-rise buildings. Few, if any, of the proponents of mandatory sprinklers for high-rise buildings analyzed the aggregate effects of such a code change in order to identify those components of a building which could be reduced or eliminated.

The NFPA Life Safety Code is one code which has maintained a perspective on the interrelation of automatic sprinklers to other building safety featues by not imposing excessively redundant fire safety requirements in addition to sprinklers. As previously mentioned, the Life Safety Code requires automatic sprinkler protection in high-rise business buildings. The Life Safety Code committee responsible for the business occupancy requirements consider automatic sprinker protection as the single most important element that ensures a high level of fire safety and, thusly, have not incorporated detailed alternative requirements.[28]

Multiple story hotels and apartment buildings, although not specifically classified into a "high rise" category in the Life Safety Code, are subject to requirements pertinent to buildings of a high-rise nature (greater than six stories in height). Provisions for smokeproof towers, smoke barriers, horizontal exits or pressurized corridors are mandatory, unless the building is provided with automatic sprinklers.

This Life Safety Code approach, which recognizes the importance of automatic sprinklers and their ability to compensate for other fire safety features, is a primary consideration in the proposed modifications to the high-rise provisions of the Dallas Building Code.

An analysis of sprinkler experience in high-rise buildings in New York City supports this approach and confirms the effectiveness of automatic sprinklers in high-rise buildings. This analysis conducted by the New York Board of Fire Underwriters, is based on data spanning a ten year period (1969-1979). Table 11 summarizes the results of this analysis for sprinklered high-rise buildings.

TABLE 11

NEW YORK CITY HIGH-RISE BUILDING FIRES

1969-1978

No. of Sprinklers Operating	No. of Fires	% of Fires (Cumulative)
1	1,054	64.0
2	308	82.6
3	110	89.3
4	49	92.3
5	31	94.2
6	16	95.1
7	15	96.1
Greater than 7 and Unknown	39	98.4
Total Satisfactory	1,622	98.4
Total Unsatisfactory	26	1.6
Total	1,648	100.0

Source: W. Robert Powers. Sprinkler Experience in High-Rise Buildings (1969-1979). Society of Fire Protection Engineers Technology Report 79-1. Boston, MA. 1979.

The table indicates that a high percentage of fires are controlled by relatively few sprinklers. Of 1,648 total high-rise fires, 1,622 fires (98.4 percent) were satisfactorily controlled. Twenty-three of the 26 unsatisfactory incidents are attributed to closed valves. Electrical supervision of sprinkler valves (a monitoring function to provide an alarm upon an impairment of the system) required by the Dallas Building Code will substantially reduce this cause of unsatisfactory performance.

The intent of the changes to the current requirements of Section 1807 of the Dallas Building Code is to eliminate unnecessary, redundant requirements relating to fire protection, assuming the building is to be fully sprinklered in accordance with UBC Standard 38-1. Accordingly, many of the features which became "standard" for high-rise buildings in the early 1970's, prior to mandatory requirements for automatic sprinkler protection, are proposed to be eliminated. The proposed changes to the Dallas Building Code parallel the progressive approach of the 1980 Kansas City (Missouri) Building Code. The Kansas City Building Code incorporates modifications to the 1979 UBC to encourage the construction of sprinklered buildings by eliminating certain redundant fire safety features.

The resulting requirements contained in these proposed code changes represent those features necessary to provide a high degree of fire safety in high-rise business and residential buildings. Although the provision of automatic sprinklers minimizes and eliminates the need for other high-rise safety features, special consideration is nonetheless given to other safety elements such as occupant movement, control of smoke, alarms, communication, elevator operations and fire department operations.

In Code Change B-26, the text has been amended to delete the option for compartmentation in high-rise Group B, Division 2 and Group R, Division 1 buildings. The references to seismic zones included in paragraph (c) of Section 1807 have been deleted as they are not applicable in the City of Dallas. The requirement for a separate control valve and waterflow device for each floor of a high-rise building, as included in paragraph (c) of Section 1807, remain as previously required. However, it should be understood that this requirement should not preclude the use of other sprinkler system designs which, in conjunction with other methods of identifying the location of the fire floor, meet the intent of this requirement.

Paragraph (d) of Section 1807 has been amended so as not to require redundant protection in mechanical, electrical and similar equipment rooms which may be protected by automatic sprinklers. Automatic sprinkler protection is considered to be a superior method of protecting such equipment rooms. It is the intent of the requirement for fully sprinklered buildings that these rooms be so protected. Therefore, the requirement for a smoke detector in these rooms would be redundant.

Additional wording is included in paragraph (d) to identify the desired function of the smoke detector located in the main return and exhaust air plenum of each air conditioning system. An exception is included allowing the elimination of these smoke detectors if the control of the air handling units and dampers needed to prevent the recirculation of smoke is actuated by automatic sprinkler waterflow. In any case, controls allowing the manual restarting of air handling equipment during an alarm condition are to be required. This requirement is intended to allow the fire department to manually restart air handling equipment to assist in the removal of smoke after the fire has been controlled.

The current requirement for the provision of a smoke detector at each connection to a vertical duct or riser serving two or more stories has been deleted as it is considered to represent an unnecessary, redundant feature which will be provided by automatic sprinkler waterflow. In most cases, it is contemplated that the building's fire alarm system will be actuated by the automatic sprinkler waterflow function, as opposed to the actuation of a duct-mounted smoke detector, because of the large quantity of smoke needed to actuate a duct-mounted smoke detector as a result of the dilution factor in the air handling system.

A rewritten paragraph (e) concerning the required alarm and communication systems in a high-rise building is included in Proposed Code Change B-26. The proposal includes a requirement that an approved automatic fire alarm system be provided in all buildings. It also includes a requirement that an approved voice communication system be provided in all high-rise buildings. The intent of the voice communication system included in the proposal is that at least one-way voice communication can be provided to all areas of a building from the central control station upon arrival of the fire department or, if available, by trained building personnel. Speakers are not required to be installed in such areas as dwelling units or guest rooms, unless the circumstances necessitate their installation in order that communications can be heard. Two-way systems are permissible, however, the use of such systems have been identified as a potential detriment from the standpoint of eavesdropping and "bugging."[29]

Operation of the building's automatic fire alarm system is required to transmit a fire alarm signal to a constantly attended location, either on the premises or at an approved central or remote station alarm receiving facility. The automatic operation of a general building alarm is not required or recommended. It is not considered advisable or necessary to automatically alert the occupants of a high-rise building of a fire which is being controlled or extinguished by automatic sprinklers. The use of such systems in an unskilled, uncontrolled or incomplete manner have resulted in confusion and ineffective occupant control as evidenced by a 1975 fire incident in the World Trade Center where occupants ignored voice directions and in an evacuation excercise conducted during 1971 in a 29-story office buildings.[30,31]

The use of pre-recorded voice messages to direct building occupants as currently required by the code may actually direct building occupants into an area of increased danger under certain circumstances by providing incomplete and ambiguous information. The psychological effects of pre-recorded messages are not known and the practical application of such messages has been questioned by Glass and Rubin.[32] However, if it is necessary to alert the occupants to either move to an alternate floor, or, to leave the building, the one-way voice communication system is available for use by trained personnel. For these reasons, the use of a pre-recorded voice alarm system, as currently required by the code, is not recommended and has been deleted. The voice communcation system specified in proposed Section 1807(e) essentially fulfills the requirements for the public address system which is included in the current Dallas Code.

The requirement in the Dallas Code for a fire department communication system is not warranted as fire department personnel utilize their own portable two-way communication equipment.

Paragraph (f) of Section 1807 has been revised to reflect the equipment being proposed for high-rise buildings. References to the voice alarm and public address system have been deleted and replaced by a reference to the voice communication system. Reference to the fire department communication system control panel has been deleted.

The requirement for control of the elevators in the central control station has been deleted. The elevator code currently requires manual recall capability of elevators at each local elevator bank. The requirement for remote control of the elevators in the central control station is an unnecessary redundancy and may also cause personal injury.

The requirement for status indicators and controls for air handling systems in the central control station is considered an unnecessary redundancy. The dependence upon the remote control of the air handling system in a sprinklered building is greatly minimized. During post-fire mop-up operations, fire department personnel can manually control air handling systems on the floor in which they are located. Similarly, the requirement to provide controls and status indicators for standby power in the central control station is considered an unnecessary redundancy and, in fact, may be hazardous to personnel in the vicinity of the standby power generator. It is sufficient to operate the standby power generator locally, as is normally provided.

The requirements for smoke control in a high-rise building have been simplified. The proposed modifications reflect the fact that all buildings will be required to be sprinklered. This approach is similar to Measure A of the Canadian National Building Code (one of 14 high-rise design options) which requires only minimal measures for smoke control. Measure A is particularly noteworthy from the standpoint that cold weather conditions in Canada create physical conditions which are significantly more conducive to smoke movement in buildings than the more moderate climate of Dallas. The NFPA Life Safety Code also recognizes the value of automatic sprinkler protection as a substitue for smoke control measures, and exempts various occupancies from requirements for smokeproof towers, smoke barriers and pressurized corridors when the respective building is protected by sprinklers.

