OE-21017
Bulletin 1962, No. 6

SCHOOL
PLANT
MANAGEMENT
SERIES

SCHOOL FIRES
Prevention
Control
Protection

By R. N. Finchum
Specialist, School Plant Management
and
Glenn C. Boerrigter
Research Assistant

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Anthony J. Celebrezze, *Secretary*
Office of Education, Sterling M. McMurrin, *Commissioner*

Foreword

FIRE SAFETY in schools is of interest and immediate concern to a large segment of the Nation's population. Approximately one-fifth of the people are either attending, or are connected in some manner with the operation of educational institutions. Fire poses a real danger to them and is a persistent, annoying problem for their parents, relatives, and friends. The threat of fire can never be completely eliminated from school buildings, but its dangers can be minimized with sound planning. This may be accomplished by a three-prong attack: *prevention*, *control*, and *protection*.

Responsibility and authority for school fire safety is shared by many persons in this Nation. The relationship of responsibility and authority to a knowledge of acceptable fire safety procedures is important in the process of eliminating or reducing fire danger in the Nation's educational institutions.

Many magazine articles, pamphlets, and publications on specific aspects of school fires are available, but few publications present an overview for a complete program of school fire safety. This publication was accordingly compiled and written for the purpose of bringing together in one document the latest available information, research, and proven practices so that administrators and others who have authority and responsibility in this area may plan a comprehensive program of school fire safety.

It is hoped that the present bulletin will aid them in understanding the total scope of the problem, in reaffirming their responsibility and authority for school fire safety, in detecting fire hazards in school facilities, in improving housekeeping and maintenance for fire safety, and in developing understanding of the place and function of fire-protective equipment.

Many helpful suggestions for this publication were received from individuals and organizations. The Office wishes to express thanks for this assistance and for the privilege of using certain drawings, tables, charts, and other quoted materials.

FRED R. BEACH,
Director, Administration Branch,
Division of Elementary and Secondary Education.

ERIC R. BABER,
Acting Assistant Commissioner,
Bureau of Educational Research and Development.

Contents

CHAPTER II. RESPONSIBILITY—Continued

LOCAL RESPONSIBILITY

BUILDINGS—Continued

CHAPTER V. SAFETY DEVICES—Continued

Chapter I
The Problem

FIRE SAFETY IN SCHOOLS, long recognized as a serious problem by both public officials and lay citizens, is concerned with preventing personal injury or death and property damage or destruction. The responsibility for this prevention is lodged in many hands, but school officials having jurisdiction in the matter are usually charged with developing and implementing administrative policies governing appropriate procedures and actions. Basic information, however, is not always available to these officials. The purpose of the present bulletin, therefore, is to incorporate and consolidate in one volume the most recent developments concerning the nature and effects of fires, responsibility for school fire safety, fire hazards prevalent on sites and in buildings, acceptable housekeeping practices, and fire protective and extinguishment devices and equipment.

National Problem

The problem of school fire safety is national in scope, since no school building, public or private, is entirely free from the hazards of fire, and no official conducting a program of education, or having an obligation for safety of persons in public places, can remove himself from the moral, if not legal, responsibility for fire safety. One national organization [1] estimates that an average of 11 school fires occur each day. Each of these is a local fire affecting a particular community, but over a period of time hundreds of communities across the entire country experience the horror of school fires. The annual school property loss and occasional loss of life point to the need for greater national knowledge and emphasis on procedures to insure school fire safety. Hence, the problem is not just local in nature, but national, deserving the attention of many persons. Concerning this problem the Federal Fire Council [2] states:

> There is a need to re-examine some of the basic concepts in the fire safety field and to increase our basic knowledge of the phenomena of fire and its

[1] National Commission on Safety Education (NEA). *Action for Safety* (vol. 14, No. 9). Washington 6: The Commission, 1201 Sixteenth Street NW. December 1961. p. 8.

[2] Federal Fire Council. *Newsletter* (vol. 2, No. 8). Washington 25: The Council, 19th and F Streets NW. October 1961.

suppression. The present day scientific tempo is out-stripping the fire safety field—partly due to an inadequate foundation which results in gaps in vital knowledge. New developments in materials, products, and operation, as well as human habits and mores, severely tax efforts to adequately safeguard against unwanted fire. Also, some problems can be traced to procedures which by-pass fire safety personnel or restrict the free flow of necessary information to them.

The statement quoted identifies several problems affecting school fire safety, few of which could be solved solely at the local level, thus indicating a need for the concept that school fire safety is a local, State, and National problem. Nelson and Royer [3] suggest that fire safety is the responsibility of everyone. They emphasize that if we are willing to gamble with mass death, then we should not be indignant when it arrives.

Nature of Fires

Understanding the processes and results of fire is important for those who are responsible for school fire safety. Knowledge of how fire starts, how it grows, how it may affect building occupants, and how man may protect himself from it, should influence responsible persons in their planning for fire safe schools.

Description

In defining the process of fire, Layman [4] says:

Fire is a chemical reaction in which oxygen combines with fuel at a rate sufficient to produce both heat and light. The essentials of this process are: Fuel—any combustible gas, liquid or solid; oxygen—sufficient in volume to support the process of combustion and usually supplied from surrounding air; heat—sufficient in volume and intensity to raise the temperature of fuel to its ignition or kindling point.

Elements

The elements of fire are smoke, expanded air, unexploded gas, uncontrolled heat, and flame. The growth of fire depends on many variable factors, several of which are the amount of oxygen, the amount of combustible material, and the concentration of heat. These variables may be difficult to calculate, but it should be remembered that the rapidity with which fire can be expected to burn is especially important to school officials.

---

[3] F. W. Nelson and Keith Royer. "Why Mass Fire Deaths." *Iowa Custodian's Newsletter* (vol. 29). March–April 1959.

[4] Lloyd Layman. *Attacking and Extinguishing Interior Fires.* Boston 10: National Fire Protection Association, 60 Batterymarch Street. 1952. p. 7.

Oxygen, one of the elements which support fire, is nearly always available. Another element needed to support it is fuel. In many cases the fuel most plentiful and available in school buildings is wood and wood products. Laboratory findings show what happens to wood when it burns. In one laboratory experiment when 1½ pounds of dry wood were placed in a retort at 300° C the results were the following:

- The wood was reduced to charcoal.
- Three-fourths of a tumbler of liquid was distilled.
- Three cubic feet of gas was formed.[5]

Coe[6] states that more lives are lost from gases than from fire itself. When gases are formed there is a tremendous atmospheric expansion; for example, 1 ton of wood heated to 400° C will produce 7,000 cubic feet of gas, 40 percent of which is deadly carbon monoxide.

Some type of fuel is generally available in school buildings. For example, an 8-foot Christmas tree with decorations and packages represents about 100 pounds of combustible materials in one classroom. If this amount of combustible material became ignited, with sufficient oxygen to support combustion, the amount of heat generated would be equal to that produced by 15 gallons of gasoline, or approximately 800,000 B.T.U.'s per hour.[7] The release of this amount of heat in from 5 to 15 minutes in one classroom would probably destroy all life in the room and do other serious damage.

Smoke, a byproduct of fire, is produced more by a smoldering than by a free-burning fire. A report[8] of the Division of Surveys and Field Services of George Peabody College states that a smoldering fire without flame produces carbon monoxide (a colorless, odorless, lethal poison) in fatal quantities, without doing material damage to the structure. This concept is supported by Layman, who indicates that, even though flame production ceases when the oxygen content of the surrounding atmosphere falls below 15 percent, smouldering burning will continue. Concerning other characteristics of smoke released from burning, he states:[9]

> Smoke released in the burning of ordinary combustibles consists of a mixture of vapors and gases in which minute particles of carbon, tar and ash are suspended. Smoke is a product of incomplete combustion. All smoke is toxic to some degree and is an irritant to the respiratory system and eyes. There is always some carbon monoxide present in smoke and

---

[5] Durham & Bates, Inc. *Stop Fires—Save Lives.* Portland, Oreg.: The Corporation. 901 S.W. Washington Street. n.d. p. 12.

[6] Theodore I. Coe. Fire—Friend and Foe of Man. *Bulletin of the American Institute of Architects* (AIA File No. R9). January–February 1954. p. 56.

[7] F. W. Nelson and Keith Royer. *op. cit.*

[8] George Peabody College for Teachers, Division of Surveys and Field Services. *Disaster Readiness in Undergraduate Education.* Nashville, Tenn. The College. 1960. p. 56. (Prepared for the Office of Civil Defense Mobilization).

[9] Lloyd Layman. *op. cit.* p. 7–8.

the amount can vary from a small trace to a deadly percentage depending upon conditions of combustion. . . .

Untenability and Evacuation

The rapidity with which smoke and heat travel through a building is not generally recognized by lay persons. Post mortems of fires prove that many fatalities result from smoke asphyxiation.

The summarized results of the Los Angeles Fire Department fire tests reveals that smoke from both smoldering and free-burning fires was the principal hazard to life, and nearly always untenable smoke conditions preceded untenable temperature conditions. In these tests, fires were started at the bottom of stairways, in classrooms, and in corridors. Untenable smoke conditions were reached in 2 to 7 minutes on at least one entire floor above the fire. At this point, it is interesting to note, evacuation time from a three-story building is estimated to be 2 to 3 minutes.[10]

The following graphs compiled from information of the Los Angeles Fire Department fire tests show the untenable heat and the unbearable smoke conditions as they existed during the tests.

> The graphs show vividly what times were recorded to reach a level of either untenable or unbearable heat on each floor that would preclude the use of building corridors as a means of escape from the building. One should keep in mind that occupants of upper floors must pass through the first floor to reach the outside of the building—whatever condition obtains on the first floor is a limiting escape factor.[11]

Test criteria were established on three items of significance:

1. Untenable heat was said to be present when thermocouples in hallways read 150° F at headheight.
2. Untenable smoke was said to be present when it was impossible to read 12-inch-high illuminated block letters on a white placard at a distance of 45 feet.
3. Evacuation drill time was established as 1 minute per floor, i.e., it would take 3 minutes to evacuate everyone from a 3-story building; 2 minutes from a 2-story building.

In stating the nature of fire and its effects, one study [12] lists the following points:

1. The lethal products of fire are smoke and toxic gases, heat, and flame.
2. Hazards of life from developing fires are likeliest to be: first, smoke and toxic gases; then heat; finally, flame.

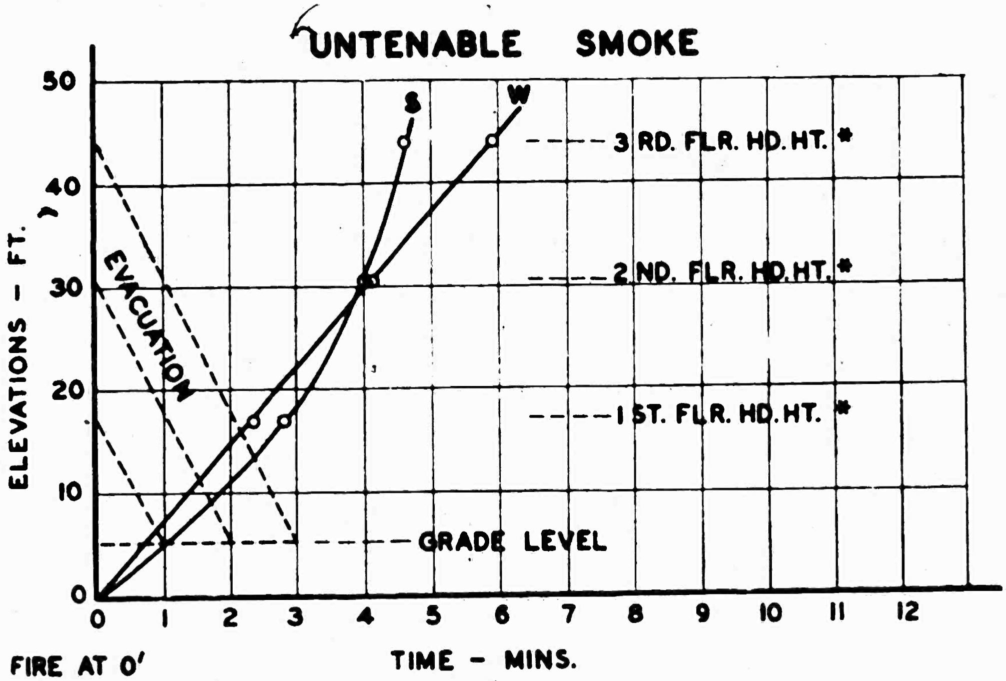
---

[10] Los Angeles Fire Department. *Operation School Burning*, by the National Fire Protection Association. 1959. p. 25–26.

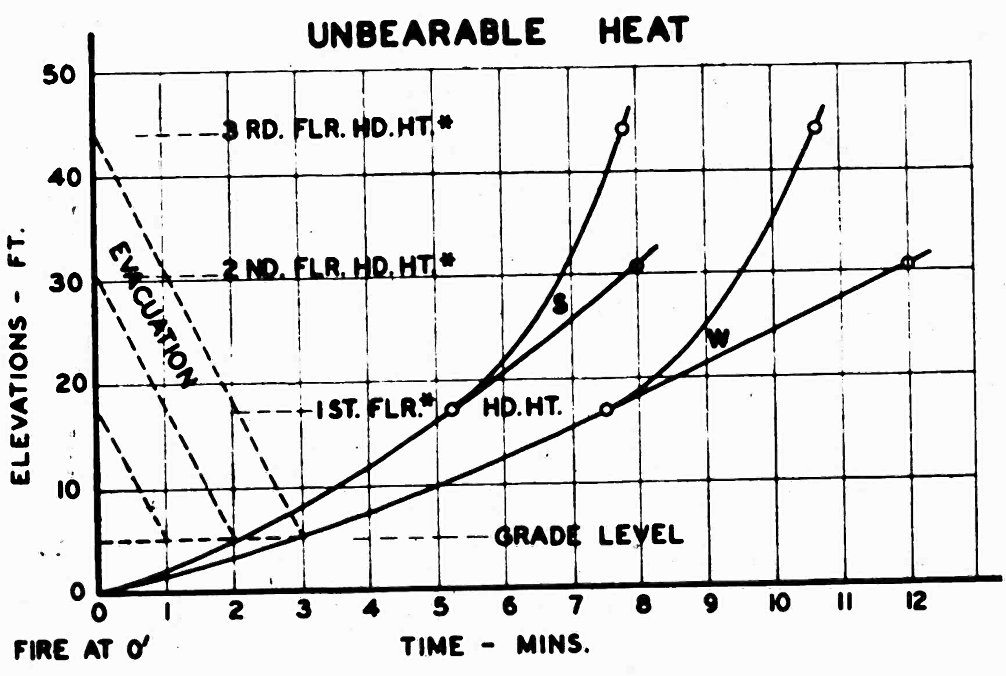
[11] Federation of Mutual Fire Insurance Companies. *Is Your Student Housing Fire Safe?* Chicago 6: The Federation, 20 North Wacker Drive. 1960. p. 39–40.