Three optional methods are proposed to provide smoke control in a high-rise building. First, windows or panels which are manually openable from within the fire floor may be provided, as allowed in the current Dallas Building Code. However, an amendment has been added to this section which specifies that at least one openable window or panel shall be provided in each dwelling unit or hotel guest room in Group R, Division 1 occupancies. Under the current Dallas Building Code text, it is conceivable that the openable windows or panels can be provided along the building perimeter in compliance with the code, but may not serve to ventilate all portions of the building, especially one which is inherently subdivided, such as a Group R, Division 1 occupancy. The additional language will assure that each dwelling unit and guest room has at least one openable panel for the purpose of smoke control if this method is elected.

A second option in the design of the smoke control for a high-rise building utilizes the mechanical air handling system. A performance statement has been included in

this option which will assist in evaluating other methods which may be elected under Option 3. The requirement to provide a minimum of one exhaust air change for each ten minutes has been deleted. It is intended that the building's mechanical air handling system be utilized at its maximum exhaust potential to create a relatively negative pressure on the fire floor. This is considered sufficient to prevent the spread of smoke to other floors in dangerous quantities. Also, the movement of large quantities of air in the fire area may negatively affect fire control.

The intent of such a system is solely to prevent the uncontrolled spread of smoke to other floors of the building, not to provide a smoke-free environment on the fire floor. Utilizing a building's conventional HVAC equipment to create necessary pressure differentials for the control of smoke can be easily accomplished and has been successfully field tested.[33] This section has been amended to further require that the system be manually operable (by the fire department) and that its status (mode) be readily distinguishable to facilitate control by the fire department.

As previously stated, Item 3 under paragraph (g) for smoke control allows the option for any other approved design which will produce equivalent results per the performance criteria specified in paragraph 2.

Paragraph (h) of Section 1807 has been amended. The first amendment constitutes an editorial clarification of the text. The second amendment deletes the requirement for elevator lobbies in high-rise buildings. This requirement apparently resulted from several recent high-rise fires in which the elevator shaft was implicated in the spread of smoke throughout the building. The requirement for the elevator lobby is intended to minimize the mechanism for the spread of smoke via the elevator shaft. As previously discussed, both the quantities and dynamics of smoke in a fully sprinklered building are considered to be significantly different from that in an unsprinklered building. (The fires which led to this requirement were in unsprinklered buildings with, in some cases, multiple code violations.) The requirement for an elevator lobby presents a severe hardship upon the function of a building and should only be required if it is a vital element to provide for the safety of the occupants. Fire loss statisics for fully sprinklered buildings without elevator [illegible] indicated that there is a problem with the spread of smoke. Therefore, there is no need to provide an elevator lobby as a minimum requirement of the code.

The section on elevators has also been revised to allow an option to provide automatic elevator recall to the main floor by means of an interlock with the building's fire alarm system. This allows the use of sprinkler waterflow to achieve automatic elevator recall. This is considered a superior method as it minimizes the false alarm problem common in many hotel buildings and can provide a faster method of activating this function for the majority of cases where fires originate in areas other than the lobby itself.

The requirements not to vent the elevator shaft through the elevator machine room and to provide special measures to prevent smoke from entering the elevator machine room have been eliminated. With the elimination of the requirement of elevator shaft venting, there is no longer a demand on the venting of the elevator shaft through the elevator machine room. In addition, because there is no natural flue action, the tendancy of smoke to enter the elevator machine room will be greatly minimized. Therefore, special precautions need not be taken. The section concerning elevator car size has been deleted from Section 1807 as it is already included in Chapter 51 dealing with elevators.

Paragraph (i) of Section 1807 has been amended to delete the emergency power requirements for the smoke control system. In a fully sprinklered building, the smoke control function is considered tertiary in providing for the safety of building occupants. The requirement to provide standby power for the smoke control function is not cost beneficial. The probability of a simultaneous fire and power failure is extremely low. In addition, it makes the choice between providing passive smoke control (openable windows) versus smoke control by the mechanical system a less desirable option. The use of the mechanical system in providing for smoke control is considered superior to the provision of openable panels or breakable windows and, therefore, should not be penalized.

The provision of standby power for fire pumps is proposed to be required only in buildings greater than 150 feet in height. The provision of emergency power for a fire pump adds considerable size to the building's emergency generator. Therefore, its benefit must be carefully analyzed. Buildings less than 150 feet in height are able to be evacuated in a reasonable amount of time. Even with the unlikely failure of the sprinkler system because of a lack of power, the building occupants will not be endangered. As identified in the discussion of the code changes proposed to Chapter 5,

the proposed allowable construction modifications still contain a reasonable degree of redundancy in providing for the structural integrity of a building even if the sprinkler system is out of service. Yet, the provision of emergency power for the fire pump in buildings where occupants may need to remain in the building is considered justifiable when taken in the context of all proposed code changes.

The requirements in paragraph (j) of Section 1807 concerning exits have been amended to eliminate the requirement for a telephone or other two-way communication system at every fifth floor in the stairway enclosure. This equipment is not necessary for providing for the life safety of building occupants in a fully sprinklered building. It is merely a convenience feature and should not be a minimum requirement of the code. The verbiage concerning smokeproof enclosures in paragraph (j) has been eliminated as well as the reference to pressurized stairways. The spread of smoke in a fully sprinklered high-rise building and its effects upon the building exiting system are expected to be minimal given the lesser quantities of smoke generated in a controlled fire, the lower temperatures expected in a fire controlled by automatic sprinklers and the automatic shut-down of air handling equipment in the affected area. The reliance upon the exiting system in a sprinklered building is reduced by the ability of the sprinkler system to control fires at their point of origin.

As previously stated, paragraph (k) concerning seismic zones has been eliminated from Section 1807. Similarly, paragraph (l) concerning the compartmentation option for high-rise building design has been eliminated.

The requirements formerly contained in paragraph (m) of Section 1807 have been incorporated into other portions of the code, if applicable for sprinklered buildings.

Subchapter 19

Subchapter 19 contains requirements for buildings of Type II construction and refers to Section 1807 for high-rise buildings which may be built under this construction classification.

A change has been proposed (B-27) to allow the roof construction of a Type II fire-resistive building to be of unprotected noncombustible construction. The rationale for this proposal is similar to that in the proposal for Section 1806 (Code Change B-25), previously discussed.

Code Change B-28 is an amendment to the exception contained in Section 3205(b) which would allow a combustible attic space to be undivided, provided that the entire building, including the attic space, is equipped with automatic sprinklers. The value of automatic sprinklers in limiting a fire to the area of origin is equivalent to the level of protection specified in the requirement for the subdivision of attic spaces in unsprinklered buildings so as not to exceed 3,000 square feet. The present code language includes an exception for attic spaces which are sprinklered. The present exception allows the undivided attic space to be up to 9,000 square feet.

Fire experience shows a leading cause of attic fires is by way of fire spread into the attic space from the occupied space below. In the case of a fully sprinklered building, the probability of a substantial fire overtaking sprinklers installed in the attic is greatly minimized. Therefore, the requirement for attic subdivision in a fully sprinklered building is recommended to be deleted. This proposal is consistent with the requirements of the Basic Building Code, which also allows the omission of draftstopping where sprinkler protection is provided in the general building areas and the combustible concealed attic spaces.

Code Change B-29 concerns Section 3206 of the Dallas Building Code, Smoke and Heat Venting. The subject of smoke and heat venting in sprinklered buildings, particularly sprinklered storage buildings, has received considerable attention in recent years. In the late 1960's, the Rack Storage Fire Protection Committee conducted a series of full scale fire tests for the storage of combustible materials in racks. All of the data developed by the Rack Storage Fire Protection Committee was subsequently turned over to the NFPA Committee on Rack Storage of Materials. The NFPA committee developed NFPA Standard 231C which was first adopted by the NFPA in May, 1971. Additional test data, the result of an on-going test program, has been incorporated into NFPA 231C since the standard was first adopted.

Certain tests included in the rack storage test program indicated an adverse affect upon the ability of an automatic sprinkler system to control the fire. When venting was introduced into the test facility, an increase in the number of sprinklers operated, an increase in sprinkler system water demand, an increase in commodity damage, and an increase in roof steel temperatures were noted. NFPA Standard 231C-1980 identifies

the fact that design densities incorporated into the standard are based upon roof vents and draft curtains not being used.

A model study conducted by Factory Mutual Research Corporation indicated that smoke and heat vents in sprinklered buildings caused a 35 percent increase in sprinkler water demand, possibly overtaxing the water supply. These tests also demonstrated a 66 percent increase in fuel consumption (fire damage) while providing only a marginal improvement in the delay of the loss of visibility in the test facility.[34] The Factory Mutual test corroborates information obtained in the Rack Storage Committee fire tests.

An industry-sponsored series of tests was conducted by the Illinois Institute of Technology Research Institute in 1981 for the purpose of quantifying the relationship between automatic sprinklers and automatic smoke and heat vents. The results of the test were inadequate to provide a general conclusion, but it was apparent in the test program that venting provided no significant benefit in fire control or fire fighting techniques in a fully sprinklered building.

Therefore, given the probability of increased fire damage coupled with a lack of information showing tangible benefits of providing automatic smoke and heat vents in a sprinklered building, the requirement to provide automatic smoke and heat vents in a fully sprinklered building is being recommended to be deleted.