[12] Building Research Advisory Board. Committee on Fire Research. *School Fires: An Approach to Life Safety*. Washington: National Academy of Sciences—National Research Council. 1960. p. 2.

Graph 1



Graph 2



* Floor Head Height

3. These hazards can be controlled and the time available for safe escape can be extended.

4. When proper measures to control these hazards are not taken, the time available for escape may be reduced to zero.

Fire Classifications and Hazard Areas

One nationally recognized classification of fires groups them into four classes.[13] This is based on the type of combustible material which feeds the fire and the type of extinguishing agent which is most effective for controlling a fire fed by this material. The classes are:

Class "A" Fires, defined as fires in ordinary combustible materials such as wood, cloth, paper, etc.

Class "B" Fires, defined as fires in flammable petroleum products or other flammable liquids, greases, etc.

Class "C" Fires, defined as fires involving energized electrical equipment where the electrical non-conductivity of the extinguishing media is of importance.

Other Fires involving certain combustible metals or reactive chemicals require, in some cases, special extinguishing agents or techniques.

The fire hazard classification of an area is dependent upon the type of construction, the materials used, and the activities conducted in the particular area. It is desirable to know the fire hazard classification of school buildings. Three types of school hazard areas are identified as follows:

1. *Light hazard:* classrooms, hallways, stairwells, gymnasiums, and auditoriums.
2. *Ordinary hazard:* stages, boiler rooms, storage areas, shops, domestic science suites, manual training departments, and the like.
3. *Extra hazard:* places where hazardous materials are present or hazardous activities occur, as in spray painting.[14]

Important Factors

Persons responsible for school fire safety need statistics concerning the origin and causes of school fires so that they may know the record and can plan accordingly.

In a study of 300 school fires, the National Fire Protection Association has drawn some conclusion as to place of origin, causes, contributing factors, time of origin, and methods of detection. Some significant findings are shown in tables 1 through 5.[15]

---

[13] National Fire Protection Association. *Portable Fire Extinguishers* (NFPA No. 10). 1961. p. 6.

[14] National Safety Council. *Findings of the Coroner's Jury.* Chicago 11: The Council. 425 North Michigan Avenue. 1959. p. 2. (Mimeograph).

[15] These tables are taken (with slight adaptations to Office of Education format for tables) from the National Fire Protection Association's *Occupancy Fire Record: Public Schools* (Fire Record Bulletin FR-57-1). 1957. p. 23-24.

Table 1.—Places Where 300 School Fires Originated

	Basement	First story	Upper story	Attic	Total
Total	**65**	**137**	**49**	**43**	**300**
Classroom	3	32	13		48
Unused area	1			40	41
Furnace room	25	5			30
Storage room	10	10	6	2	28
Auditorium	1	16	3		20
Stage	1	14	3		18
Unknown usage	10	5	2		17
Janitor's room	4	5	2		11
Floor or ceiling		8	1	1	10
Gymnasium		9	1		10
Manual training room	2	6	1		9
Hallway	2	4	2		8
Kitchen	2	4	1		7
Wall	1	4	2		7
Laboratory		2	5		7
Under building or in yard					6
Office		3	3		6
Cafeteria	1	3			4
Teacher's room		2	1		3
Library		1	2		3
Student locker room		3			3
Utility room	1		1		2
Lavatory	1	1			2

Table 2.—Percentage Analysis of the Causes of 300 School Fires

Cause	*Percent*
ELECTRICAL	*34.5*
Wiring, overload or short circuit	29.1
Appliances, defective	3.9
Motors, defective	1.5
Heating and cooking equipment, defective or poor installation	*18.4*
Central heating systems	9.7
Smokepipes	3.4
Chimneys	2.9
Unit heaters and stoves	2.4
Incendiary	*12.6*
Vandalism	7.3
Other or unknown persons	5.3
Smoking and matches	11.6

Table 2.—Percentage Analysis of the Causes of 300 School Fires—Continued

Cause	*Percent*
Lightning	5.8
Spontaneous ignition: rags and mops	4.9
Gas explosions	2.9
Originated outside, spread to building	1.9
Children and matches	1.0
Light bulb in contact with stage curtain	1.0
Sparks on roof	1.0
Miscellaneous known causes	4.4
Total	100.0

Table 3.—Factors Contributing to Extent of Damage in 300 School Fires

	Number of fires
PUBLIC FIRE PROTECTION	
No water for fire fighting	57
Inadequate water for fire fighting	44
No public fire department available	38
Inadequate manpower and equipment	6
PRIVATE FIRE PROTECTION	
No sprinklers	277
No automatic detection or watchman	259
Employees fought fire, delayed alarm	7
Watchman protection substandard	5
Partial sprinklers, origin in unsprinkled area	2
CONTENTS	
Records destroyed	32
Oil and other flammable floor finish	30
Combustible stage curtains	11
Combustible decorations	7
Flammable liquids improperly stored	6
Combustible material improperly stored	4
Dirt in heating ducts	3
CONSTRUCTION	
Undivided attics	67
Open stairways	52
Nonfirestopped walls	46
Combustible interior finish	37
Fibreboard	25
Plywood	7
Miscellaneous other	5
Furnace not cut off	22
Nonfirestopped joist channels	21
No division walls where needed	17
Ventilating ducts terminating in attic	15
Unprotected openings in fire wall	11

Table 3.—Factors Contributing to Extent of Damage in 300 School Fires—Con.

CONSTRUCTION (con't.)

	Number of fires
Spread through heating ducts	8
Open pipe shafts	6
No proscenium curtain	4
Combustible air ducts	4
Open paper chute	3

Table 4.—Time of 300 School Fires and Operating Status of the School

Time	
Midnight to 6 a.m	102
6:00 a.m. to noon	58
Noon to 6:00 p.m	69
6:00 p.m. to midnight	71
Operating Status	
School closed	206
School occupied, not in session	50
School in session	44

Early discovery is important in the control of fires. Thus, it is of interest to note how the 300 fires studied by the Association were detected, as revealed in table 5 below.

Table 5.—*Ways in Which 300 School Fires Were Discovered*

Total			**300**
Teachers	9	Outsiders	205
Sprinkler alarms	5	Janitors	31
Explosions	4	Students	24
Watchmen	4	Unknown occupants	18

In another study of 21 large-loss school fires involving a total damage of $9,033,500 in 1956, the National Fire Protection Association[16] reported that 18 were in elementary and secondary schools and 3 were in colleges. Of these 21 fires, 6 were discovered while school was in session, but none promptly. This leads to a conclusion drawn by the Association that automatic protection-detection equipment is necessary for prompt discovery and control of fires even when a building is occupied. Other significant items reported in this study are the following:

- None of the schools had a central-station or fire department connected automatic alarm system.
- None of the buildings had a complete sprinkler system.
- None of the 21 large-loss school fires involved buildings of fire-resistive or noncombustible construction.
- All but two of these fires spread beyond the floor of origin.

[16] Twenty-one Large Loss School Fires. In *Large Loss Fires of 1956*. 1957. p. 311–12. (Reprint from the *NFPA Quarterly*, April 1957.)

- One of the two fires that did not spread beyond the story of origin occurred in a one-story building without a basement; the other fire originated in the attic while the school was occupied, and burned off the roof.
- Open stairways (14 cases) and walls that were not firestopped (7 cases) were the most common routes followed by the fires.

Effects of School Fires

The effects of school fires can never be completely calculated, especially in terms of monetary values. For example, the value of lives lost because of fire cannot be expressed in dollars and cents. In fact, the loss can be reported only in terms of cold statistics, which do not express the personal loss to families and relatives or the overall loss to society. The loss of, or damage to, property can be calculated, and where insured losses are high, insurance rates are also usually high, creating a demand for school funds that might otherwise be spent on the educational program itself. Moreover, if insurance coverage obligates insurance companies to pay total property replacement costs, the indemnification would not cover such intangibles as loss of time, inconvenience, and disruption to the educational program. Thus, students in particular and society in general lose when fires strike school buildings.

Fatalities and Factors

Since the numerical loss of life and the dollar value of property loss are the only factors which can be calculated, some statistics on these two factors are of interest. Records[17] reveal that in the United States and Canada, 821 lives were lost in 37 fatal school fires during the years 1900–58. Of the 821 lives lost, 358 were due to explosions, 14 to entering or re-entering the building, and 449 because of other factors. Many of this last group might have been saved except for delays in evacuating the building after the fire started.

Loss of life from school fires may be further emphasized by showing that each year during the past 50 years an average of 18 people (children, teachers, and firemen) died.[18]

Internal explosions, combustible contents, and inadequate or improper exits contributed to the loss of 40 lives in 35 fatal school fires. More specifically, half of these persons died because they could not

[17] Building Research Advisory Board, Committee on Fire Research. *op. cit.* p. 1.
[18] Educational Facilities Laboratories, Inc. *Ring the Alarm.* New York 22: The Laboratories, 477 Madison Avenue. 1959. p. 5–6.

get out. Insufficient exits caused the loss of six lives; open stairways, six; stairway obstructions, six; and barred windows, two.[19]

Explosions pose a special problem, but poor planning, improper maintenance, and illogical actions in emergencies have been a substantial factor of life loss from school fires.[20] Generally speaking, the causes of life loss in school fires are the following:

- ✦ *Delays* in detecting the presence of fire
- ✦ *Delays* in sounding the alarm
- ✦ *Delays* in leaving the building.

Property Losses

The number of fires and the amount of property loss in the case of public schools and colleges from 1956 through 1960, as estimated by the National Fire Protection Association, are shown in table 6.

Table 6:—Property Loss in School Fires: 1956–60[1]

Year	*Type of occupancy*	*Number of fires*	*Amount of loss*
1956 [2]	Schools and colleges	4, 100	$23, 824, 000
1957 [2]	do	4, 300	30, 199, 000
1958 [2]	do	4, 000	23, 981, 000
1959	Elementary and secondary schools.	2, 900	17, 350, 000
1960	do	3, 000	16, 100, 000

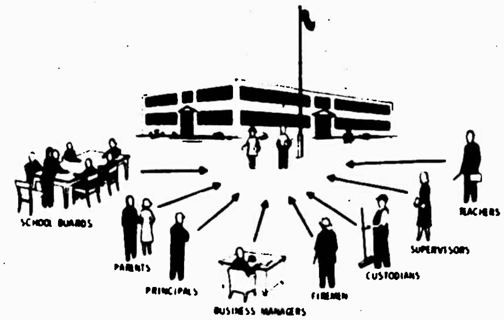
[1] From the Association's "Fires and Fire Losses Classified," *appearing each year in the October issue of its Quarterly.* (Table adapted slightly to conform with printing requirements of the present bulletin.)

[2] Detailed information was not available to separate the elementary and secondary school losses from those of the colleges.

This is an annual average of 3,660 fires, with an average annual property loss of $24,090,800. On the basis of school facility costs of $40,000 per classroom, including necessary related space (and this is a figure frequently quoted for classroom costs), more than 602 classrooms and related facilities, or the equivalent of more than 30 school buildings containing 20 classrooms each, go up in smoke each year. The country can ill afford a waste of this magnitude.

[19] National Fire Protection Association. *Occupancy Fire Record: Public Schools.* p. 3.

[20] Building Research Advisory Board, Committee on Fire Research. *op. cit.* p. 2.



Chapter II

Responsibility

THE THREE LEVELS of responsibility for public education in the United States are the National, State, and local. Authority at each level is based on constitutional or statutory provisions, or both. Certain unique functions are performed by designated agencies at each level. These agencies are supported by public funds, are responsive to public will, and have a common goal. One factor affecting the achievement of this goal is safety, particularly safety from fire.

Children of school age are normally required to attend school. Both the children and their parents have a right to expect safe living conditions during the period of attendance. Responsible officials and school employees have an obligation to provide these conditions. The obligation (legal and obligatory in some instances; moral and voluntary in others) is imposed by society in varying degrees at all levels of authority. Some specific areas of responsibility at each level are discussed here.

National Responsibility

Some obligation for promoting school fire safety is assumed—and accepted—at the national level by both Government agencies and non-Government organizations. The activities of these agencies and organizations in behalf of fire safety are not to be confused with duties and responsibilities of State and local agencies, often imposed by statute, to protect school children from fire. Historically, agencies and organizations at the national level perform their services voluntarily, aiming to improve and advance the knowledge about fire safety for the entire Nation.

Among the national agencies affiliated in some way with the Federal Government and making significant contributions in the area of fire safety are the Federal Fire Council, the National Academy of Sciences—National Research Council, the National Bureau of Standards, the Office of Civil Defense, the Office of Education, and the Office of Emergency Planning. Of these, the Office of Education and the National Academy of Sciences—National Research Council are more directly concerned with school fire safety. However, the Office of Civil Defense and the Office of Emergency Planning are currently devoting some attention to school facilities from the standpoint of fall-out shelters, safety from fire, and damage assessment, in case of enemy attack.

Office of Education

The Federal statute creating the U.S. Department of Education in 1867 authorized it to collect statistics and facts that would show the condition and progress of education, to diffuse information that would aid the people of the United States in the establishment and maintenance of efficient school systems, and otherwise to promote the cause of education throughout the land.[1] Although the title of the Department is now the U.S. Office of Education, and although congressional enactments and Executive orders have broadened the scope of its functions, those functions originally prescribed for it continue to serve as the basic purpose of the Office. On this basis, the Office has a responsibility for collecting and disseminating information on school fire safety, a responsibility discharged in many ways, this study being one of those ways.

Academy-Research Council

The National Academy of Sciences—National Research Council has a Division of Engineering and Industrial Research, of which the Building Research Advisory Board (BRAB) and the Committee on Fire Research (CFR) are units. The most recent contribution of this organization on fire safety actually grew out of an Exploratory Conference on School Fire Safety, called in 1959 by the American Institute of Architects, and attended by representatives of 14 national organizations. As an outgrowth of this conference, which supported the view that an impartial study of school fire safety should be initiated, the Educational Facilities Laboratories, Incorporated, made a grant to the National Academy of Sciences to conduct the study. Administrative responsibility was vested in BRAB, whose chairman, with the approval of the president of the Academy and the concurrence of the Committee on Fire Research, appointed a special committee on Safety to Life from Fire in Elementary and Secondary Schools. This special committee developed plans, worked out details, held conferences, heard panel reports, and finally prepared a report published under the title *School Fires, An Approach to Life Safety*. This report, approved by both BRAB and CFR, is a guide to assist responsible individuals and organizations in making value judgments that may be necessary in the interest of fire safety.

---

[1] *United States Government Organization Manual, 1959–1960.* Washington: Office of Federal Register, National Archives and Records Service, General Services Administration. n.d. p. 389.

Offices of Emergency Planning and Civil Defense

The Office of Emergency Planning and the Office of Civil Defense, created from the former Office of Civilian and Defense Mobilization by an Executive order, are attached to the Executive Branch and to the Department of Defense, respectively. The former is interested in assessing damages and in helping to plan the restoration of schools in case they are destroyed; the latter, in evaluating all public buildings, including schools, from the standpoint of defense shelters in case of enemy attack. In this connection, the Office of Civil Defense exercises a role of leadership in planning and organizing school fire safety procedures at both State and local levels. It seems pertinent to suggest, therefore, that school officials at all levels be aware of the availability of plans and suggestions which now emanate from that Office concerning school safety.

Nongovernmental Organizations

Several national associations or organizations, not affiliated with the Federal Government, but composed of voluntary membership of scientists, engineers, and other technicians representing industry, have developed various codes relating to safety in connection with the products and services supplied by the industries they represent. Many of these codes are recognized nationally, but are enforceable only as they have been *approved* and *adopted* by State and local governing bodies having jurisdiction.

According to the American Institute of Steel Construction, *The Southern Standard Building Code* (of the Southern Building Code Congress), *The Uniform Building Code* (of the International Conference of Building Officials), *The Basic Building Code* (of the Building Officials' Conference of America), and *The National Building Code* (of the National Board of Fire Underwriters) are nationally recognized.[2] Other codes having similar recognition are *Fire Prevention Code* of the National Board of Fire Underwriters; and *Building Exits Code*, *Flammable Liquids Code*, and *National Electrical Code* of the National Fire Protection Association. The *Exits Code* has evolved over a period of approximately 45 years and represents the work of hundreds of technical experts representing more than 110 companies which are members of the Association.

Other national associations or organizations which develop codes and standards relating to fire safety in the construction, occupancy, and utilization of school buildings are the American Society for Test-

[2] American Institute of Steel Construction. *Fire-Resistant Construction in Modern Steel-Framed Buildings.* New York: The Institute, 101 Park Avenue. n.d. p. 3.

ing Materials, the American Standards Association, and the International Association of Fire Chiefs.

State Responsibility

State responsibility for maintaining and operating the public schools is firmly established in this country. This concept is regarded by most people as being the best way to retain local control. In most States, much authority and responsibility for operating the schools has been delegated by the States, through legislative action, to intermediate, and local districts. Regardless of the amount of responsibility that is retained by the States or is delegated to local districts, the State legislatures have an obligation to provide for the safety of their school children or to enact legislation obligating local districts to do so. In some States, this obligation is jointly shared by the State government and by the local school districts. In general, State statutes concerning responsibility for fire safety in schools may be classified under one of the following groups:

1. Those giving responsibility, authority, and direction to State personnel
2. Those regulating the construction of public buildings
3. Those giving responsibility, authority, and direction to local personnel.

Statutes: Responsibility for Fire Safety

Fire safety records can be improved when responsible persons are authorized to enforce effective safety regulations. State statutes on this subject vary, but in general they assign limited authority, give permissive authority, or give specific authorization to certain officials or agencies to enforce applicable regulation. Some current State practices regarding authority for school fire safety are described here.

Chief State School Officers or State Departments of Education

The executive school officers of the bodies which administer State educational programs occupy the same relative position from State to State, and applicable statutes refer to the executive officers, the administrative bodies, or both. This is particularly true where the State superintendent of public instruction, because of his position, is the executive head of both the State board of education and the State department of education. In some States, the constitution and/or statutes themselves enumerate specific duties and obligations of the Chief State School Officer and of the State board of education; in others, the constitution and statutes delegate authority to the State board of education to develop rules and regulations concerning duties, obligations, and responsibilities of all public school officials. In these cases, State board regulations generally have the effect of law, but may be amended or repealed by the board at any time, subject to legal provisions for such a change.

The responsibilities of the Chief State School Officers and State departments of education regarding school fire safety may be grouped into three categories: (1) those relating to existing school buildings and new construction, (2) those relating to inspections, and (3) those shared with other State officials or agencies.

Existing school buildings and new construction.—In Idaho, the Superintendent of Public Instruction, as elective officer and executive secretary of the State board of education, is charged with carrying out the educational laws of the State and the policies and directives of the State board of education. In the field of school plant planning and construction, the State board of education, through its delegated agency—the State department of education—advises on, but does not assume responsibility for, school building structural design, strength, or durability; and for all new construction shares some measure of jurisdiction with the State electrical board and other State agencies.[3]

In Kentucky the Superintendent of Public Instruction, upon request, must provide consultative services to local districts on school building construction, but does not assume responsibility for structural design. The State board of education is authorized to adopt and enforce regulations for pupil safety. Responsibility for financing, planning, and erecting school buildings rests with local boards of educations; but building specifications and construction standards for schools must comply with those established by the State board of education, the State superintendent of public instruction,[4] and the State fire marshal.

West Virginia State board regulations require that preliminary drawings, as well as final plans and specifications for new building construction, be submitted to, and have the approval of, the State department of education.[5]

Inspection.—Most State boards do not assume responsibility for design or structural safety in schools and hence seldom inspect new or existing construction. However, New York recognizes the importance of school inspections, and requires the State commissioner of education to furnish fire inspection forms to local school officials for

---

[3] Idaho State Department of Education. *Manual of Regulations and Recommendations for School Building Planning and Construction.* Boise: The Department. 1958. p. 1–8. (Mimeograph).

[4] Kentucky State Department of Education. *Education Bulletin; Planning School Plant Construction* (vol. 26, No. 11). Frankfort: The Department. 1958. p. 10–34.

[5] West Virginia Council on Schoolhouse Construction. *Standards for Schoolhouse Construction.* Charleston: Division of School Plant Planning, State Department of Education. 1951 (rev.). p. 7–8.

their use in conducting and reporting the annual fire inspection of all school buildings, as required, before December 1 each year.[6]

In North Carolina, the school principal is required to file a building-inspection report and a fire-drill report once each month with an appropriate local official, as prescribed jointly by the State board of education, the State superintendent of public instruction, and the State insurance commissioner.[7]

Cooperation with other State offices.—North Carolina statutes require the Commissioner of Insurance, the Superintendent of Public Instruction, and the State Board of Education to develop and prescribe regulations for school fire safety. These regulations must be posted on a bulletin board in each school building.[8] In addition, the State officials are instructed to prepare a pamphlet containing printed instructions on school fire drills. Copies of this pamphlet must be sent to all principals of public and private schools. Each principal is required to conduct at least one fire drill each school month.[9]

In Pennsylvania, the Superintendent of Public Instruction, in consultation with the State police, is required to prepare a book of instructions on school fire safety.[10]

In New York, the Commissioner of Education is directed to prescribe and provide for local school use a course of instruction relating to fire prevention and the protection of life and property.[11]

State Fire Inspection Bureaus

In most States there are officials other than those concerned with education who have some responsibilities for school fire safety in existing and new buildings.

In Michigan, the State Fire Marshal's office reviews school building plans upon referral from the Superintendent of Public Instruction, as well as referrals by architects, engineers, or other school plant planners. Also, a representative of this office is required to inspect each building twice while it is under construction.[12]

In South Dakota, no plans and specifications for proposed new construction or alteration of existing school buildings can be advertised for bids until these plans and specifications have been reviewed and approved by the State Fire Marshal. Also, the plans and specifica-

---

[6] New York State Education Department, Bureau of Elementary Curriculum Development, Bureau of Secondary Curriculum Development. *Fire Prevention Education*. Albany: The Department. 1957. p. 60–61.

[7] North Carolina State Department of Public Instruction. *Fire Safety—North Carolina Public Schools* (Publication No. 316). Raleigh: The Department. 1957. p. 3–10.

[8] *Ibid.*

[9] *Ibid.*

[10] Pennsylvania State Department of Public Instruction. *A Program of Fire Prevention in the Schools* (Bulletin No. 399). Harrisburg: The Department. 1951. p. XIV.

[11] New York State Education Department. *op. cit.* p. 63.

[12] Michigan State Department of Public Instruction. *Fire Prevention Section* (School Bulletin No. 412). Lansing 2: The Department. 1959. p. 2.

tions for new construction must be prepared by a duly registered architect and a duly registered engineer.[13]

In Tennessee, the Commissioner of Labor, as State Fire Marshal, has the prescribed duty of enforcing laws concerning prevention of fires, explosions, installation and maintenance of fire extinguishing equipment, construction and maintenance of fire escapes, adequacy of exits, and suppression of arson. Fire insurance companies are required to file annual reports on their fire loss and damage in the State to this Commissioner,[14] who compiles a composite report of these losses.

The statutes of many States are not specific as to the right of the State Fire Marshal (or someone designated by him) to enter and inspect a school building without authorization by local school officials or without being petitioned to do so by interested citizens. However, the National Board of Fire Underwriters recommends that the Chief of a local fire department or the Chief of the Bureau of Fire Prevention (or any inspector thereof) should be permitted to enter school building premises at all reasonable hours for the purpose of making an inspection.[15]

Boiler Inspection

Some States have enacted statutes requiring periodic inspection of all boilers in public buildings and have created boiler inspection bureaus whose personnel are required to check these boilers for safety. In most cases, school districts pay a nominal fee on each boiler for this inspection service, but the early detection of defects which might cause explosions and subsequent fires is a precaution worthy of public support.

Electrical Inspection

North Carolina requires that an approved electrical inspector, or county fire marshal, shall make an inspection of conditions found in schools in his territory. The Commissioner of Insurance suggests that these electrical inspections be made every four months and that they be made immediately before school opens, immediately after school begins following the Christmas holidays, and immediately after the last day of the school year.[16]

[13] South Dakota State Fire Marshal. *Rules and Regulations Covering Public, Private, and Parochial Schools of All Grades, Primary Through Adult Levels.* Pierre: State of South Dakota. 1959. p. 7.

[14] Department of Insurance and Banking. *Statutes of Tennessee Relating to Arson and Fire Prevention.* Nashville 3: The Michie Co., Charlottesville, Va. 1950. p. 5–7. (Reprinted from Williams' Tennessee Code Annotated and 1949 Cumulative Supplement).

[15] National Board of Fire Underwriters. *Fire Prevention Code.* New York 38: The Underwriters, 85 John Street. 1960. p. 5.

[16] North Carolina State Department of Public Instruction, and Commissioner of Insurance. *Fire Safety—North Carolina Public Schools* (Publication No. 329). Raleigh: The Department. 1959. p. 9–10.

The electrical inspector is directed to check the entire electrical installation to determine whether wiring is safe or overloaded. When any alterations or additions are to be made in the wiring system of a school building, the electrical inspector must be notified before the work begins and he must be told the approximate date when it will be completed. When an electrical installation is completed, it must be checked by the electrical inspector, who must furnish a detailed report to the principal. The latter then supplies a copy of the report to the superintendent of schools.[17]

Statutes: Constructing and Equipping Fire-Safe Buildings

One phase of State responsibility for school fire safety and fire prevention is that of regulating school building construction. Strevell and Burke [18] emphasize this point when they say:

> Statutes should allocate responsibility for school building between State agencies and local units, provide authority for State or local units to formulate and enforce school building codes to protect the health, safety, and investment of public funds, and provide for the financing of school buildings. Although school building codes, regulations, or standards promulgated by the State educational agency are easier to change than statutes, this does not prevent them from imposing upon localities standards that have not been conclusively demonstrated by research and experimentation, that have become outdated, or that prevent desirable changes in educational policies, programs, methods, and practices.

If a building code has statewide application, it would seem expedient that provisions should be made for exceptions where necessary, and that the code should be limited to the fewest provisions necessary to protect health, safety, and comfort, and the future usefulness of the facility. Provisions which promote these points should be expressed as performance standards rather than as specific construction details, since some current construction methods and types of building materials may soon be outmoded.

New Construction and Remodeling

Many fire and structural safety features can be designed into new buildings or be included when buildings are remodeled. It is therefore of utmost importance that States establish some standards of safety in new school construction and apply them when existing school buildings are remodeled. If hazardous conditions exist in buildings that are not scheduled for remodeling, but must continue to be used

[17] *Ibid.*

[18] Wallace H. Strevell *and* Arvid J. Burke. *Administering the School Building Program.* New York: McGraw-Hill Book Company. 1959. p. 111.

for school purposes, the necessary corrections to protect the lives of the children should be made without delay. Procrastination in making these corrections could prove disastrous for the school district.