Subchapter 33

Subchapter 33 of the Dallas Building Code contains specific requirements for exits, stairways and the calculation procedure for determining the occupant load (number of persons) for the purpose of designing exit facilities.

Proposed Code Change B-30 represents an amendment to the procedure utilized to determine the number of required exits for any given story of a building. At the present time, the number of exits for any story of a building is determined by calculating the occupant load of that story plus 50 percent of the occupant load in each adjacent story, if any, plus 25 percent of the occupant load in the story immediately beyond the first adjacent stories. The method of determining occupant load in the Uniform Building Code is unique in this respect. Other building codes only require the

calculation of the number of occupants for a given story with no allowance for occupants on other adjacent stories to be included, except in those cases where simultaneous exiting is contemplated or where exits from other floors converge at an intermediate floor.

Use of the occupant load calculation procedure outlined in the Uniform Building Code may, in some cases, place a unreasonable demand to provide exit facilities on a given level, as will be discussed further in the following code change proposal.

Nevertheless, the use of this procedure to determine the number of exits for a story can place an unreasonable demand upon the configuration of a building and its associated cost. Of particular interest is the fact that the occupant load for a given story as calculated per the procedure outlined in the UBC may never be realized in most situations where the occupants are merely passing "through" a floor in an exit enclosure without discharging upon that floor. It is conceivable that the floor under consideration may be required to have additional exits for a theoretical occupant load which will never exist.

In order to relieve the potential burden of providing additional exit facilities in sprinklered buildings, an exception is proposed to the calculation procedure which exempts sprinklered buildings from complying with the requirement to determine the number of exits on the basis of the cumulative loading formula. The number of exits required for a given story in a fully sprinklered building will be determined solely by the number of occupants on that story. An exception is provided, however, for the floor serving as the level of exit discharge which would have its number of exits determined in the traditional manner.

As previously mentioned, the occupant load calculation procedure used to determine exit width may place an unreasonable demand to provide exit facilities on a given level. The exit width currently required for a given level of a building is based on the number of people expected to be on a floor plus 50 percent of the first adjacent story above (and below, if applicable), and 25 percent of the story immediately adjacent to the first adjacent story. The number of expected people on a level is generally determined from the building code's occupant load factors which quantify the projected square foot area for each person of a particular occupancy or use. Multiplying the square foot areas by the associated occupant load factors results in the number of expected occupants for a

particular level of a building. Again, adding the cumulative effects of the adjacent floors results in the number of people for which exit width must be provided on that floor.

For example, consider a four-story office building with each level having 30,000 square feet of floor area. The occupant load factor given for office occupancies is one person per 100 square feet of floor area. Multiplying the floor area by the occupant load factor (30,000 x 1/100) results in a anticipated occupant load of 300 persons per floor level. The width in feet of exits required for the fourth floor is calculated by dividing the calculated occupant load by the number 50 (one foot of exit stair or door per 50 persons is the determining factor for exit width in the Uniform Building Code). This calculation results in six feet of required exit width for the occupant load of the fourth floor.

The preferred method of exiting for this type of building is via stairways. Since the code requires a minimum of two stairs at a minimum design dimension of 44 inches, a total exit width of seven feet, four inches will be provided for the fourth floor. To calculate the exit width for the third floor, a percentage of the fourth floor occupant load is required to be added into the third floor occupant load. The code requires 50 percent of the first adjacent floor (fourth floor) to be added to the third floor occupant load. The result of this addition, 450 total persons, is the number of occupants for which exit width must be provided. Dividing 450 persons by 50 gives a total exit width of nine feet, which must be provided for the third floor of the office building. Unlike the fourth floor, two minimum dimension stairways will not provide adequate exit width, necessitating either adding a stairway, increasing the size of the two stairways which descend from the fourth floor, or providing a two-hour fire separation for horizontal exiting purposes.

Exit width required for the second floor is based on the second floor's actual occupant load plus 50 percent of the third floor occupant load and 25 percent of the fourth floor occupant load. The exit width and number of exits required by the current provisions of the code for the second floor and those other floors of this example are summarized in Table 12.

TABLE 12
EXAMPLE OF CURRENT AND PROPOSED EXIT REQUIREMENTS

EXITS REQUIRED BY **CURRENT** CODE
FOR EXAMPLE SPRINKLERED OFFICE BUILDING

Floor	Number of Occupants	Number of Occupants Plus Required Percentage of Floors Above	Total Feet of Exit Width Required	Number of Exits Required
Fourth	300	300	7.3(6.0)*	2
Third	300	450	9.0	2
Second	300	525	10.5	3
First	300	525	10.5	3

EXITS REQUIRED BY **PROPOSED** CODE
FOR EXAMPLE SPRINKLERED OFFICE BUILDING

Floor	Number of Occupants	Number of Occupants Plus Required Percentage of Floors Above	Total Feet of Exit Width Required	Number of Exits Required
Fourth	300	300	7.3(6.0)*	2
Third	300	300	7.3(6.0)*	2
Second	300	300	7.3(6.0)*	2
First	300	300	6.0	2

*Minimum required stair width is greater than actual calculated width shown in parenthesis.

This four-story office building example is an over-simplification provided to illustrate the basic application of these current exit requirements. As evidenced in the table, the number of exits and the size of exits can be materially affected by the occupant loads of other floors. In buildings housing occupancies with greater anticipated populations, such as assembly-type occupancies, the percentage increments can dramatically increase the number of exits and exit width. This, of course, results in loss of available floor area as more or larger stairways must be installed and also may inhibit a building design by necessitating the use of horizontal exits. Code Change B-31 proposes to modify the exit width calculation procedure to permit the calculation of exit width capacity without considering the cumulative effects of adjacent floors. This proposed procedure is only to be applicable for buildings fully protected by automatic sprinklers, but will still require the percentage effects of adjacent levels to be considered for those floors into which occupants from other levels discharge. For an exit in a sprinklered building that discharges into another floor level, the level where the discharge occurs will be subject to the present code provisions for determination of exit width. The exit width for all other stories of sprinklered buildings, need be provided only for the number of occupants expected on that level. In the previous example, the stairways of the office building need be only wide enough to serve the 300 occupants of each floor. (See Table 12.) This permits the use of two 44-inch wide stair exits. Proposed Code Change B-31 has the effect of indirectly allowing an increase in exit capacity for the provision of automatic sprinklers in buildings where cumulative loading now is required.

This proposed change, which precludes cumulative loading in sprinklered buildings, will result in exit designs closely resembling designs that would result from the application of other codes. The majority of buildign codes do not consider cumulative loading (except where floor levels openly communicate). To understand the similarities between the codes, this report will briefly compare the exit capacity factors and design requirements of the Uniform Building Code with the design criteria of several other codes.

The Basic Building Code and Chicago Building Code are noted for crediting exit facilities in sprinklered buildings with [illegible] The Life Safety Code also permits additional capacity credit in health care occupancies. Unlike the Uniform Building Code, the Basic Building Code, Standard Building Code and NFPA Life Safety Code all base exit capacity on a 22-inch unit of exit width and factors which

specify the number of persons per 22-inch unit that can be accommodated by exit facilities. The 22-inch unit of exit width, which is used in all but the Uniform Building Code, represents the medium width of the human body at shoulder height. The Uniform Building Code's exit capacity factor is one foot of required exit width for every 50 persons of occupant load. This factor implies an exit capacity of 100 people per 24 inches of exit width. Based on the 22-inch exit system utilized by other codes, this factor translates to an exit capacity of approximately 92 people per exit unit. This compares favorably with the exit capacity factors stipulated by the Basic Building Code for sprinklered buildings as well as the Life Safety Code and Standard Building Code which do not differentiate between sprinklered and unsprinklered occupancies. The factors of these codes and the Uniform Building Code are shown in Table 13 for comparison purposes.

The capacity factor of the Uniform Building Code is nearly equal to the capacity factors of the Basic Building Code for stairs and is more conservative than that allowed for level travel. The capacity factors of the Life Safety Code and the Standard Building Code do not distinguish between sprinklered and unsprinklered buildings (except as noted). However, application of a 50 percent increase for sprinklered buildings, as permitted by the Basic Building Code would result in capacity factors almost identical to those found in the Basic Building Code. Even without such an allowable increase, the Uniform Building Code's capacity factor, 92 persons per unit of exit width, is slightly more conservative than either the Life Safety Code or Standard Building Code factors of 100 persons per unit for level travel.

The differences between the Uniform Building Code, the Life Safety Code and Standard Building Code for stair travel are more significant. The Life Safety Code and Standard Building Code stairway capacity factors of 60 and 75 persons per unit are more conservative than the Uniform Building Code capacity of 92. This difference is not as significant a factor as it may appear. In the design of exits for buildings, the factors controlling the width of exits will often be the minimum dimensions required for stairs and doors. This is particularly true where the location of exits is dependent on travel distances rather than upon occupant loads. All three of the model building codes and the Life Safety Code require basic minimum dimensions of 44 inches for stairways and 32 inches of unobstructed doorway. Referring again to the office building example, application of the proposed exit capacity requirements results in equivalent dimensions of stairs and doors as would be derived from application of the Life Safety Code, the Basic Building Code or Standard Building Code. This result is due to the minimum dimension requirements common to the codes.

TABLE 13
EXIT CAPACITY FACTORS OF THE MODEL CODES FOR SPRINKLERED BUILDINGS
(PERSONS PER 22-INCH UNIT OF EACH EXIT WIDTH)

	Uniform* Building Code		Basic** Building Code		Standard** Building Code		NFPA Life** Safety Code	
	Stairs	Level Travel (Corridors, doors, ramps, etc.)	Stairs	Level Travel (Corridors, doors, ramps, etc.)	Stairs	Level Travel (Corridors, doors, ramps, etc.)	Stairs	Level Travel (Corridors, doors, ramps, etc.)
Assembly	91.7	91.7	113	150	75	100	75	100
Business	91.7	91.7	90	150	60	100	60	100
Factory/Industrial	91.7	91.7	90	150	60	100	60	100
Educational	91.7	91.7	113	150	75	100	60	100
Mercantile	91.7	91.7	90	150	60	100	60	100
Storage	91.7	91.7	90	150	60	100	60	100
Residential	91.7	91.7	113	150	75	100	75	100
Institutional/Health Care	91.7	91.7	33	45	35	45	35	45

*Exit capacity is based on 1 foot of exit width for 50 persons of occupant load. Credit given for any dimension of exit width.

**Exit capacity is based on a unit of exit width of 22 inches with 12 iches or more considered as ½ unit in addition to one or more units.

The exit capacity factors for the other model codes listed in Table 13 for institutional/health care occupancies, are much more conservative than the criteria of the Uniform Building Code. While this might be of some apparent concern, there is no record of adverse experience of exit designs based on the Uniform Building Code requirements and, therefore, no change is contemplated in the capacity factor as it relates to institutional/health care occupancies. Reliance for fire safety in institutional/health care occupancies is more dependent on the "defend in place" features (smoke partitions, sprinklers, compartmentation) stipulated by the code, than exits. This is in recognition of the lack of physical and mental capabilities of institutional occupants. Also, due to the intensity of regulation of the health care industry by state, governmental and private entities, including the Texas Department of Health, U.S. Department of Health and Human Services, and the Joint Commission on Accreditation of Hospitals, institutional/health care facilities are usually subject to the more conservative requirements of the NFPA Life Safety Code.

Code provisions governing the capacity of means of egress are intended to assure that exits can adequately accommodate expected occupant loads during fire emergencies. In an unsprinklered building, an uncontrolled fire situation can cause an exiting response from the occupants of several adjacent floors. The cause of such movement will either be initiated by the physical observation of smoke and flame on the part of building occupants or by activation and sounding of alarm signals on other floors. In a building protected by automatic sprinklers, the sprinklers serve to stop the growth of the fire and thus limit the development of smoke and flame propogation which may otherwise require occupant movement. The ability of automatic sprinklers to defend occupants in place minimizes the need to anticipate occupant movement from floors other than the fire floor of a building.

A comprehensive review of technical literature by Stahl, Crosson, and Margulis has identified substantial evidence indicating that audible alarm signal systems are of questionable effectiveness in arousing egress behavior.[35] This further supports the supposition that simultaneous exiting will not occur, even where alarms are provided. With the exception of institutional/health care occupancies, the proposed requirements for the design of exits will closely parallel the requirements of other codes and will, in many cases, remain more conservative.

The Uniform Building Code is the only major model code which provides definitive requirements for separation of exits. Up to and including the 1949 edition of the Uniform Building Code, exits were required to be located as remote from each other as practicable to minimize the possibility that both may be blocked by fire or other emergency conditions. This provision parallels the present provisions of the NFPA Life Safety Code, the Basic Building Code and the Standard Building Code. Following the 1949 edition of the Uniform Building Code, the exit separation provisions were changed to require a minimum distance between exits not less than one-fifth of the perimeter of the building or area served. In the early 1970's the one-fifth perimeter basis was changed to require the distance between exits to be not less than one-half of the length of the maximum overall diagonal dimension of the building or area to be served. Up until the adoption of the 1982 edition of the Uniform Building Code, the City of Dallas maintained and enforced the one-fifth perimeter rule. The requirement found in Section 3302(c) of the 1979 Dallas Building Code is applicable where only two exits are necessary and is intended to assure a measurable degree of exit separation. Where more than two exits are required, a definitive minimum separation of additional exits is not specifically stated and only a reasonable separation is required to be provided.

Designers generally prefer the use of the performance-oriented exit requirements found in the other model codes. However, the lack of a specific requirement results in variable interpretations. To prevent variable interpretations and potential inadequacies in the design of exits, but also differentiate between the risk potential of unsprinklered and sprinklered buildings, the definitive nature of Section 3302(c) is retained, but modified by permitting a 50 percent reduction in the required separation distance. The one-fifth perimeter requirement, as stated in the 1979 Dallas Building Code is proposed to be applicable to unsprinklered buildings only and a one-tenth perimeter concept would be applicable to buildings protected by automatic sprinklers. As of 1983, the City of Dallas has adopted the 1982 edition of the the UBC which utilizes one-half of the diagonal concept. Although this method of defining adequate exit separation differs from the 1979 Dallas Building Code, the intent of Code Change B-32 remains unchanged. A 50 percent reduction of the required exit separation is similarly recommended for sprinklered buildings subject to 1983 code provisions. Based on the 1983 UBC requirements, one-fourth of the diagonal concept would result as the criteria for determining separation distance in two-exit building designs.

The premise for allowing this reduction considers the ability of automatic sprinklers to limit a fire to the area of origin. The potential of fire precluding the use of one exit is a fundamental assumption related to exit design. In unsprinklered buildings where two exits are not remotely located, the potential for an uncontrolled fire to block at least one exit, and possibly both exits, is significant. Automatic sprinklers provided to control and limit the spread of fire minimize the probability of a single exit blockage and almost negates any probability of a fire blocking two exits simultaneously.

The exit travel distance requirements of the Dallas Building Code are currently uniform for all occupancies. Section 3302(d) of the Dallas Building Code limits the distance of travel from any point to 150 feet in an unsprinklered building. The travel distance limit in buildings protected by automatic sprinklers is 200 feet. Code Change B-33, which modifies Section 3302(d), is relatively minor and essentially maintains the current criteria of the code for all but three occupancy classifications. The proposed code change will allow a travel distance of 300 feet in the following three occupancies when protected by automatic sprinkler systems: Group B-2 occupancies (except wholesale and retail stores), Group H-2 occupancies, Group H-3 occupancies. The additional 100 feet of travel distance allowed for these occupancies is basically consistent with the travel distance limitations of the Basic Building Code which stipulates 300-foot travel limits for business, factory, industrial and storage type occupancies. The change is also consistent with the Life Safety Code which permits maximum travel limits of 300 feet for sprinklered business occupancies and up to 400 feet travel distance for storage and industrial buildings.

The provisions for the design of exits in buildings generally prohibit various rooms from serving as exit routes. Section 3302(e) of the Dallas Building Code contains such a requirement which disallows exit passage through kitchens, store rooms, rest rooms, closets and similar spaces. Code Change B-34 amends this requirement allowing exits to pass through kitchens or store rooms in buildings having an approved automatic sprinkler system. Allowing exiting through kitchens or store rooms as a secondary exit route is not considered to pose any unusual risk to occupants than would be posed by egress through other available egress routes. In the event of fire, it is expected that occupants will normally move away from the fire occurrance. The provision of automatic sprinklers will compensate the elimination of an exit route that may result from a fire in a kitchen or store room. Automatic sprinklers provided to suppress and limit a fire will afford the additional necessary time for occupants to

utilize alternate exit routes. The prohibition of exiting through rest rooms, closets and similar spaces will remain applicable. The use of such small rooms for exit routes, some of which are subject to locking, is not consistent with recognized engineering practice.

Another requirement in the Dallas Building Code which concerns the arrangement of exits and is proposed to be modified is the requirement of Section 3304(e) which limits the length of a dead-end corridor. A dead end, as stated in the NFPA Fire Protection Handbook, is an extension of a corridor an aisle beyond an exit or an access to exit that forms a pocket in which occupants may be trapped. People may become trapped in a dead-end corridor in one of two ways. People who occupy the dead-end corridor area could be trapped by the fire or smoke which occurs between them and the point at which a choice of travel is available. The other possibility is that people moving within the corridor system could enter a dead-end and become confused under smokey conditions or be trapped by a spreading fire. Dead-end corridors are an undesirable feature, but for purposes of design freedom and effective space arrangement, dead ends are permissible within reasonable limits.

Building Code Change B-35 amends Section 3304(e) of the Dallas Building Code allowing an increase in the maximum dead-end length of to 50 feet for Group B, Division 2 occupancies which are protected by automatic sprinkler systems, and 30 feet for Group I, Division 1 occupancies, which are similarly protected. This change represents an increase from the current code requirement of 20 feet. Since the existing requirement does not differentiate between buildings protected by automatic sprinklers and buildings not so protected, it is considered reasonable to permit an increase under the circumstances where sprinkler protection is installed. The 50 foot limit and 30 foot limit proposed for sprinklered B-2 and I-1 occupancies is permitted by the NFPA Life Safety Code in unsprinklered mercantile, industrial, and business occupancies (which are the equivalent of the B-2 classification) and unsprinklered health care occupancies which is basically the equivalent of the I-1 classification.