Classification of Construction.—From the standpoint of fire safety, buildings are usually classified according to the combustibility of the materials from which constructed. New York State designates buildings as class A, B, or C. From the standpoint of combustibility, these classifications are typical of those established by other States.

1. *Class A (fireproof and certain fire-resistant) buildings*
   Buildings, the walls of which are constructed of brick, stone, concrete, metal or other incombustible materials, and in which there are no wooden beams or lintels, and in which the floors, roofs, stairways and other means of vertical communication between floors and their enclosures are built entirely of brick, stone, metal, or other incombustible materials, and in which no woodwork or other flammable materials is used in any of the rough partitions, floor or ceiling structures, *or*

   Buildings, not more than one story above the ground, the outer walls of which are constructed of brick, stone, concrete, metal, stucco or other fire-resisting material and which are to be used as schoolhouses by school districts wholly outside of a city.
2. *Class B (fire-resistant) builidngs*
   Buildings, the outer walls of which are constructed of brick, stone, concrete, metal, stucco or other fire-resisting material.
3. *Class C buildings*
   Buildings which are neither class A nor class B as defined in items (1) and (2) above, including any such building which is rebuilt or altered so that it, together with any addition or vertical or other extension, is not fireproof or fire-resisting, as thus defined.[19]

Building Height.—The height of a school building affects school fire safety, since the evacuation time for a multi-story building is much longer than for a single-story building. For example, it normally takes only about one-third the time to evacuate a single-story building as a three-story building. Also, heat and smoke travel upward, making the upper stories more hazardous. If more than one story is necessary, careful attention should therefore be given to construction details and especial attention to designing safe routes of escape.

New York permits class A, B, or C construction for one-story school buildings. Two-story buildings should be of class A or B construction. Buildings of three or more stories should be of class A construction.[20]

Ordinarily, a story of a building consists of a group of rooms at or above grade level along at least one entire side, with at least 6 feet, 6 inches of head room. Michigan laws indicate that all school buildings

[19] New York State Education Department. *Planning for Safety in School Buildings.* Albany: The Department, Division of Buildings and Grounds. 1958. p. 13.
[20] *Ibid.* p. 5.

more than one story in height must be of fire-resistant construction, with materials that will afford at least 1 hour's resistance to fire.[21] Florida's State Department of Education indicates that insofar as practical buildings shall be constructed so that basement rooms are not necessary; and that only when special permission is granted by the State Superintendent of Public Instruction shall basements be included in school buildings.[22]

Corridors and passageways.—The design, construction, and width of corridors are important factors in school fire safety. New Jersey recommends that the width of primary corridors be no less than 7 feet in elementary schools and no less than 7 feet, 6 inches in secondary schools, unless there are other special conditions. An additional foot of space should be allowed in corridors for each row of lockers. Drinking fountains should not project more than 9 inches into the corridors and other recessed equipment not more than 6 inches. Each corridor on the first floor must terminate with a direct exit to the outside of the building. Minimum ceiling height for corridors is set at 7 feet, 6 inches. Secondary corridors or branch corridors may be somewhat reduced in width, but any passageway should not be less than 4 feet in width.[23]

West Virginia recommends that corridors be constructed of fire-resistive material, and that projection of equipment into them and sudden reduction in their width shall be avoided. If there are plans for future expansion of a building, its corridors may need to be 10 feet in width. Steps should not be placed in corridors, variations in elevations being accommodated by gently sloping ramps.[24]

Exits and doors.—One of the most important provisions for saving lives from fire is to have adequate exits and doors. Michigan recommends a minimum of two exits remote from each other on each floor; and if the seating capacity of a balcony exceeds 500 persons, three separate balcony exits must be provided. No required exit route of travel can be through openings with sliding, folding, or roll-down doors. Separate exits must be provided from stage wings so that those on stage can escape without entering the auditorium or gymnasium. The number and location of exits from any area are determined on the basis of occupancy and the nature of use of that area. Rooms having an occupancy in excess of 40 pupils must have two means of egress. Where two exits are required in classrooms, one shall lead to the corridor or to the exterior; the other may lead to an ad-

---

[21] Michigan State Department of Public Instruction. *op. cit.* p. 2.

[22] Florida State Department of Education. *Laws and Regulations Relating to School Building & Construction in Florida* (part II). Tallahassee: The Department. 1955. p. 3.

[23] New Jersey State Department of Education. *Schoolhouse Planning and Construction Guide.* Trenton: The Department. 1958 (with 1960 revisions). p. 32–34.

[24] West Virginia Council on Schoolhouse Construction. *op. cit.* p. 36–38.

joining room. Other places of public assembly, such as an auditorium, must have exits in accordance with regulations concerning public assemblage.[25]

Virginia requires a 22-inch unit of exit width of stairways and doorways, and the aggregate nominal width of first-floor exterior exit doorways must be the sum of:

- ✦ One unit of door width for each unit of required stairs from the upper floors
- ✦ One additional unit of door width for each unit of required stairs from the basement
- ✦ One additional unit of door width for each 4,000 square feet (one person per 40 square-feet gross floor area, times 100 persons per first-floor unit) or fraction thereof of gross area of the first floor, other than places of assembly
- ✦ One additional unit of door width for each 600 square feet (one person per six square feet net floor area, times 100 persons per first-floor exit unit) or fraction thereof of floor area of auditorium and gymnasium on the first floor.[26]

In determining the required width of egress from upper floors, Virginia stipulates that the unit of stairway width used as a measure of exit capacity shall be 22 inches. Fractions of a unit are not included except that an allowance of one-half unit may be made when 12 inches are added to two units of stair width. For floors above the first, stairways or ramps must be provided in accordance with the following formula:

$$\text{Number of units of exit width (one unit}=22\text{ inches)} = \frac{\textit{Gross area per floor (in sq. ft.)}}{2400}$$

NOTE: This formula is derived by figuring one person per 40 square-feet gross floor area (including outside walls) and one unit of stairway width for each 60 persons. The 1959 revision of Virginia's *School Planning Manual* omits specific details concerning methods of calculating widths of doors and exits, referring, instead, to the Virginia *Fire Safety Regulations* and to the *Building Exits Code* of the National Fire Protection Association.[27]

In determining the number of exit units required for places of assembly, New York uses these formulas:

Auditoriums: $\dfrac{\textit{Floor area (in square feet)}}{600}$

Stage (including wings): $\dfrac{\textit{Floor area}}{1200}$

Gymnasium: $\dfrac{\textit{Bleacher area}}{250}$ plus $\dfrac{\textit{remaining rectangular free area}}{600}$

Cafeteria: $\dfrac{\textit{Floor area}}{600}$

---

[25] Michigan State Department of Public Instruction. *op. cit.* p. 5–8.

[26] Virginia State Board of Education. *School Planning Manual* (37 : 7 : 209). Richmond 16: The Board. 1954.

[27] Virginia State Board of Education. *op. cit.* p. 208.

Exits are calculated on the basis of 22 inches per exit unit, and any exit units may be computed on the basis of one-half unit of exit width for every 50 persons of fraction thereof; but no exit can be less than 36 inches wide.[28]

Where exit requirements are not specifically stated or defined in the New York regulations, they must be in accordance with the current edition of the *Building Exits Code* of the National Fire Protection Association.[29] It should be recognized at this point that the *Building Exits Code* serves as a basis for many building exit standards and is recognized both nationally and internationally.

Michigan's standards concerning exit doors include the following regulations: All doors from classrooms and other student-occupied rooms must enter the corridors between exists, or there must be direct egress from the rooms to the outside. Required exit doors must be side-hinged, swing doors. Classroom doors to corridors can not be less than 36 inches wide, must open into the corridor, must swing in the direction of egress, and may not project more than 8 inches into the corridor at the termination of their swing. Required exterior exit doors from all traffic corridors must be equipped with panic hardware, and all required exit doors from places of public assembly must be equipped with panic hardware or push-pull hardware with no locking devices. If there are double doors from places of public assembly, either of which is equipped with hardware for locking or holding, the hardware that activates the top and bottom bolts on the standing leaf must be of the panic hardware type. Any single door that serves as an exit from a corridor directly to the outside must not be less than 40 inches wide. If exterior doors are glazed for visibility, the glazing must be shatterproof, or of wired glass, unless the glazing is located at least 6 inches above the opening hardware. All required exit doors must swing outward with the flow of traffic and can not be less than 6 feet, 8 inches in height. Double-action doors are not permitted in any exitway. Exit hardware for early elementary grade rooms to the outside must be installed low enough for easy operation by small children. Locks of all interior doors shall lock only by key and shall be operative from the inside at all times by a knob only, whether locked or not.[30]

Indiana requires all exit and entrance doors or gates to swing in the direction of exit travel and if provided with latches, these must be of the self-releasing type. All doors should be installed so as not to decrease the required width of any opening, passageway, or corridor. No single-width door of more than 3 feet, 6 inches in width is permitted and every exit door on the exterior of a building must have

[28] New York State Education Department. *op. cit.* p. 10.
[29] *Ibid.* p. 5.
[30] Michigan State Department of Public Instruction. *op. cit.* p. 5–8.

a fire-resistance rating of at least 1 hour. Doors opening from within a building into a stair or ramp enclosure may be of metal clad construction. No obstructions are permitted in any aisles or exits. No bars can be placed upon any windows or any other openings.[31]

Stairs, fire towers, and ramps.—Stairs and fire towers are important means of safe egress. Michigan recommends that all required stairways and stair shafts between floors be located on outside walls and be continuous to the outside grade. There must be at least two stairways, remote from each other, located so that there can be no dead ends in corridors, and so that they are always accessible from the corridor of every room used by pupils. Required stairway units of width are 22 inches, not including handrails and newels, but no required stairway less than 40 inches wide is permitted. No stairway may have a continuous run of more than 9 feet between landings. Ramps may be substituted for runs of fewer than 4 risers. No stair risers can be more than 7⅛ inches high and no tread can be less than 11 inches wide, exclusive of nosing. Winders are not permitted. Landing widths shall be not less than the width of the stairs they serve. Handrails varying in height between 2 feet, 6 inches and 2 feet, 9 inches are required on every stair. The top of a balustrade must not be less than 42 inches in height. If a stairway is wide enough for four lanes of traffic, center handrails must be provided. All stairways serving more than two stories must be enclosed in stair shafts of 1-hour fire rating, and must be equipped with "C" labeled fire door and frame assemblies, with no other glass permitted. Stairs shall be adequately lighted.[32]

West Virginia stipulates that stairways are not to be located in pockets or dead-end corridors, and that closets or storage spaces must not be located beneath stairs or landings.[33] Kentucky recommends that every schoolhouse of two stories or more shall be equipped with two stairways remote from each other and constructed of concrete or metal.[34]

New York does not permit fire escapes on new construction. Authorities in that State recommend that stairways of either two or four lanes be provided and stipulate that one unit of stairway (22 inches) is required for each 3,300 square feet, or fraction thereof, of gross floor area of the top story, with the exception of a building three or more stories high. Partial units of width are not counted. Width of stairways serving places of assembly is computed on the basis of 60 persons per unit of width. Each stairway from story to story must be in two

---

[31] Administrative Building Council of Indiana. *School Construction Rules and Regulations.* Indianapolis 7: The Council, State Board of Health Building. 1955. p. 23–24.
[32] Michigan State Department of Public Instruction. *op. cit.* p. 10–12.
[33] West Virginia Council on Schoolhouse Construction. *op. cit.* p. 38–42.
[34] Kentucky State Department of Education. *op. cit.* p. 1056.

or more runs. Any stairway serving two or more floors above the first or principal floor must be enclosed with fire-resistive material and closed off by automatic doors of Class "C" or better rating at each floor. No stairway for pupil use may be constructed with winders. All stairs and stairwells must be constructed of incombustible materials. Where stair requirements are not specifically defined, they must meet standards recommended by the current *Building Exits Code* of the National Fire Protection Association.[35]

Special areas.—Boiler, storage, and fuel rooms and other special areas are danger spots; they require special consideration. New York recommends that these rooms be of fire-resistive construction with a fire rating of 2 hours or more. If there are basement storage rooms, their walls and ceilings must be finished of fire-resistive material.[36]

Existing Buildings and Remodeling

Laws and regulations usually are not retroactive, and those pertaining to school fire safety often apply to existing buildings only when they are to be remodeled or expanded. Safety to life is of sufficient importance in our society to warrant the enactment of legislation that will give maximum assurance that existing school buildings will meet acceptable standards for fire safety.

Some specific State regulations illustrate this point. In Michigan an existing heating plant cannot be expanded in capacity if it is located beneath a portion of a school building. If an existing building is to be used for a different type of occupancy, all fire-protection requirements of the State for the new occupancy must be met before the building is converted to the new use. If an addition to a new building is to be constructed, the plans must include portions of the building being added to, showing existing exits and room occupancies which may be affected by the addition; if alterations, remodeling, or additions are being made to an existing building and the work in progress obstructs required exits, emergency-exit facilities must be provided while the building is occupied.[37] In Idaho, plans and specifications for alterations to existing school buildings must be prepared by a licensed architect in accordance with the Idaho Code.[38] West Virginia requires that metal fire escapes be provided for existing multi-story school buildings, in strict compliance with regulations of the State fire marshal, but such escapes are not permitted in new buildings, since enclosed fireproof stair towers are required.[39]

---

[35] New York State Department of Education. *op. cit.* p. 7–8.
[36] *Ibid.* p. 11.
[37] Michigan State Department of Public Instruction. *op. cit.* p. 2–20.
[38] Idaho State Department of Education. *op. cit.* p. 74–76.
[39] West Virginia Council on Schoolhouse Construction. *op. cit.* p. 74.

Essential Equipment

Adequate fire detective and protective equipment is essential to the total school fire-safety and fire-prevention program. The installation, operation, and maintenance of this equipment requires special technical knowledge. Some States recognize the significance of national standards of technical organizations and societies in this field and adhere strictly to them.