The next change, B-36, proposed to the Dallas Building Code is rather significant and could result in substantial cost savings for occupancies [illegible] corridor designs. Code Change B-36 proposes to exempt sprinklered buildings from the provisions of Section 3304(g), which requires walls of corridors serving more than 30 occupants to be of not less than one-hour fire-resistive construction and ceilings of

corridors to be constructed of materials required for one-hour fire-resistive floor/ ceiling assemblies. This particular code change is a companion change to Proposed Code Change B-8 which has been previously discussed and Proposed Code Change B-39 which is specifically applicable to educational occupancies. In order to avoid redundant explanations of these three proposed code changes, the following discussion will serve as a final discourse on the topic of corridor separations.

Essentially, the corridor provisions of the Dallas Building Code require corridors serving 30 persons to be enclosed by one-hour fire-resistive construction. Associated with this requirement is the additional provision for self-closing 20 minute fire-resistive rated corridor doors (with gaskets) and fire dampers in duct work having openings into the corridor. The intent of the corridor enclosure requirements is to maintain the integrity of the corridor and prevent smoke and flames from blocking the exit access route. The use of passive fire-resistive features, such as doors, walls, ceilings and dampers to maintain tenable conditions in the corridor and enable occupants to safely travel to the exits can also be accomplished with the application of active fire suppression, namely automatic sprinkler systems.

Accordingly, Code Changes B-8, B-36 and B-39, exempt corridors in sprinklered buildings from the requirements for fire resistance and continuity (Section 3304(g)), self-closing doors (3304(h)) and fire dampers (Section 4306(i)). Group H-1 occupancies (facilities storing and handling hazardous and highly flammable materials), I-3 occupancies (mental hospitals, jails, prisons) and Group R occupancies (hotels, apartments) are not exempt from this requirement if provided with sprinklers. The nature of these occupancies necessitates redundancies of both sprinklers and corridor separation to assure adequate life safety.

Similar to the Dallas Building Code, the Basic Building Code contains provisions for corridors serving more than 30 persons to be enclosed. However, unlike the Dallas Building Code, the Basic Building Code does provide formal recognition of the ability of supervised sprinkler systems to compensate for fire-resistant corridor construction in business, factory, industrial, mercantile, storage and limited types of assembly occupancies. Several tests, previously discussed with regard to Code Change B-8, have been conducted which substantiate the ability of sprinklers to maintain tenable conditions in actual fire situations.

One series of detailed tests, known as "Operation School Burning," was conducted by the Los Angeles Fire Department in 1959 through 1961 and is particularly notable. The official test report, "Operation School Burning No. 2," cites why automatic sprinklers are successful in preventing dangerous fire conditions.

> When the automatic sprinkler head operates, it immediately serves to "knock-down" and extinguish the fire. The automatic sprinkler then serves to stop the growth of the fire and thus prevents the development of untenable smoke or temperature conditions within the building.

Tenability, as it relates to these tests, was determined as follows:

- Untenable temperature conditions were considered to exist whenever a temperature reading of 150°F was reached at a point five feet above the floor level of corridors.

- Untenable smoke conditions were considered to exist on the basis of visibility and an irritant of products of combustion.

- Visibility was determined by placing an illuminated placard bearing a 12 inch letter five feet from the floor and 45 feet down the hallway from an observer. When the letter was no longer visible to the observer, the time was recorded as the point of untenable smoke conditions.

- The judgment of firemen observers and others determined when the products of combustion were so irritating that students and teachers could not withstand the conditions.

- Visibility and irritation were correlated with smoke density measuring instruments which were adjusted for a reading of 50 microamperes when the hallways were clear of smoke. The hallways were considered to be untenable when instruments had a reading of 10 microamperes which corresponded to 80 percent smoke obscuration.

With the criteria set, a series of 30 fires were conducted to test the performance of automatic sprinklers. Twenty-six fires were of sufficient size to operate the automatic sprinkler systems and in each of these tests, the automatic sprinklers extinguished the

fires before the development of untenable conditions. These results are clearly indicative of automatic sprinklers' capability to maintain the integrity of corridors or other egress routes for safe occupant egress. Although the proposed code changes will exempt sprinklered buildings from the specified criteria for fire resistance and continuity of corridor enclosures, a degree of inherent capability of a non-rated barrier (e.g., glass) to prevent the spread of fire and smoke into the corridor will be provided where corridor designs are used.

The preceeding discussion of the role of sprinklers to maintain tenable conditions also serves as a basis for the next code change, B-37, which deletes the requirement for gaskets on smoke and draft control door assemblies in sprinklered buildings. However, there are some additional items to consider.

As previously pointed out, the corridor enclosure requirements of the Dallas Building Code are proposed to remain applicable to residential, highly hazardous and restrained institutional types of occupancies. As a result, the associated provisions of the Dallas Building Code require corridor doors to have gasket seals where the doors abut the door frames. The requirement for the gasket is intended to minimize the smoke leakage potential of doors, attributed to the gaps and clearance tolerances necessary for proper door operation. Fully developed fires in unsprinklered buildings can create significant pressure differentials between a room or area and the corridor, resulting in the transfer of smoke and gases across the gaps in a door from the area of higher pressure, namely the fire area, to the area of lower pressure. The provision of automatic sprinklers precludes the need for gaskets by providing the capability to limit the size and growth of a fire and consequently limit the magnitude of the pressure differentials which cause smoke movement.

Other model codes -- Basic Building Code, Southern Building Code and the Life Safety Code -- recognize corridor door assemblies without gaskets as adequate barriers to the passage of smoke and gases. Although the purpose of gaskets is recognized, the effectiveness and reliability of the requirement for a gasket is questionable due to their limited life span. Over a period of time, gaskets will inevitably be subjected to damage and other deteriorating conditions. Automatic sprinklers provide a more reliable solution to the effective control of smoke and, although gaps and clearances may be found in doors, the doors will nonetheless provide a significant smoke barrier function.

Discussion of Code Change B-38 will complete the discussion of proposed changes to Subchapter 33. Proposed Code Change B-38 eliminates Section 3309 completely and its requirements for smokeproof enclosures. Smokeproof enclosures are as specified in the Dallas Building Code, continuous stair enclosures with access via balconies open to the outside or with mechanically ventilated vestibules. At least one smokeproof enclosure is currently required to be installed in a building when the floor of any story is located more than 75 feet above grade. This provision for only a single protected smoke-free exit enclosure implies the code's intent to provide a protected access route for fire fighters in buildings where the "stack effect" may cause smoke movement and where higher floors are beyond the reach of fire department aerial equipment.

The current smokeproof enclosure requirement does not discriminate between sprinklered and unsprinklered buildings. However, with the implementation of Code Change B-40, which requires automatic sprinklers in all buildings over 7,500 square feet, all buildings over 75 feet in height will likely be protected by automatic sprinkler systems. In recognition of the greater level of safety provided in buildings protected by automatic sprinklers, Code Change B-38 eliminates the smokeproof enclosure requirement. In sprinklered buildings, it is seldom expected that fire fighters will encounter problems in accessing the fire area or problems with visibility due to smoke. In extreme cases, to contend with possible problems of smoke and toxic gases, the fire department maintains and has available for use, self-contained breathing apparatus. The movement of smoke through the mechanism known as "stack effect" is less of a concern in the moderate climate of Dallas and its spread to other floors would not necessarily be limited in a building having smokeproof exit enclosures.

From a life safety standpoint the provision of a single smokeproof enclosure has questionable impact upon a building's exiting system due to the observation that occupants will not discriminate in their choice of exits. The Life Safety Code does not mandate smokeproof enclosures for any occupancy, however, it does permit the use of such exit arrangements. Consistent with the Life Safety Code, Proposed Code Change B-38 will not mandate smokeproof enclosures for structures. However, it is important to remember that this code change is dependent upon a corollary proposal for mandatory automatic sprinklers. It is not the intent of Code Change B-38 to prohibit the use smokeproof enclosures.

Subchapter 38

Subchapter 38 of the Dallas Building Code contains requirements for fire extinguishing systems including automatic sprinkler systems and standpipe systems.

Automatic sprinklers, as simply defined in the National Fire Protection Association's Fire Protection Handbook,

> ...are devices for automatically distributing water upon a fire in sufficient quantity either to extinguish it entirely or to prevent its spread in the event that the initial fire is out of range of, or is of a type that cannot be completely extinguished by, water discharged from sprinklers.

This simple concept represents the single most viable solution to our nation's fire problem, and is gaining impetus for application as research and development make sprinkler installations more practical and economical for dwellings and as the public is made aware of the benefits derived from automatic sprinkler installations. The technology for the practical application of automatic sprinkler systems is, and has for many years, been present. This is reflected by the existing provisions of Section 3802 of the Dallas Building Code which currently stipulates sprinkler requirements ranging from partial installations for specific areas (e.g., trash rooms, basements) to all inclusive requirements for the total area of a building.

Recognizing automatic sprinklers as a highly effective means of controlling building fires and safeguarding against the loss of life and property, the City of Dallas, in 1981, proposed several changes to their building code which would have resulted in a wider application of sprinkler system requirments. Due to concerns for the appropriateness of these requirements, the city commissioned this study to identify those requirements of the current city codes which could be amended in order to provide an improved level of fire safety without imposing an economic hardship upon the community.

The premise of an improved level of safety culminates in Code Change B-40 which proposes to require the installation of automatic sprinkler systems in all occupancies where the floor area exceeds 7,500 square feet. Although the consequences of this change are significant, it is noted that the sprinkler requirements for several occupancy classifications in the Dallas Building Code are already more stringent than the proposed 7,500 square foot requirement. These existing requirements will remain applicable in

the interest of maintaining the level of safety currently afforded by the existing sprinkler requirements of the Dallas Building Code. For two other occupancy groups, the maximum allowable unsprinklered area will be reduced from 12,000 square feet to 7,500 square feet. The 7,500 square foot criteria figure represents an intermediate floor area less than those areas currently stipulated by code requirements but greater than theoretically derived figures. Many other communities have adopted similar ordinances based on square foot values. Several of these are listed as follows with a basic description of the adopted ordinance:

Culver City, California	Sprinkler ordinance for buildings 12,000 square feet or more than three stories.
Los Altos, California	Sprinklers required for all buildings 8,000 square feet in area, including one-and two-family residences.
Monterey, California	Sprinklers required in buildings greater than 10,000 square feet.
Monterey Park, California	Sprinklers are required in all commercial buildings over 6,000 square feet.
Mount Prospect, Illinois	Sprinklers are required in all buildings 3 stories and 2 stories in height, if over 5,000 square feet.
Oakbrook, Illinois	Sprinklers are required in all buildings that exceed 1,000 square feet (except residential).
Oak Ridge, Tennessee	Sprinklers required in commercial buildings and areas of more than 7,500 square feet.
Sioux Falls, South Dakota	Sprinklers required in all buildings with 25,000 square feet and two stories in height or housing five handicapped persons.

Similarities between community ordinances and the code changes proposed for Dallas extend beyond the requirement for sprinklers in buildings of a specified size. A review of the report entitled "State and Local Ordinances for Sprinkler Systems" prepared by the International Association of Fire Chie[illegible]ion reveals that many communities have been concerned about the economic ramifications of automatic sprinkler installations. In recognition of possible cost impacts, many communities have developed incentive plans in current sprinkler installations and/or also allow reductions, modifications or eliminations of specific code requirements.

Up to this point, Code Change B-40 has been discussed with regard to the overall concept of expanding the sprinkler requirements of the Dallas Building Code. However, there are several other changes to Section 3802 which require explanation.

Three exceptions are instituted to the requirement for sprinklers in structures over 7,500 square feet in area. Two of these exceptions exclude open-air structures from compliance with the proposed ordinance. The first of the two open-air exceptions applies to open-air stadiums, reviewing stands and amusement park structures. This type of open-air structure is generally not subject to fire safety risks associated with enclosed structures. The potential for the rapid development in spread of fires is much greater in confined structures than in open-air structures. Also, the problems associated with smoke and heat are reduced in open-air occupancies. This same reasoning applies to the second exception, which precludes open parking garages from the proposed sprinkler requirement. Fires in parking garages seldom involve more than one or two vehicles and can be extinguished with minimum efforts by the fire department, as previously discussed.

A third exception allows sprinklers to be omitted, in hotels and apartments, from closets less than 24 square feet in area, and bathrooms less than 55 square feet in area provided only noncombustible plumbing fixtures are installed. The omission of sprinklers in these limited size areas will result in reduced costs for the installation of sprinkler systems. The exception is consistent with the Life Safety Code which permits the exclusion of sprinklers from 24 square foot closets and 55 square foot bathrooms. This exception is based upon residential fire statistics that indicate there is a low frequency of fires originating in closets and bathrooms. The areas of origin most often cited for fires in residential occupancies are the living room, bedroom and kitchen. These areas will require automatic sprinkler protection.

The existing requirements of Section 3802 related to hospitals allow significant omission of sprinklers from various areas. In hospitals of Type I, Type II fire resistive, and Type II one-hour construction, automatic sprinklers are permitted to be omitted from operating, delivery, cardiac, x-ray, intensive care, and patient sleeping rooms less than 450 square feet when supervised smoke detectors are provided. This permitted deletion of sprinklers from patient sleeping rooms, so arranged, is inconsistent with the intent of Code Change B-40 to provide complete automatic sprinkler protection throughout buildings. Therefore, the reference in this section of the code to patient

sleeping rooms is deleted. The risk posed by accidental water discharge to patient operating, delivery, cardiac, x-ray and intensive care room, however remote, is recognized. Accordingly, the omission of automatic sprinklers in these areas will be permitted. However, in order to provide redundant features commensurate with the capabilities of sprinklers, additional features are required. Smoke detectors located in such unsprinklered rooms, connected to a constantly attended location, will replace the alarm function normally provided by the sprinklers. Also, the corridor separation requirements of 3304(g) and 3304(h) of the building code will be applicable to those rooms lacking sprinklers. This will compensate for the fire control mechanism lost by the omission of sprinklers in these rooms, yet is intended to limit any fires to the room of origin.

The performance of automatic sprinklers as reported by the Fire Record Department of the National Fire Protection Association is 96.2 percent satisfactory in achieving fire control. This is based on the records of 81,425 fires that occurred during the period from 1925 to 1970. The validity of the high success rate of automatic sprinklers in the United States has been corroborated by two studies conducted in New York City (98.4 percent and 98.5 percent), two studies in Australia and New Zealand (99.8 percent and 99.5 percent) and a study recently completed by the United States Department of Energy (98.3 percent). Other conclusions of these studies are as follows:

- Properly installed and maintained, automatic sprinklers are a highly effective safeguard against the loss of life and property from fire. Fire loss statistics show no record of multiple deaths due to fire in compeletely sprinklered buildings. Fire fatalities in sprinklered buildings have been reported only for persons intimately involved with the fire ignition.

- A significantly high percentage of fires are controlled by relatively few sprinklers. NFPA statistics indicated 85 percent of all fires are controlled by ten or less sprinklers and 70.1 percent of all fires are controlled by four or less sprinklers.

- A high level of reliable sprinkler performance is ensured by [illegible] electrical supervision of the system for waterflow and conditions which may impair sprinkler operation.

The satisfactory and unsatisfactory operation of sprinklers, as reported to the NFPA, are summarized for various occupancies in Table 14. Table 15 reveals that closure of water control valves is a major cause of failure attributable to unsatisfactory performance. The proposal (Code Change B-41) to modify Section 3802(c) is directed at preventing this kind of failure. The existing wording in the code is considered to be unclear in its intent for supervision. The change proposed to this section defines those functions which are required to be supervised. The proposed wording calls for waterflow, valve position and other conditions (e.g., fire pump power, low water level, etc.) which may impair the operation of the sprinkler system to be supervised when the building contains more than 100 sprinklers or is sprinklered per the "7,500 square foot" rule. The supervision of sprinkler valves is considered an extremely important feature which must be provided in order to assure a high degree of reliability of the automatic sprinkler systems. The supervision function must be monitored by an alarm system company, propriety or remote station service or a local alarm which will give an audible signal at a constantly attended location. This function provides the means by which impairments of a sprinkler system will be immediately identified in time to permit correction before sprinklers are needed.

Building Code Change B-42 adds a new section, Section 3803(f), to the Dallas Building Code. This new requirement is intended to assure that fire department standpipes are charged with water for immediate application. This change also requires standpipes in buildings exceeding 150 feet in height to be provided with an approved water supply in accordance with the Uniform Building Code Standard 38-3. This will assure that water is available for manual fire fighting at heights where the fire deparment pumpers may not be able to provide sufficient pressure for interior hose streams. Table 38-A, which summarizes the standpipe requirements of the Dallas Building Code, is modified by deleting references for other than Class I standpipes in the sprinklered building category. This change will have the effect of deleting the requirement for standpipes to be located within 30 feet of a nozzle attached to 100 feet of hose. The location of standpipes will instead be dependent upon the location of stairways and horizontal exits. The location of standpipes in required stairways is considered to be an adequate distribution, especially since fire fighting activities on upper floors of buildings will generally be staged from the stairway enclosures. This proposed code change also eliminates the requirement for occupant use hose in Group A, Division 2.1 occupancies.

TABLE 14
SPRINKLER PERFORMANCE SUMMARY

OCCUPANCIES	TOTAL NO. OF FIRES	TOTAL UNSATIS-FACTORY	TOTAL SATIS-FACTORY	TOTAL SATIS-FACTORY PER-CENT
Residential	1,073	48	1,025	95.5
Assembly	1,551	52	1,499	96.6
Educational	241	20	221	91.7
Institutional	305	12	293	96.1
Office	494	13	481	97.4
Mercantile	6,237	176	6,061	97.2
Industrial				
Beverages, essential oils	543	64	479	88.2
Chemicals	4,147	198	3,949	95.2
Fiber products	539	25	514	95.3
Food products	2,484	133	2,351	94.6
Glass products	519	23	496	95.6
Leather, leather products	2,864	114	2,750	96.0
Metal, metal products	9,807	305	9,502	96.9
Mineral products	394	19	375	95.2
Paper, paper products	7,147	234	6,913	96.7
Rubber, rubber products	1,489	61	1,428	95.9
Textiles—manufacturing	16,119	291	15,828	98.2
Textiles—processing	6,527	127	6,400	98.1
Wood products	5,353	492	4,861	90.8
Miscellaneous industries	9,013	265	8,748	97.1
Total (Industrial)	66,945	2,351	64,594	96.5
Storage Occupancies	4,160	375	3,785	91.0
Other Occupancies	419	87	332	79.2
Total (All Occupancies)	81,425	3,134	78,291	96.2

Source: John L. Bryan, Automatic Sprinkler and Standpipe Sytems.