Fire extinguishers.—In South Dakota, fire extinguishers must be installed in schools in accordance with applicable provisions for the *Installation, Maintenance, and Use of Portable Fire Extinguishers* as described by the National Fire Protection Association.[40]

Detective and protective equipment.—Virginia's regulations indicate that when detection and sprinkler equipment is required because of hazardous conditions, this equipment must be of an approved type, and that there must be an approved water supply with adequate pressure. To secure approval, this equipment must comply with the standards of the National Fire Protection Association in the following publications:

Installation of Sprinkler Systems (NFPA, Pamphlet No. 13)

Fire Department Hose Connections for Sprinklers and Standpipe Systems (NFPA, Pamphlet No. 23)

Standpipe and Hose Systems (NFPA, Pamphlet No. 14)

Installation, Maintenance and Use of Proprietary, Auxiliary, and Local Protective Signaling Systems (NFPA, Pamphlet No. 72)[41]

Service Systems

The electrical heating and ventilating systems are important to the comfort of occupants of a building, and may govern to a great extent the activities which take place there. These systems may be particularly hazardous if not properly installed, adequately maintained, and operated with care. A number of States, recognizing the dangers of improper installation, operation, and maintenance of service systems, have adopted technical standards and codes to cover the installation and operation of these systems.

Electrical.—Michigan requires electrical wiring and apparatus used in schools to be installed according to the provisions of the State Electrical Law and the current provisions of the National Electrical Code. Also, all electrical plans and specifications must be approved by the local electrical inspection authority or by the State Electrical Administration Board. When the electrical installations are completed, an inspection must be made by an agency authorized to certify com-

[40] South Dakota State Fire Marshal. *op. cit.* p. 31.

[41] Virginia State Corporation Commission. *Virginia Fire Safety Regulations.* Richmond: The Commission. 1953. p. 96–97.

pliances. Exit lights shall be installed as required by law. Electrical wall outlets designated for sewing machines, electric irons, and other special appliances must be provided with switch controls and pilot lights.[42]

Heating, ventilating, and air conditioning.—The Florida State Board of Education recently revised its recommendations concerning the installation of ventilating and air-conditioning equipment. This equipment must be installed in accordance with standard practices for safe installation and use, as recommended by the *National Building Code*, 1955 edition. Concerning the use of fuel-oil and gas burners, the State board of education requires that they be installed in accordance with the standards of the National Board of Fire Underwriters and the American Gas Association. No type of heating equipment can be installed in such a manner as to allow the escape of combustion fumes into the interior of a building.[43]

Gas.—Indiana's regulations state that gas service must be installed in such a manner as to protect health and safety. No gas service main can be installed under a building, and gas service entering a building must be provided with an approved outside shutoff valve conspicuously marked. Where more than one gas outlet is provided in a room, there must be a master gas shutoff valve with a locking device.[44]

LOCAL RESPONSIBILITY

State Statutes

Most States have statutes or State board regulations which impose definite obligations and responsibilities concerning school fire safety on local officials. The scope and nature of these obligations and duties vary from State to State, but in general they are concerned with occupancy, maintenance and housekeeping, inspection and reports, fire drills, and safety education. The effectiveness of school fire prevention and safety programs will be determined by local acceptance of the responsibility.

Occupancy

Safety from fire for the occupants of a building may be dependent on the number of persons permitted in an area of assemblage at a given time. If more people are assigned to, or are allowed to enter, a given area than it was designed to hold, excessive time may be required

[42] Michigan State Department of Public Instruction. *op. cit.* p. 20.
[43] Florida State Department of Education. *Regulations of the State Board of Education of Florida.* Sections 209.3–209.5. 1960. (Mimeograph).
[44] Administrative Building Council of Indiana. *op. cit.* 40–41.

to evacuate the area in an emergency. The Oregon State Department of Education recommends that the principal determine the seating capacity of auditoriums, classrooms, and other building areas where pupils, parents, and others congregate and that he admit no more than can safely be seated in these rooms.[45] South Dakota's regulations state that in places of assembly where more than 200 occupants are seated in rows, the seats must be fastened to the floor. Where seats are not provided in rows nor attached to the floor, such as in some gymnasium seating arrangements, adequate aisles must be provided. Every aisle must lead to a door opening, or to a cross-aisle running to a door opening. In general, 15 square feet of floor space should be allowed for each chair of loose seating. The capacity of seating, such as bleachers without dividing arms, is determined by allowing 18 inches of seat room per occupant.[46]

Maintenance

Adequate maintenance and good housekeeping are especially important factors in fire safety. South Dakota's regulations stress the importance of maintenance and good housekeeping by requiring all premises to be kept clean and free of all combustible waste materials and rubbish. These must be burned or carted away from the premises within 24 hours after being collected. If stored on the premises for 24 hours or less, waste materials from all areas except offices and classrooms must be placed in metal containers with metal tops. Storage areas underneath stairs and stair landings are prohibited. All electrical installations and all appliances must be kept in good and safe repair. All such installation and repair practices must reasonably conform to national standards.[47]

Inspection and Reports

Regular inspections of a school building by qualified persons can contribute significantly to fire prevention in that existing hazards or hazardous practices may be discovered, reported, and corrected or eliminated.

In North Carolina, the principal is required to make certain that all stairways, corridors, halls, and exits are kept clear and free of obstructions; that all doors are in good working condition; that all combustible instructional materials necessary for the curriculum are stored in a safe and orderly manner; that all supplies, such as

[45] Oregon State Department of Education, and State Fire Marshal Department. *Fire Safety in Oregon Schools.* Salem: The Departments. 1960. p. 1.

[46] South Dakota State Fire Marshal. *op. cit.* p. 13–15.

[47] South Dakota State Fire Marshal. *op. cit.* p. 30–31.

oily rags, mops, sweeping compounds, and other substances which could ignite spontaneously or supply fuel for fire, are stored in an orderly manner; that trash is removed daily from the building; and that rubbish is not allowed to accumulate in attics, basements, or other remote places on the premises. Also, the principal is required to cooperate with outside technicians or officials who are required by law to inspect the building.[48] These statutes are rather specific in that they require the principal to cooperate in every way with the authorized building inspector, the electrical inspector, the fire marshal, or any other designated person making an inspection. He also reports to the superintendent of schools on all recommendations growing out of the inspections in order that corrections can be made. Furthermore, he must report to the superintendent concerning the failure of any inspector to make the required inspections. The principal must inspect each building in his charge at least twice each month during the regular school session. In his inspection he must determine whether:

1. All corridors, halls, and tower stairways used for exits are clear; and anything stored or kept in or on them could in any way interfere with the orderly exit of occupants.
2. All doors used for exits are plainly marked and are in good working condition. This requires *daily inspection* to see that:
   - ✦ All exit doors are unlocked at all times when the building is occupied by the public or for school purposes.
   - ✦ Doors serving as safety paths of egress (e.g., those on stairway enclosures) are closed and under no circumstances blocked open.
   - ✦ Outside stairs and fire escape stairs are free from all obstruction (including snow and ice)—particularly outside exit doors.
3. All storage rooms are kept locked when not in use.
4. Supplies, such as oily rags, mops, etc., are stored in a safe and orderly manner in a well-ventilated place or in an approved metal container with self-closing lid.
5. Combustible liquids are stored in approved containers with vapor-tight covers in proper locations.
6. Combustible materials are stored in a safe and orderly manner.
7. All accumulations of trash and rubbish are removed daily from all the buildings on the premises.
8. Fire extinguishers have been checked within the past year.

A written report by the principal to the district superintendent must be filed at the end of each school month during the regular school session. This report will:

1. State the date the last fire drill was held and the time consumed in evacuating each building.

---

[48] North Carolina State Department of Public Instruction and Commissioner of Insurance. *op. cit.* p. 4–9.

2. Certify that the inspection described above has been made as prescribed by law.

3. Give such other information as may be deemed necessary for fire safety as determined by the insurance commissioner, the superintendent of public instruction, and the State board of education.[49]

Kentucky requires local boards of education to cause every school building to be carefully examined annually by a competent insurance inspector who must make a written report to the board with recommendations based on his inspection.[50]

New York requires that annual inspections be made for fire hazards and that the inspections be completed by one of the following procedures:

- Employing persons either regularly or specifically, who, in the judgment of school authorities, are qualified to make such inspections
- Contracting for inspections by qualified persons
- Requesting inspection by the fire department of any city, town, village, or fire district in which the building is located
- Requesting inspection by a fire corporation
- Requesting inspection by other competent county officials.

When an inspection has been made, a report based on it must be filed in the office of the Director of the Division of Safety and with the Commissioner of Education.[51]

Fire Drills

Fire drills, properly planned and executed, are an important aspect of school fire safety. Guiding statements concerning the proper planning and execution of these drills, as illustrated by North Carolina and New York regulations, are given here.

In North Carolina, the school principal is required to conduct a fire drill during the first week of the school year and one each month thereafter during the school year.[52] A statement of the purpose of conducting a fire drill follows:

Purpose.—The purpose of fire exit drills is to ensure the safe evacuation of the building by the orderly use of all available exit facilities in case of an actual fire. Order and control are the primary aspects of the drill. While speed is desirable, it is not in itself an object and should be secondary to the maintenance of proper order and discipline. Proper drills, therefore, should establish habits of orderly exit and thereby prevent panic

[49] *Ibid.* p. 9–10.

[50] Kentucky State Department of Education. *Fire Prevention Manual: Course Study for Kentucky Boys and Girls.* Frankfort: The Department. 1959. p. 273.

[51] The New York State Education Department, Bureau of Elementary Curriculum Development, Bureau of Secondary Curriculum Development. *op. cit.* p. 60–61.

[52] North Carolina State Department of Public Instruction and Commissioner of Insurance. *op. cit.* p. 7–8.

and ensuing loss of life. Since fire is always unexpected, the fire drill likewise should be carefully planned to simulate actual fire conditions.

Conduct of drills.—Evacuation of buildings shall take precedence over fire-extinguishing operations, except when necessary to permit rescue of trapped occupants. In case of actual fire, regardless of size, the following procedure should be followed:

- *First,* sound alarm to evacuate building.
- *Second,* call fire department.
- *Third,* use fire extinguisher, if feasible.

The principal, as executive officer of the school, is charged by law with many responsibilities. It shall be his duty to prepare and post in each building under his jurisdiction written fire-drill procedures which shall include the following rules and regulations:

1. It shall be the duty of the principal to conduct a fire drill during the first week after the opening of school, and thereafter at least one fire drill each school month, in each building in his charge where children are assembled.
2. The principal shall devise a fire alarm or signal system audible throughout the building and grounds, for evacuating the building and for re-entering the building at the conclusion of a drill or actual fire. If an electric system is used, a substitute system should be devised for use in case the electric system fails.
3. Procedures by the principal shall define the fire alarm system for the school and shall include a chart showing the exits for all buildings. The principal and teachers shall instruct all personnel and pupils concerning these procedures.
4. Fire drills shall include all pupils and school employees. To the extent practicable, disabled pupils shall be seated near exit doors and assigned to rooms close to outside exits.
5. Fire drills shall make use of various ways of egress, particularly emergency exits which are not used during normal occupancy of the building. Actual fire shall be simulated by blocking different exits when conducting fire drills.
6. Fire drills shall be executed at different hours of the day or evening, during the changing of classes, when the school is at assembly, during recess or physical education periods, and at other times.
7. Fire drill procedures shall designate persons to search all general service areas (library, auditorium, toilets, etc.) immediately upon the sound of alarm.
8. Monitors from the more mature pupils (or from the School Patrol) shall be appointed to assist in the proper execution of all drills. Among other duties, they shall:

Help take care of any pupils incapable of holding their places in the line.

Hold exit doors open for evacuation, or close doors and windows when necessary to prevent spread of fire or smoke.

Carry signs reading "Stop! School Fire Drill!" (or equivalent for stopping traffic) when it is necessary for drill lines to cross roadways or streets.

Do other necessary things assigned by the teacher.

(Two substitutes for each monitor shall be appointed so as to provide proper performance in the absence of the regular monitors.)

9. Each class or group upon sound of the fire alarm and as directed by the teacher shall:

Form its ranks quietly and quickly, without obtaining clothing and personal items, and move in orderly lines without running toward exits.

Proceed to predetermined point on the grounds, sufficiently far away from the building and out of the way of other groups or fire department operations, for attendance check by the teacher.

Remain at this point until signal for dismissal or return to the building is given.

10. It shall be the duty of all teachers to instruct their classes in fire safety and fire prevention.

Fire-Safety Education

New York prescribes that the principal or person in charge of public or private schools of 100 or more pupils, or maintained in a building two or more stories high, must instruct pupils, by means of drills, in procedures for evacuating the building without panicking during an emergency. The drills must be held 12 times per year, 8 of which must come between September 1 and December 1. At least one-third of all these drills must make use of fire escapes, where they are provided. Signals for fire-escape drills are to be distinct from those directed through corridors. It is further required that the board of education or governing body must cause this section of the law to be printed in a handbook of manuals for the guidance of teachers.[53]

Fire safety education is generally concerned with developing an overall knowledge of fire and its causes, how it can be prevented, and how various precautions may prevent loss of life and property by fire. Fire safety education may include fire exit drills; but in a broader sense it may be integrated into the total school curriculum, or it may be conducted as a special program.

New York laws, for example, prescribe that the board of education and other persons in charge of public or private schools must arrange for giving a course of instruction in fire prevention in every school under their control or direction, and that the instruction shall be for not less than 15 minutes in every week.[54]

State Codes

State regulations prescribing safety standards for public buildings are promulgated by officials or agencies having jurisdiction, or by legislative action; are usually based upon, or patterned after, applicable national or regional codes; are usually less restrictive than local or

---

[53] The New York State Education Department, Bureau of Elementary Curriculum Development, Bureau of Secondary Curriculum Development. *op. cit.* p. 60.