TABLE 15

SUMMARY ANALYSIS OF UNSATISFACTORY SPRINKLER PERFORMANCE

OCCUPANCIES	WATER SHUT OFF	PARTIAL PROTECTION	INADEQUATE WATER SUPPLIES	SYSTEM FROZEN	SLOW OPERATION	DEFECTIVE DRY-PIPE VALVE	FAULTY BUILDING CONSTRUCTION	OBSTRUCTION TO DISTRIBUTION	HAZARD OF OCCUPANCY	EXPOSURE FIRE	INADEQUATE MAINTENANCE	ANTIQUATED SYSTEM	MISCELLANEOUS AND UNKNOWN
Residential	13	9	5	1	...	...	11	3	1	...	2	2	1
Assembly	23	10	3	...	1	...	9	1	...	1	4	...	...
Educational	4	8	1	...	...	...	5	...	...	...	1	1	...
Institutional	3	3	2	...	...	...	1	...	1	...	...	...	2
Office	4	2	1	...	...	1	2	...	1	...	1	1	...
Mercantile	83	11	4	4	4	5	35	11	12	1	4	1	1
Industrial													
Beverages, essential oils	17	4	9	...	...	1	2	1	18	3	3	5	1
Chemicals	33	11	19	...	3	3	1	13	95	2	12	1	5
Fiber products	6	...	4	1	...	2	...	5	4	...	2	1	...
Food products	43	11	8	1	2	1	7	9	29	4	12	1	5
Glass products	8	...	3	1	...	...	2	1	5	...	3	...	...
Leather, leather products	43	8	7	3	2	4	9	7	9	4	9	6	3
Metal, metal products	91	36	22	3	6	6	15	35	43	6	29	7	6
Mineral products	10	4	2	...	...	...	1	...	...	...	1	1	...
Paper, paper products	75	16	34	3	2	2	16	32	21	2	23	4	4
Rubber, rubber products	21	4	3	...	1	1	1	10	14	1	5	...	...
Textiles—manufacturing	109	15	32	3	5	3	11	27	18	1	50	9	8
Textiles—processing	52	6	11	...	5	1	8	13	15	2	7	1	6
Wood products	137	57	84	9	16	14	27	19	77	8	24	12	8
Miscellaneous industries	146	15	14	8	3	...	12	11	18	3	27	8	...
Total (Industrial)	791	187	252	32	45	38	112	183	366	36	207	56	46
Storage Occupancies	122	24	48	5	6	9	10	57	38	11	40	3	7
Other Occupancies	67	...	...	2	...	...	2	1	5	3	3	1	3
Total (All Occupancies)	1,110	254	311	44	56	53	187	256	424	52	262	65	60

Source: John L. Bryan, Automatic Sprinkler and Standpipe Sytems.

Building Code Change B-44 also addresses requirements for standpipes. The current requirement of Section 3803(c) requires a three-way outlet to be located above the roof line of a building. This outlet is intended to be used for exterior fighting, preventing building-to-building fire spread. The installation of this type of an outlet requires special installation measures to guard against freezing temperatures for outlets seldom utilized by fire department personnel. This provision represents unnecessary addtional costs for combined sprinkler-standpipe installations. The change to Section 3803(c) is proposed to require a two-way outlet in at least one stairway at the upper-most floor of the building. This will provide an adequately accessible connection for fire fighting operations necessitated at the roof level, yet reduces system cost.

A code change (B-45) has been proposed for Section 3804(b) concerning standpipes in buildings under construction. Currently, standpipes must be provided in buildings under construction when the progress of construction is not more than 50 feet in height above grade. The standpipe system is to be extended as construction progresses to within one floor of the highest point of construction having secure decking or flooring. The code currently requires the provision of a permanent water supply for construction height requiring the installation of a Class II standpipe. However, since Class II standpipes will essentially be eliminated from the proposed new code, a new criterion must be developed for the requirement for permanent water supply.

Depending upon the construction schedule for a building, the permanent water supply, including the provision of a fire pump, may not coincide with the progress of construction. The Dallas Fire Department can supply the standpipe system to a height of approximately 550 feet. The proposed code modification will allow the use of a fire department connection to supply the standpipe for buildings under construction. A figure of 275 feet has been inserted as the determining point where on-site water supplies must be provided. This coincides with the maximum dimension allowed for a standpipe system zone in NFPA 14 and UBC Standard 38-3. Use of the fire department pumper to meet the water supply requirement is allowed for construction up to 550 feet. However, because of the pressures involved at the lower levels of the building, piping must be specially designed to accommodate these pressures in order to take advantage of this provision.

Subchapter 51

Subchapter 51 of the Dallas Building Code contains provisions applicable to the design, construction, installation, operation, alteration and repair of elevators, dumbwaiters, escalators and moving walks and their hoistways. Section 5103(d) of the Dallas Building Code requires the provision of a smoke detector in each elevator lobby arranged to prohibit the opening of elevator doors when the detector is activated. Literally, this code requirement does not require automatic recall to the ground floor of the building. The Dallas Code references ANSI Standard A17.1 for elevator design and operation, requiring the automatic recall function of the elevator for tall buildings which prohibits the opening of the elevator doors on the fire floor.

An exception is proposed to this requirement to eliminate the provision of the elevator lobby smoke detector in buildings which are protected throughout by an approved automatic sprinkler system. It is interesting to note that the current provisions do not require the automatic recall of the elevator to the ground floor. Other code provisions requiring the recall of elevators are considered sufficient protection. Therefore, this provision for sprinklered buildings need not be applicable.

Subchapter 52

Proposed Code Changes B-47 and B-48 relate to the use of plastic roof panels and plastic skylight units. The current provisions of the Dallas Building Code are being modified to be consistent with more liberal recommendations of the Board for the Coordination for Model Codes. BCMC reviewed the skylight text in the model codes and determined that the potential contribution to a fire by these panels is significantly reduced in a sprinklered building. The resulting provisions will allow additional architectural freedom without jeopardizing the safety of the building occupants.

FIRE CODE CHANGES

Article XIII

The Dallas Fire Code prescribes regulations for safeguarding against the hazards of fire and explosion. Unlike the Building Code requirements, the provisions of the Fire Code are retroactive and may be applied to existing buildings. Of six changes proposed to the

Fire Code, five changes address the requirements in Article XIII for fire protection equipment and systems.

The first proposed change, F-1, amends the definition of "standard size water main." The term "standard size water main" is used to quantify the size and water supply required for water mains serving fire hydrants. Fire hydrants are required to be located on water mains at least six inches in size, which are to be further connected to mains no less than eight inches. The quantity of waterflow, known as "fire flow," required to supply hydrants is based on the Fire Suppression Rating Schedule of the Insurance Services Office (ISO). The fire flow for a building is based upon the occupancy, floor area, construction type, automatic sprinkler protection and exposures of the building. Until recently, the criteria for determining fire flow did not provide significant recognition of the decreased need for public fire suppression of properties protected by automatic sprinklers. Buildings protected by automatic sprinklers would often necessitate a fire flow significantly in excess of the flow of water required for the successful operation of the building sprinkler system. Now, however, the ISO Fire Suppression Rating Schedule provides such recognition and excludes all properties with standard automatic sprinkler systems from the development of a needed fire flow.

The change to the definition of "standard size water main" clarifies this current approach of the ISO and requires that the flow for hydrants serving sprinklered buildings be at least equal the water supply criteria stipulated by the sprinkler installation standard, UBC Standard 38-1. This standard stipulates the flow of water necessary for effective sprinkler system operation and supplemental hose streams. Application of water via an automatic sprinkler system is the primary concern of the fire department. The new wording, however, assures that a fire flow for supplemental manual application will be available to hydrants, if necessary.

The next change proposed to the Fire Code, F-2, allows increased hydrant spacing for properties protected by automatic sprinkler systems. Currently, all occupancies -- other than small structures such as single family dwellings, car ports, and garages -- are required to have fire hydrants located in a manner that requires only 300 feet of hose to reach a respective building. The small structures mentioned above are required to comply with a similar hydrant requirement stipulating a 400 foot maximum dimension.

The proposed change recognizes the decreased importance of response time to fires in sprinklered buildings and accordingly permits an additional 200 feet between hydrants and buildings protected by automatic sprinkler systems. With this change, the 300 and 400 foot hydrant-positioning dimensions remain applicable to unsprinklered structures, while 500 and 600 feet, respectively, are applicable to structures protected by automatic sprinklers. The 500 foot dimension permitted for commercial, industrial, large residential and other public buildings which are sprinklered is consistent with the hydrant location requirements of the National Fire Protection Association's "Standard for Outside Protection (NFPA 24)." The 600 foot dimension applicable to small residential-type structures, considers the effectiveness of fire department trucks to initially attack fires in these structures utilizing the water supply available from a fire truck's water tank. The greater hydrant spacing dimensions permitted for sprinklered buildings is also intended to provide an incentive to developers to provide sprinklers in small commercial buildings and residential developments.

Section 16-13.401(A) of the Fire Code is a recently adopted section which requires buildings occupied by more than ten persons to contain an automatic fire alarm system actuated by smoke detection devices and capable of warning all occupants of a building in the event of fire. This requirement, however, does not differentiate between sprinklered and unsprinklered buildings. The current provisions of the Building Code, including any modifications proposed in this report, adequately provide for alarm systems in sprinklered buildings. Therefore, this additional requirement of the Fire Code is considered unnecessarily restrictive for buildings protected by automatic sprinklers. Subsequently, Code Change F-3 is proposed which adds an exception for sprinklered buildings from compliance with the Fire Code requirement for alarm systems.

Exempting sprinklered buildings from this Fire Code alarm system requirement will not eliminate alarm functions in sprinklered buildings. Building Code Change B-41 will require sprinkler systems to be monitored for waterflow alarms and other conditions. The need for general warning signals, however, are not necessitated in many sprinklered occupancies where the occupants are of a mobile and alert nature and sprinklers provide the ability to defend occupants in place. Educational occupancies, institutional occupancies, residential occupancies, high-rise buildings and malls will require additional alarm functions as accounted for in the building code.

As previously discussed, the requirements of the Fire Code are retroactively applicable and, therefore, Code Change F-3 will also impact existing buildings. The proposed exception applies to existing structures in the same manner as it applies to new structures. The provision for alarm functions of a sprinkler system in existing buildings is included in the definitions section of the Fire Code. The definition of "automatic sprinkler system" requires that the system provides aural and electric alarm signals. In addition to relieving sprinklered buildings from unnecessary alarm system requirements, the proposed exception also serves as an incentive for building owners to install automatic sprinkler protection. In the case of unsprinklered buildings, the current provisions will remain aplicable as currently adopted.

Code Change F-4 deletes the requirement that fire department siamese connections to standpipes be located on each side of a sprinklered building. More specifically, the Fire Code requires every side of a building facing a designated fire equipment access road and having a linear dimension in excess of 150 feet to contain a siamese connection to the building standpipe system. The proposed code change will require only one siamese connection for standpipe systems in sprinklered buildings. The ability of automatic sprinklers to provide initial control, if not extinguishment, of a fire reduces the importance of a fire department response dependent upon the availability of siamese connections. With sprinklers to affect and maintain control of a fire, additional time is available to fire department personnel to locate and tie into the siamese connection. Even with a single siamese connection, the Fire Code requirement for the connection to be located on a designated horizontal access, subject to the approval of the fire department in the plan review process, will assure relatively rapid location of the siamese connection. The provision of a single siamese connection is consistent with the requirements of UBC Standard 38-1, NFPA 13, UBC Standard 38-3 and NFPA 14.

The last change proposed to Article XIII of the Fire Code concerns the provisions of Section 16-13.503 for hose outlets and fire hose connections to standpipe systems. This change, F-5, correlates the requirements proposed to the Building Code with those found in the Fire Code. Currently, the Fire Code requires any standpipe system to have a one and one-half inch fire hose, a one and one-half inch hose outlet and a two and one-half inch outlet on every floor of a building. The one and one-half inch fire hose and associated outlet are intended for use by building occupants. Bryan[36] points out that the provision of standpipes with attached hose lines for occupant use in occupancies other than those having trained fire brigades could create the possibility of

extremely hazardous conditions for building occupants. The potential hazard of fire hose usage by untrained building occupants has recently become a concern of the NFPA Committee on Standpipes and a proposal to permit the use of smaller size hoses is under consideration.

The NFPA Fire Protection Handbook notes that standpipe and hose systems do not take the place of an automatic extinguishing system. Many jurisdictions have discounted the requirement for occupant-use hose systems in buildings that are completely protected by automatic sprinklers.[37] In buildings protected by automatic sprinkler systems, there is no need to subject occupants to the hazards of fire fighting; therefore, Code Change F-5 deletes the requirement for occupant-use fire hoses and the associated outlets. The requirement for an attached fire hose is also a superfluous concern of fire fighters. Fire hose dedicated to standpipe systems in buildings is often found to be in an unreliable condition. For this reason, fire fighters will replace househose with fire department hose of known strength and reliability. The requirement for two and one-half inch standpipe outlets for use by fire department personnel remains applicable to standpipes for all buildings.

Article XXXV

Fire Code Section 16-35.108 requires two sides of a building to be provided with at least one door in each 100 linear feet. This requirement is intended to provide fire department perimeter access with some degree of regularity, thereby allowing for quicker response time of fire department personnel to an internal fire.

Similar requirements of the Basic Building Code for fire department access have recently been studied by an ad hoc committee of the Building Officials and Code Administrators International (BOCA). Currently, the Basic Building Code (1981 edition) requires fire access panels and/or grade-level doors to be located at regular intervals in the exterior walls of a building. These requirements have been recommended for deletion by the BOCA Code Changes Committee for the 1984 Basic Building Code as a result of an ad hoc committee proposal. The reasoning behind the committee's proposal cites exterior exit doors and exit stairways, which are required to maintain clear and unobstructed paths, as providing adequate fire fighting access to buildings. The committee also recognized the provision for access panels or doors as incongruent with the intent of the code to permit "windowless stories" that are required to be protected

by automatic sprinklers. This reasoning provides substantiation for Code Change F-6 which will exclude sprinklered buildings from the provision for regularly spaced access doors. Automatic sprinklers effectively satisfy the concern for fire suppression by automatic means inside the building as opposed to manual suppression techniques via the exterior. Life safety concerns are similarly addressed by other exiting provisions with the building code.

WATERWORKS ORDINANCES

Portions of the Dallas Waterworks Ordinances related to sprinkler systems were reviewed for possible amendment. In addition, a circular of the Dallas Water Utilities Distribution Division entitled, "Fire Service Metering," was reviewed. Two proposed changes to the waterworks ordinances are proposed in the appendix of this report.

Section 49-26 of the Waterworks Ordinance consists of several paragraphs. Several changes have been proposed to this section in code change W-1. The first change is editorial in nature, intending to clarify that certain types of sprinkler or fire service connections may be permitted without a meter; the current wording concerning this subject is somewhat confusing. An amendment has been made which clearly identifies the circumstances under which a meter may be omitted. Fire service connections having an automatic waterflow fire alarm system as an intregal part of the piping should be allowed to be exempted from the requirements for a meter since any flow of water through the system will automatically actuate a fire alarm signal either on the premises, off-site, or both. This should be a sufficient safeguard to prevent the unwarranted use of water from the fire service connection.

The installation cost of a detector check valve and meter for an eight-inch service is approximately $3,000. This cost can represent a substantial protion of total system cost, especially for a relatively small building, creating disincentives for the installation of a superior method of fire protection.

A second proposal has been made concerning the first paragraph of Section 49-26. This amendment is intended to assure that the discontinuation of water service to a customer would not be made without approval of the fire marshal. This amendment is important in that the maintenance of water supply to fire protection equipment, including an automatic sprinkler system, can affect the life safety of the building occupants, occupants of adjacent structures, fire fighters and property.

An amendment has also been proposed to the third paragraph of Section 49-26. Certain sections of this paragraph have been deleted which presently affect the sizing of fire service mains connected to city mains. Presently, fire service connections are required to be at least one size smaller than the city mains serving the fire service line. Furthermore, the section currently prohibits the fire service main from being enlarged beyond the connection to the city main. These requirements can adversely affect the ability to economically supply water for fire protection systems. Such provisions may, in fact, require the provision of an on-site booster pump, or, in severe cases, the provision of an on-site water supply and fire pump. The sizing of water mains for fire service is dependent upon hydraulic calculations to meet the theoretical demand of the fire protection system. As previously indicated, the overall demand to control a fire in a sprinkered building is substantially less than that required by the fire service to extinguish an uncontrolled fire in a similar building without automatic sprinklers. Owners of buildings having automatic sprinkler systems should not be penalized for providing a superior method of fire protection which, at the same time, places a smaller demand upon the city water distribution system. This amendment will allow the full advantage of the use of hydraulic calculations in accordance with generally accepted engineering practices for fire protection systems.

A second amendment to the third paragraph is proposed which is intended to allow the use of a pressure tank to supply fire protection water, provided that an approved check valve is installed to prevent backflow from the pressure tank to the city distribution system. Presently, Section 49-26 prohibits the use of a pressure tank under all circumstances. Pressure tanks have been used for many years in fire protection systems throughout the country without any reported adverse affects due to backflow into a city distribution system.

Code change W-2 is an amendment to Section 49-26A of the Waterworks Ordinances concerning charges for fire service systems. Presently, sprinkler or fire service systems which are not metered or otherwise subject to maintenance and inspection charges are billed at a rate of one dollar per month per inch of inside diameter. Again, this ordinance places an economic burden on those property owners who are providing a superior method of fire protection and, in the case of an actual fire, a lesser demand on the waterworks distribution system.

The apparent theory behind such charges is that large connections for fire protection systems create a demand upon the water system which should be borne by the customer. Sprinkler systems do not create a demand unless there is an actual fire (or for periodic tests). The water demand of a sprinkler system is substantially less than that created by the fire department manually extinguishing a fire in the same building. The elimination of this charge is consistent with the overall intent of encouraging automatic sprinkler protection to reduce fire fighting demands on the Dallas Fire Department and water demand on the water system which will ultimately translate into cost savings for the city.