[54] *Ibid.* p. 63.

municipal codes; and are often intended as minimum, not maximum standards. These State codes, or other standards which exceed them, must be observed throughout the States adopting them. In municipalities or other subdivisions of the State where local codes are more exacting and enforceable by local jurisdictions, the more rigid standards may be substituted for the State code. In general, State building codes formulated by executive agencies on the basis of performance, rather than on detailed specifications, permit greater flexibility, are more easily amended, and provide greater building safety than those promulgated by legislative bodies and written into the statutes. This flexibility and ease of amendment facilitates the elimination of obsolete codes, often permits the use of new and safer materials at less cost, and stimulates architects to be more imaginative in designing safe school buildings.

This is illustrated by a concept, supported by the American Institute of Steel Construction,[55] that "modern building codes should specify minimum fire-resistance requirements based on scientific studies and techniques of fire protection engineers" to determine fire hazards involved for each type and size of construction and for each class of occupancy. A scientific evaluation of the fire hazard determines the degree of fire resistance required for the building and for any structural component. Degree of fire resistance is expressed in terms of ability to withstand fire exposure in accordance with the requirements of the "Standard Time-Temperature Fire Test"[56] of the American Society for Testing Materials (ASTM).

The Concept of Local Responsibility

The concept that the overall program for school fire safety is a local responsibility is generally accepted. The effective discharge of this responsibility requires authority, leadership, interest, and a desire for fire safe schools—elements which involve members of the board of education and other local governing bodies, professional and other school employees, local civic organizations and community groups interested in school safety, and the school children themselves. The State may enact laws which authorize and require certain State and local officials to perform specific duties regarding fire safety, and

[55] American Institute of Steel Construction. *op. cit.* p. 2.

[56] The ASTM Standard Time-Temperature Fire Test (Specification E–119–58) of the American Society for Testing Materials is the universally accepted standard for classifying the duration and intensity of fires, and for measuring the degree of fire resistance provided by building materials and construction . . . the fire resistance rating is expressed as the time, in hours, that the assembly is able to withstand exposure to the standard fire before the critical point in its behavior is reached. These tests indicate the period of time during which structural members such as columns and beams, are capable of maintaining their strength and rigidity when subjected to the standard fire. They also establish the period of time during which floors, roofs, walls, or partitions will prevent fire spread by protecting against the passage of flame, hot gasses, and excessive heat.

which may empower State and local governments to levy and collect taxes for the purpose of promoting and enforcing regulatory construction codes, developing sound maintenance and operation practices, and implementing a plan designed to improve the human factor in relation to fire safety. Local and State responsibility for, and efforts to, improve school fire safety deserve recognition by, and help from, the National level. Primarily, this help should be in the form of sound information which will aid in organizing and promoting school fire safety programs.

New Construction

Public school buildings are generally regarded as belonging to the State, but the local board of education, as an agency of the State, is in control and should make final decisions about them within their scope of power as delegated by the State. The essential function of the State in planning school construction is to provide advisory and consultative services to local districts through the State department of education. This is a cooperative relationship in which certain duties are performed by the State and others by the local board of education, as illustrated by school plant planning procedures in several States. The local board of education should recognize its responsibility for fire safety by making sure that safety features are incorporated in all plans for new construction.

Board of Education

The American Association of School Administrators affirms the position that local boards have responsibility for safety, and cautions against a conflict between authority and responsibility by stating:[57]

> The board of education is charged with the responsibility for caring for children's physical safety and mental well-being, but authority sometimes has been assumed by others—resulting in conflict between authority and responsibility . . .

In Kentucky the local board of education employs specialists, including administrators, teachers, custodians, architects, contractors and consultants to carry on its school plant planning operation, to advise it on technical and professional matters, and to perform other assigned tasks.[58] The local board of education may obtain advice from school building specialists, educational consultants, State department

[57] American Association of School Administrators (NEA). *Safety, Sanity and the Schools.* Washington 6: The Association, 1201 16th Street NW. 1959.

[58] Kentucky State Department of Education. *Educational Bulletin: Planning School Plant Construction.* p. 1065–66.

of education personnel, architects, engineers, technical consultants, and from the local district governing body. Each of these performs a unique function and has a definite responsibility in school plant planning. Even though many groups, agencies, and individuals may help in planning new buildings for safety, the local board of education must approve the plans and accept the completed building on behalf of the school system.

In summarizing the function and role of the board of education it may be indicated that the local unit or district is a legal subdivision of the State, created for the purpose of operating and maintaining public education. This unit has enabling powers, both specified and implied, granted either by the Constitution or by the statutes of the State. The school board, as an agency of the State, represents the interests of both the local and total citizenry of the State. Some of the duties of the board of education may be delegated, but its basic function is policy making. It must make the final determination of the needs for school facilities except in those instances where its decisions are subject to review by a State agency or some other government agency.

Superintendent of Schools

The superintendent of schools recommends policies for board consideration, provides guidance for the school plant planning committee, directs the school building program, and furnishes evaluation reports to the board. He is expected to visualize the procedural steps in planning and constructing school buildings. As executive officer of the board, he is responsible for school safety which includes fire prevention; thus it is his duty to advise the board and other planners of their moral and legal responsibilities for fire safety construction.

Building Planning Committees

Local school building planning committees may be composed of individuals from the professional staff, consultants, and lay citizens. Many groups may have a role to play in planning, constructing, operating, and maintaining fire safe schools—including architects, firemen, principals, teachers, students, custodians, maids, maintenance personnel, and outside agencies. However, the board of education generally initiates action by inviting members from all interests and cross-sections of the community to function as a central planning organization. It is important that this group be given specific responsibilities by the board of education. One of the committee's functions should be to recommend specific fire safety features for the buildings that are being planned. It should advise the board of its findings and should be disbanded upon completion of its purpose.

Planning Division

Many large school districts have an administrative organization with a division for school plant planning. At the head of this division is an assistant superintendent in charge of buildings and grounds (or someone with a similar title). Recognizing that the planning of new construction and the management of existing properties are time-consuming and require technical competencies for which the executive officer may not be trained, boards have wisely delegated many responsibilities relating to school physical facilities to an assistant superintendent whose background and training is in the field. In districts where this type of administrative organization prevails, duties and obligations relating to fire safety, previously discussed as obligatory on the superintendent, become the responsibilities of the planning division and its staff.

Community Agencies

Planning and constructing new school buildings requires the cooperation of various governmental units and agencies. For example, advice may be obtained from local building inspectors and local fire chiefs. Also, local insurance agents could be consulted and the building plans might be reviewed by the fire protection engineers of the State inspection and rating bureau. The ability of a school system to proceed with a capital program often depends upon agreement by other units of government. The administrator will therefore need to establishing cooperative working arrangements with all governmental units having responsibility in this area.

Existing Buildings

The way in which existing school buildings are used, operated, and maintained will affect their safety from fire hazards. These daily building operational procedures are determined to a great extent by what the community, the board of education, and the superintendent of schools believe to be important with respect to life and fire safety. The initiative which these groups exert will influence the relative safety of a specific building from fire.

The management of existing school buildings is a grave responsibility since it is concerned with safety to life and the preservation of public property. This responsibility is both moral and legal and rests on all who have accepted school stewardship, including parents. Most of the responsibility, however, rests with the local board of education and its superintendent of schools. The superintendent, for example, should prepare (or cause to be prepared), with the approval of the board of education, an emergency evacuation plan and establish the responsibilities and duties of all personnel and employees of the school district. In addition, he should plan, or require principals to plan in detail, a program for each building, including such things as the sounding alarm, fire prevention, plans for evacuating the building, first aid, and fire fighting procedures.[59]

Carroll [60] emphasizes that in planning for fire safety, the superintendent and school board should stress the importance of fire prevention to principals, teachers, and others interested in the problem of fire safety. He states that unsound planning will result in:

1. Unnecessary prolongation of life of inadequate and relatively unsafe buildings
2. Unbalanced programs in which too much emphasis is placed on one aspect of safety with the consequent neglect of other equally important aspects
3. Expenditure of funds for the same devices in all schools, though some of these devices would be of limited value in certain situations
4. Too much reliance on design, construction, and devices, with too little regard for the importance of human elements in the planning for fire safety—attitudes of understanding, cooperation, and acceptance of responsibility.

In summarizing the board's responsibility for school fire safety, the American Association of School Administrators [61] indicates that the board should direct the superintendent to comply with existing fire safety regulations, make regular inspections of the school plant, and review periodically the adequacy of the existing safety program. Furthermore, the board's willingness to spend funds on correcting authenticated inadequacies will speak much louder than any policy made toward problems of overcrowding, or other procedures which affect fire safety.

---

[59] New Jersey State Department of Education. *Smoke Signals*. Trenton 25: The Department. n.d. p. 1.

[60] Charles F. Carroll. Fire Safety Through Sound Planning. *The Bulletin of the National Association of Secondary-School Principals*, 45: 101–06. February 1961.

[61] American Association of School Administrators. *op. cit.*

The superintendent is specifically mandated by the board of education to carry out its fire safety policies, according to the American Association of School Administrators: [62]

> The superintendent, as the executive officer of the school board, operating within broad written board policies, must assume major responsibility for initiating and maintaining a well-coordinated, system-wide program of school safety. To do this, he must enlist the support of many people—teachers, principals, custodians, maintenance men, children, and others. Too, the superintendent must not overlook an opportunity to enlist the support of public and of fire protection and safety organizations existing in the community and in the State.

In an address to the Fire Marshal's Association of North America, Morrill [63] stated that one of the major causes for school fires is human failure, failure to do the right thing at the right time. He emphasized that it is the duty of the superintendent of schools to direct the formulation of a plan of action which can and will work when catastrophe strikes.

Administrative lines of authority should be clearly established for each situation anticipated. This is of particular importance since the administrator and teachers are in positions of leadership during emergencies. The success of a plan will depend on a clear understanding of the responsibilities of each person in the execution of the plan. Also, every person in a position of authority in the chain of command from the principal down should have a substitute who can assume responsibility.

Principal.—The school principal, the responsible officer designated to implement policy within his building, should make frequent and thoughtful inspections in order to be aware of all hazards under his jurisdiction. He should have periodic conferences with his staff to be sure that all existing fire safety regulations and individual responsibilities are understood. He is responsible to the superintendent's office for developing evacuation plans, conducting regular and surprise exit drills throughout the year; checking fire fighting equipment and equipment and training adults in his building to use it; completing inspection report forms, and training staff members to function adequately in emergency situations.

The principal should designate one or more assistants to discharge specific duties during a fire emergency whenever he, the principal, is absent. The teachers, janitors, and pupils should be familiar with

---

[62] *Ibid.*

[63] Radcliffe Morrill. *The School Superintendent's Responsibility for Fire Safety.* Boston 10: National Fire Protection Association, 60 Batterymarch Street. p. 1. (An address to the Fire Marshals Association of North America, presented June 1, 1959.)

this alternate line of authority. Also, the principal should prepare or supervise the preparation of exit plans for his building and rules relating to them, all of which should have board-of-education approval. Custodians and teachers should be assigned, and held responsible for, specific responsibilities, such as seeing that exits and exit lanes are free of obstruction and that alarm systems are properly maintained.

Teachers.—Teachers should instruct pupils in procedures and regulations to be followed during evacuations. They should post instructions concerning exit drills and evacuation procedures in all rooms used by them, should assign monitors and instruct them in their duties, and should set arrexample for their students.

The American Association of School Administrators[64] defined the teachers' responsibility in broader terms and stressed the fact that they must have predetermined responsibilities covering emergency situations that may require immediate action. They must be able to exercise sound judgment and obtain coordinated, collective action from their pupils during an evacuation, particularly if they encounter unforseen obstacles, such as blocked stairways or untenable passageways.

Custodians and maids.—School officials should carefully and cooperatively work out with custodians and maids their responsibilities and duties under both emergency and daily conditions. Custodians should work closely with the professional staff to investigate and report unsafe practices and conditions existing in and around the school. They should keep all exit passages clear of obstructions, check rails on stairways at frequent intervals, maintain good housekeeping practices, and understand the operation of emergency lighting and sprinkler systems if these are provided. The custodian force should know how to maintain and operate all alarms, detection devices, and other equipment related to fire prevention, evacuation, and control. In general, the assignment to custodians should be sufficiently flexible for them to use some discretion when pre-determined plans may not be followed.

Other duties and responsibilities of school plant operating personnel might include reporting periodically to the principal in writing concerning fire protective equipment, knowing the location of the gas meter and the cutoff valve, and having a key to it readily available if an emergency requires that gas be shut off, stopping motors of ventilating fans and other equipment to retard the spread of heat and smoke when the emergency exit alarm sounds, assisting in the evacuation of handicapped children if necessary, and performing first-aid fire fighting duties.

Maintenance personnel.—Since they are not usually stationed at a particular building on a permanent basis, maintenance personnel may

---

[64] American Association of School Administrators. *op. cit.*

not have specific assignments as to building evacuations or exit drills. These people, however, should have definite responsibilities for maintaining buildings in a fire-safe condition. Physical hazards which may cause fires (such as frayed insulation on electric wires, damaged electrical outlets, switches, and motors, overloaded circuits, exposed wood surfaces in furnace rooms, and other conditions constituting fire hazards) should be corrected by them when they work at a particular building.

Community Groups

The community as a whole also has a responsibility for fire safety. The American Association of School Administrators[65] endorses the principle in the following statement:

> The concept of safety is not an absolute factor—it is a relative concept. There will always be the threat of fire and, while the community cannot completely banish the possibility of a destructive fire, it can make a possibility even more remote.

Although the safety of any building is dependent on school authorities, it will always be dependent on what the community holds important. However, before a community can act intelligently it must know what exists and what can exist. It can have safety if it desires to do so, but only if it provides the finances and puts forth the effort to correct professionally authenticated inadequacies.

The chief of the local fire department can render assistance in the school fire safety program. For example, a qualified fireman might meet annually or semiannually with instructional and custodial personnel, presenting information on, and giving instructions about, fire safety. These instructions could cover such topics as handling and use of portable fire extinguishers, first aid fire fighting, fire-safe housekeeping, building inspection techniques, and the operation of internal building fire alarm systems. Also, the fire department could inspect school buildings, reporting if hazardous conditions were found, and could advise school authorities concerning removal or correction of these conditions.

The students themselves constitute another group whose responsiveness to safety measures helps determine the effectiveness of these measures. They can be taught to identify fire hazards, and in many instances can assume some responsibility for eliminating the hazards they identify. In this way they recognize that safety education is a cooperative enterprise which requires them to observe safety rules and regulations at all times.

---

[65] American Association of School Administrators. *op. cit.*

Fire Safety Practices

Three activities to be performed at the local level are especially important in a fire safety program: inspections, exit drills, and instruction in fire safety.

Inspections

The two main types of safety inspections for schools are the daily and the periodic. Daily inspections should be conducted by the principal and his custodians; periodic, by engineers, by personnel of the local fire department, or by insurance inspectors. Regardless of who conducts them, inspections are made for the purpose of detecting deficiencies in such things as exit hardware, detection devices, alarm systems, emergency lighting, fire fighting equipment, heating systems, electrical wiring, and appliance installations.

Inspectors—Fire inspectors for school buildings should be appointed only because they possess specialized knowledge which will enable them to identify hazards with minimum disruption to the education program. Their inspections can serve as the basis for recommendations to school officials concerning necessary improvements to buildings where deficiencies are found. Such inspections are of particular value in preventing disaster when school authorities cooperate by correcting or eliminating the hazards.

Surveys—Some States have laws or regulations that require inspections to be made by specialists such as fire marshals, but the diverse nature of the problem makes the team approach more effective.[66] Seldom is one person qualified to evaluate all diverse elements, such as structural safety, fire hazards, mechanical and electrical deficiencies, evacuation problems, space requirements for pupil circulation and types of occupancy, principles of protection, and established administrative policies and decisions. It is therefore suggested that an educator, an architect, and a fire protection engineer serve as the basic members of a survey committee (who might be supplemented by others) to inspect school buildings for fire safety. The type of survey would attempt to find answers to the following questions:

- Where could fires readily start, and by what means?
- If a fire started, when and how could it be detected?
- How would the alarm be sounded and from where?
- How rapidly might the fire develop in size and severity?
- How would the answers to these questions influence evacuation efforts?

---

[66] Building Research Advisory Board, Committee on Fire Research. *School Fires: An Approach to Life Safety*. Washington: National Academy of Sciences—National Research Council. 1960. p. 87.

- ✦ **What fire safety equipment and devices are provided, and what is their current condition?**
- ✦ **Does this site provide for evacuation space and easy, quick access by fire fighters and emergency personnel?**[47]

Accepted administrative procedure makes a principal responsible for his building and the activities carried on in it. He may delegate some of his responsibility to others, but he should develop an inspection check list for his school. (See appendix A for samples.)

Exit Drills

Exit drills (or "fire drills," as they are often called) are an integral part of the principal's fire safety program. The principal should establish in the minds of pupils an awareness of the need for rapid and efficient exit drills, pointing out that a building or portion of a building may become untenable within a few minutes after a fire starts and that the untenability is often caused by smoke at first, and then by heat. He should also point out that fires are not always discovered immediately, thus leaving very little time for evacuation. Normally, it takes one minute to evacuate each floor of a school building. After the alarm has been sounded, it would take three minutes to evacuate pupils from the third story of a building. In some instances, it should be made clear that three minutes of time for safe evacuation purposes may not be available.

Purpose and frequency.—The exit drill should be a learning experience. It should be planned to meet all conceivable situations, so that when an emergency arises, teachers and pupils will leave the building without panic or disorder. Most exit drills should be conducted as surprise drills, and an average of two drills per month would not be too many for life safety purposes.

Building exit plan.—The principal needs much information about a building, its occupants, and the community, to develop an exit plan. This information should include data on adequacy of the building and its exits in relation to evacuation speed; activities and age range of occupants; where each group is located in the building; physical infirmities and handicaps of students and staff; types of community services available in case of an emergency; and the time required for personnel from the fire, police, and public health departments to arrive on the scene.

[47] *Ibid.*

With these types of information, the principal should work cooperatively with his staff and perhaps the local fire chief to develop a plan that:

- ✦ Designates normal evacuation from all areas of the building and establishes alternate routes in case the ordinary routes cannot be used.
- ✦ Insures rapid, orderly evacuation of all occupants.
- ✦ Permits two teachers in adjacent rooms to combine their groups so that one teacher can lead the children and the other maintain order along the line for the two groups.
- ✦ Trains pupils to leave the building in an orderly fashion without teacher supervision if necessary.
- ✦ Insures adequate care of handicapped pupils and teachers.
- ✦ Specifies definite outside assembly areas or stopping points at least 50 feet from fire hydrants for each group as well as rapid roll call after evacuation.
- ✦ Designates staff members to check toilets and other special areas for pupils who may not be at their regular stations at the time of evacuation.
- ✦ Instructs students in physical education classes as to desirable procedures concerning street clothes.
- ✦ Provides for window and door closure, and turning off motors, burners, and gas valves.
- ✦ Cautions against retrieval of personal belongings.
- ✦ Gives explicit instructions as to line of authority.
- ✦ Instructs the children concerning future school activities in case the building must be abandoned temporarily.
- ✦ Designates key personnel (not students) to re-enter the building, if feasible, to do first aid fire fighting.
- ✦ Provides instructions to students and teachers for crossing streets or highways in case conditions become untenable on school grounds.

The alarm.—Sounding of the fire alarm and the procedures which take place after the alarm sounds are especially important if a safe orderly evacuation is to be achieved.

The principal should make certain that all school personnel (teachers, custodians, maids, lunchroom workers, and students) know exactly where each alarm station is located in the building (or on the premises) and that they fully understand the steps to be taken to activate the signal.

In case of fire, or any suspicion of fire, the alarm should be sounded immediately from the nearest signal box by the individual who discovers the fire or suspects there is one. When the fire alarm signal is given, the building must be evacuated with no exceptions. The principal should select teachers, on a rotating basis, to ring the alarm in practice drills. This policy will cause them to become acquainted with the idea and help them overcome any fears of breaking the fire alarm glass.[20]

---

[20] Radcliffe Morrill. *op. cit.* p. 8.

When the alarm sounds, or the fire gong rings, the following procedures should be followed:

- Pupils stop work immediately; turn off motors, torches, etc., according to a prearranged plan; pupils at blackboard return to regular stations.
- Teacher takes charge, picks up class record, signals pupils to rise, proceeds to exit door of room, instructs students to leave books and not to seek wraps.
- Teacher starts pupils moving according to the prearranged plan, forming lines in corridors if space permits.
- Teacher of one of the two rooms leads lines, directing change in route if designated route is blocked; directs monitors, if needed, to hold exit doors open, or to assist with street crossing. Teacher of companion room takes charge of other monitors, who assist in searching and clearing special areas, help the handicapped, then follow the lines.
- Pupils in toilets and other special areas join nearest lines in making exit, proceed to stopping place; then with permission of those in charge at the stopping place, rejoin their own groups, reporting to their own teacher and taking their places in line.
- Custodians should shut off all electric motors, close valves of gas supply lines, stop all ventilating fans, start first aid fire fighting, and render other assistance when and where needed.
- Finally, the principal, assistants, and custodians make a final check to ascertain that the building is clear of occupants.

When the drill is completed, the principal should discuss it with his staff; if necessary, he should conduct another drill within a few days for the purpose of correcting observed weaknesses. Custodians should report in writing on the operation of alarm equipment and on defects, if any, of exit doors and anti-panic hardware.

Re-entry.—Every precaution must be taken to prevent unauthorized persons from returning to the building before an all-clear signal is given. This signal should be predetermined, understood, easily recognized from other bell signals; otherwise pupils might re-enter a burning building.

Appendix B contains an *Emergency Drill Check List* prepared by the National Safety Council.

Fire Safety Education

The third area of responsibility for fire safety by the local school system is the area of fire safety education. The teaching of fire safety will be reflected, both in the school and in the community, by the actions and attitudes of the students. In North Carolina this concept is emphasized by the State Department of Public Instruction in the following statement:

> Society is sure to reflect what is taught in the schools. Teach children about fire prevention and there will be fewer buildings burned and fewer lives lost as a result of fire. The service which the school must render in

this matter is very great. Teachers and pupils have obligations and responsibilities in preventing fire.[69]

Objectives.—The report of a study conducted by the National Safety Council reveals that local school systems most often mentioned the following objectives of fire safety education:

- To create an awareness of fire hazards.
- To educate pupils and teachers to evacuate a building, quickly and quietly.
- To develop an awareness of the need for fire safety in every day living.
- To eliminate many existing fire hazards.
- To present a fire prevention program.[70]

Approach.—There must be a positive approach in teaching fire safety education. The things that are to be done should be emphasized rather than those that are not to be done. Fire safety education should be correlated with other subject areas in the school curriculum. Choice of material, manner of presentation, and sequence of topics should rest with school officials themselves, but it is important that instruction in this area begin at the elementary level.[71]

Local Codes

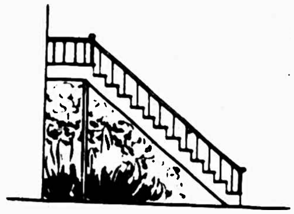
In school districts where local construction codes or other local regulations concerning maintenance and occupancy of public buildings are more stringent than State codes and regulations, there may be a greater degree of safety from school fires than in districts depending entirely on State regulations. Usually, cities and densely populated suburban communities adopt the more stringent codes because danger to life and property from fire is greater in densely populated areas, where buildings and houses are in close proximity, than in sparsely populated sections. Where rigid local controls are adopted, however, there is a danger that they may be permitted to become obsolete, thereby serving to block the use of new and better materials for construction and hence contributing to unsafe fire conditions rather than eliminating them. Local governing bodies can prevent this danger by being alert to new developments and by amending their codes, as necessary, to accommodate newer, safer standards.

---

[69] North Carolina State Department of Public Instruction. *Fire Safety—North Carolina Public Schools* (Publication No. 316). p. 11–15.

[70] "Your Fire Safety Education Program May Be Inadequate." *Safety Education.* January 1957. p. 6–8

[71] New York State Education Department, Bureau of Elementary Curriculum Development, Bureau of Secondary Curriculum Development. *op. cit.* p. 10–18.



Chapter III

Hazards

SCHOOL FIRE HAZARDS often exist, or may be permitted to develop, both inside and outside school buildings. Persons responsible for planning and operating educational facilities must be aware of the nature of these hazards and must eliminate those that exist and work diligently to prevent others from developing, if our schools are to be reasonably safe from fire. This chapter is concerned with a number of factors which influence the fire hazards of sites and of buildings.

Sites

School sites, whether currently occupied by buildings or intended for future ones, may have inherent fire hazards, or may acquire them as a result of business and other activities conducted in the neighborhood. On the other hand, the sites may have certain characteristics that contribute to fire safety, or they may be located close to community fire safety facilities. It is important that school officials select and acquire school sites well in advance of actual need. When considering new educational centers, these officials can have some assurance that new sites may not soon develop into fire hazards if they seek the advice of, and work cooperatively with, State and local planning agencies. Three important factors determining the number and extent of fire hazards associated with school sites are site location, size, and physical characteristics.

Location

Three major elements are important to school site location as regards fire safety: convenience, accessibility for the population served, and absence of undesirable exposure. From the standpoint of school fire safety, the last two are immensely significant.

Community Services and Protective Facilities

Typical of many State regulations concerning location of school sites is one by the Georgia State Department of Education which identifies residential or rural areas as having the most desirable environment for schools. However, in these areas consideration must be given to the availability of community utility services, particularly electricity, water, telephone, and gas. An adequate and continuous supply of water for both sewage service and emergency fire fighting is especially important. Telephone service is needed to summon help in case of fire. Also, the availability of adequate community fire service is of first importance. A school building should be so located that movement of equipment from the fire department to the school will not be impeded by poor streets or roads, that this equipment will not have to be moved great distances, and that the activities of the department in response to any alarm will not create safety problems for the school.[1]

Exposure

The importance of locating a school so that the hazards of undesirable exposure are minimized is often stressed. Connecticut[2] emphasizes that schools should not be located in congested industrial areas or on heavily traveled highway; or near railroads, airfields, fire stations, stores, mills, or factories—all of these usually objectionable because of noise, activities carried on in connection with them, or other physical hazards. Another type of exposure is that created by the proximity of hazardous enterprises, such as the storage of gasoline, butane or propane gas, and other flammables, and the presence of gas and electrical transmission lines. Fire hazards for schools from these sources increase in proportion to the number and extent of the installations in the school neighborhood.

Size

From the standpoint of fire safety, the size of a site should be such that it does not of itself create dangers, but instead satisfies several requirements including ample space for:

- Students and school personnel to be evacuated
- Evacuated personnel to assemble at a safe distance from the building
- Fire fighting equipment to maneuver without endangering lives.[3]

Other desirable features of the school site are that an adequate number of fire hydrants, with an ample and constant supply of water under correct pressure, be strategically located on or near the premises; that entrances and driveways be designed to accomodate fire

[1] Georgia State Department of Education. *A Guide for Selecting School Sites.* Atlanta 3: The Department. 1953. (Mimeograph)

[2] Connecticut State Department of Education. *School Sites, Selection and Acquisition* (The School Building Economy Series No. 3). Hartford 15: The Department. 1960. p. 8.

[3] Building Research Advisory Board. Committee on Fire Research. *School Fires—An Approach to Life Safety.* Washington: National Academy of Sciences—National Research Council. 1960. p. 28.

department equipment; that driveways be laid out so that children will not be endangered by the arrival, maneuvering, or departure of this equipment; and that entrances and driveways be kept open at all times for quick admission of fire fighting equipment.

Physical Characteristics

McLeary [4] suggests that a rectangular site whose length is not more than four times its width is most desirable. The site's elevation should not be lower than the immediate, surrounding area and the skyline from all sides of its building should not be more than 30 degrees.

Buildings

School buildings may be designed, equipped, maintained, and utilized so that their fire hazards are minimized, but some dangers are always present. Persons responsible for school fire safety need to be aware of the nature of these dangers if proper precautions are to be observed and if fire safety procedures are to be practiced in existing buildings. Planning school buildings that are as fire safe as ingenuity can make them requires that attention be given to their design, height, exitways, area, corridors, stairways, basements, open courts, roof structure, vertical openings, hidden spaces, and windows.

Design

Probably no one single form of building design is always best from the standpoint of fire safety. Each design offers its distinct evacuation opportunities as well as other fire-safety advantages and disadvantages. If a given building design meets minimum standards (or better) for fire safety, it can be justified, then, from that standpoint.

Height

In the past it has been customary for some cities to construct school buildings with more stories than present safety standards suggest as maximum. A building of two or more stories may create a potentially dangerous situation when pupil traffic becomes intensified during an emergency. In rural and suburban communities, where large sites usually are available, there is an advantage of direct egress and maximum safety in constructing one-story buildings. The National

[4] Ralph D. McLeary. *Guide for Evaluating School Buildings.* Cambridge 38: Mass: Spaulding House, 20 Oxford Street. 1952. p. 7–9.

Board of Fire Underwriters[5] recommends that all buildings of more than two stories in height be fire-resistive construction throughout; but suggests that buildings of fewer stories may be of less-fire-resistive construction, provided ample well-arranged exit facilities are available and hazards are well guarded.

Exits

Too few, too narrow, or improperly located exits constitute a distinct hazard to life safety. Every single or multi-story school building should have at least two means of egress remote from each other. The actual number of required exists for each building should be determined in accordance with standards described in the *Building Exits Code.*

Herrick[6] suggests that for maximum safety of egress, every school building should be of one-story design; and each classroom in every building should have two means of egress, at the opposite sides of the room, one through the corridor, the other directly to the outside. Corridor doors of each room should not be directly across the corridor from each other. Every occupant leaving any classroom through a corridor should have two ways to turn. If one exit is blocked, another exit route, independent and remote from the other one, should be available.[6]

Areas located on the second story or above of a school building may be hazardous, since two adequate means of egress are more difficult to provide for second-story than for ground-level floors. Windows at this level may provide some measure of life safety protection in an extreme emergency, but they do not constitute a satisfactory means of egress. Provision of a second doorway from the area, either directly to the corridor or to an adjoining area with adequate exits, may at least reduce danger to life from fire.

State and local governing units that have adopted building codes and exit standards for public buildings have relied heavily on those developed over a period of about 50 years and published in the *Building Exits Code* by the National Fire Protection Association. Now in its eighteenth edition, the *Code* deals with public safety from fire and and like emergencies; specifies number, size, and arrangement of exit facilities; discusses construction, protection, and occupancy features of buildings that minimize danger to life from fire, smoke, fumes, or panic before evacuation; describes procedures to be used in fire exit drills; defines terms most often used in connection with buildings

[5] National Board of Fire Underwriters. *Fire Safe Schools.* New York 38: The Underwriters, 85 John Street. 1959. p. 1.

[6] John H. Herrick *and others. From School Program to School Plant.* New York: Henry Holt and Company. 1956. p. 394.

and fire safety; identifies other fire protection standards; and suggests that conflicts and difficulties over construction details might be minimized if the standards of the *Exits Code* are used concurrently with those contained in municipal building codes.

Large Areas

In large, unrestricted areas of buildings where the essential elements of combustion are present, fire, smoke, and heat can spread rapidly. Insurance underwriters try to encourage owners to eliminate hazards attributed to large areas by offering cheaper fire insurance rates on non-fire-resistive buildings that have no individual areas in excess of 7,500 square feet, a space they also recognize as desirable maximum for fire-resistive buildings. Other special areas, often recognized as potential fire hazards, are shops, laboratories, kitchens, storage areas, boiler rooms, and incinerator rooms. Special consideration is given to owners by the underwriters if these rooms are segregated by fire-resisting walls from the remainder of the building and are provided with fire doors at openings.[7]

Corridors and Passageways

Corridors and passageways, the arteries of horizontal traffic in buildings, permit access to and egress from all points on one level. Movement from one level to another, or vertical traffic, is accommodated by ramps, stairs, or elevators. (Probably few schools have escalators.) Safe evacuation of building occupants in case of fire usually depends upon adequate, well-planned routes of egress from all points within a building. Corridor adequacy is measured in terms of such factors as width; length; type of construction materials used; type of finish for floors, walls, and ceilings; and the presence or absence of other means of egress.

Width and length are dimensional factors which must be equated against corridor load (double or single), number of rooms and type of occupancy, and the number of people to be served. In general, however, the width of an individual corridor should be constant, free of projections at any point, and completely unobstructed. A distance of 150 feet from any room or point served by a corridor to an exit is considered maximum for safety.

Some State and local building codes, under certain conditions, permit corridors with dead-end pockets, but such pockets are not looked upon with favor by safety engineers. If these dead-end corridors are used to accommodate classrooms at levels above grade, exit doors from

[7] National Board of Fire Underwriters. *op. cit.* p. 2.

these rooms should be located not more than one and one-half times the width of the corridor from a stairwell or other escape route.

Adequate lighting of all corridors is essential, but, contrary to practices in some schools, lighting should not be key-controlled. Corridors constructed of fire-resistive materials and/or decorated with flame retardant paint also contribute to life safety from fire.

Stairways and Stairwells

Heat, flame, smoke, and toxic gases rise rapidly to the uppermost portions of a building through open vertical passageways such as stairwells, elevator shafts, and plenums. These vertical passageways should be constructed of noncombustible materials, with openings to them covered by approved fire doors. Viewing panels, if any, in these doors, should be of wired glass. Doors which open into stairwells should remain in a closed position except when in use, and all stairs should lead directly to the outside. Every building of more than one story should have two or more stairways remote from each other. The width and number of stairways needed are generally determined by the area and capacity of the space to be served. Stairways between two stories should have at least two runs of risers, broken by a landing, and these runs should not be in the same direction. Storage closets should not be permitted under landings or in the stairwells.

Basements

Basement areas often constitute special fire hazards. Some basements open only into the first floor by way of a stairwell located in the middle of the building. In case of fire, the only place for smoke to escape is up and into the building. Also, there may be no way for firemen to fight the fire except by using the smoke-filled stairway. Furthermore, smoke and gases which build up in a basement usually are highly explosive. Several openings to basement areas on opposite sides of the building with light controls near each door are desirable. Probably the best fire safety device and warning system for basement areas is an approved wet sprinkler system.[8]

Open Courts

Enclosed courts as factors contributing to fire spread have received little attention. Windows opening upon them have been known to permit fire to jump from floor to floor and from wing to wing.

---

[8] "The Architect's Responsibility for Fire Safety." *Bulletin of the American Institute of Architects* (AIA File No. 29). March–April 1956. p. 58.

Rescue efforts of fire departments are hindered where courts are enclosed. If school buildings are designed with courts, one side of each court should remain open to prevent entrapment of occupants and to permit entrance by rescue teams.

Roofs and Roofing

Certain kinds of roofs and roofing materials increase the fire hazards of buildings. Sparks from a smokestack or from an exposing fire may ignite a combustible roof from the outside; interior fires may cause heat and gas to collect under the roof deck and build up to the point where dangerous explosions may occur causing combustible roofing materials to burn. If appropriate roof vents are constructed, they may discharge much heat and gas from a building, preventing explosions and permitting firemen to enter and fight the fire. Some modern buildings have concrete roof decks which increase the difficulties for firemen when an interior fire has gained headway, thus curtailing their activities until gas and smoke can be discharged.

Openings

Many openings, whether vertical and extending from floor to floor, or horizontal and extending from room to room, are often responsible for the rapid spread of fire. Some old school buildings have large open ventilating wells, or waster-paper chutes extending through several floors. These openings should be floored over and the shaft enclosed with fire-resistive casing. If chutes are necessary, they should be of fire-resistive construction with self-closing doors. Warm air heating, ventilating, and air-conditioning ducts which pass through the walls and extend from room to room are examples of horizontal openings. These ducts should be constructed to conform to national standards for air-conditioning and ventilating systems. Some school buildings have masonry ventilation shafts that end in open attics. These shafts should be torn out to prevent them from serving as flues in case of fire.

Storage

Storage of materials, whether for instructional purposes or for operation and maintenance, often constitutes fire hazards. All storage space should be ample for the needs of the school, and should be properly located, well-designed, effectively ventilated, and suitably protected. This space should be located away from the routes of egress, isolated from the main structure, and constructed of fire-resestive material, Metal containers and cabinets should be provided for further isolation of volatile and flamable substances. In storage management, neatness should be encouraged; congestion avoided.

Unobserved Spaces

Concealed spaces do not usually come under the daily observance of those responsible for operating buildings. Such spaces can be extremely hazardous, since fires originating here may not be detected in their incipient stages. Unless these spaces are protected by an approved sprinkler system, or unless fire stops are provided, they should be avoided. Fire stops for concealed spaces should meet the following requirements:[9]

- **Exterior and interior wall and partitions shall be fire stopped at each floor level, at the top story ceiling, and at the level of support for roofs.**
- **Unoccupied attic spaces shall be subdivided by fire stops into areas not to exceed 3,000 square feet.**
- **Concealed spaces between the ceiling and the floor or roof above shall be firestopped for the full depth of space along the line of support.**

Unattended spaces such as vents, flues, plenums, false ceilings, attics, areas between ceilings and flat roofs, crawl spaces, service areas, basement areas, and unused classrooms are hazardous because a fire that starts in one of these areas may reach substantial proportions before it is discovered. Such a fire can be especially dangerous if the area which it starts is near a point of egress. All unattended building areas should be studied to determine the need of fire breaks, automatic fire detectors, sprinklers, or other types of control and protection; and if such areas exist under floors that are below grade, they should be well ventilated, and special attention should be given to the installation of protective equipment in them.

Windowless and Underground Construction

Windowless and underground buildings present special fire hazard problems since egress through windows is eliminated. Smoke venting from such a building is difficult, thus increasing the task of moving and operating extinguishing equipment. Lack of windows may also cause a delay in the discovery of fire and may permit a more rapid involvement of the entire structure, since the heat cannot be dissipated. Windows, for example, permit the entrance of breathable air for occupants and allow heat and other toxic elements to escape. Since windowless buildings must have mechanical ventilation, the equipment should be designed to detect and remove smoke automatically in

---

[9] National Fire Protection Association. *Building Exits Code* (NFPA No. 101—18th ed.). Boston 10: The Association, 60 Batterymarch Street. 1961. p. 26–28.

case of fire. It is especially important that the discharge apertures be arranged to keep exhaust smoke away from the exits. Also, another serious problem is that of panic from darkness in case of light failure in a windowless building.

Specific solutions to these and other fire safety problems peculiar to windowless and underground structures require that consideration be given to such factors as interior finish and construction, number of occupants, contents of the structure, means of egress for occupants, and access provisions for firemen. Some safety features considered as minimum in overcoming the dangers inherent in windowless and underground structures include emergency lighting; automatic smoke detection and ventilation systems; automatic sprinkler protection; provision that ascending stairs, ramps, or other upwards exits (from underground) be cut off from main floor areas and be designed to prevent their becoming flues for smoke and fire; and, in windowless buildings, outside access panels on each floor level should be provided for utilization by the fire department or for the rescue of trapped occupants. The reader is referred to the *Building Exits Code* [10] for details concerning other safety features for buildings of this type.

Construction

Construction features of school buildings affect their rating for fire safety. These features are usually subsumed, and are discussed here, under three headings: types of construction; height and area; and interior finishes and materials.

Types

In a very broad sense, school buildings can be classified according to one of three types of construction: fire-resistive, semifire-resistive, or combustible. Since the last two differ only in degree or rate of burnability, the classification might be reduced to fire-resistive and nonfire-resistive. Various technical associations have developed more specific categories for construction types. One association [11] lists eight types of construction as follows:

> *Fire-resistive.*—Structural members including walls, partitions, columns, floors, and roofs are of fire-resistive materials with specified fire-resistive ratings.
>
> *Heavy timber.*—This is so-called mill or slow-burning construction with masonry walls.

[10] National FiFre Protection Association. *op. cit.* p. 214.

[11] National Fire Protection Association. *Standard Types of Building Construction* (NFPA No. 220). 1961. p. 3–6.

Noncombustible.—This permits the use of unprotected steel.

Protected noncombustible.—This must have one-hour structural fire-resistance, but does not qualify for fire-resistive construction.

Ordinary construction.—This has masonry walls, wood interior.

Protected ordinary.—This has a one-hour structural fire resistance.

Wood frame.—This is lighter construction than Heavy Timber.

Protected wood frame—This has a one-hour structural fire resistance.

This association, however, does not generally recognize the last seven of these construction types as having much application to life safety from fire. It is suggested that a building of wood interior construction, with combustible contents, presents substantial fire hazards to its occupants regardless of whether or not its combustible interior is enclosed with exterior masonry walls.

Another organization,[12] interested in buildings from the standpoint of casualty insurance risks, recognizes seven types of construction as follows:

Fire-resistive: Type A.—All structural members including walls, columns, piers, beams, girders, trusses, floors, and roofs are of approved noncombustible materials, each with specified fire-resistance rating according to detailed standards; also, other strict structural standards pertaining to fire resistance are applied.

Fire-resistive: Type B.—Standards are almost identical to those required for type A, except that the fire-resistance rating for structural members is somewhat less.

Protected Noncombustible.—Encompasses buildings in which all structural members are of non-combustible materials, with each member having a fire-resistive rating of not less than one hour; and in which other structural standards, somewhat less restrictive than those used in the first two classifications, are applied.

Unprotected Noncombustible.—Includes buildings having structural members of approved noncombustible material that has been rated for fire-resistance under stipulated conditions, and having roof construction and interior partitions that meet specific standards.

Heavy timber.—Applies to buildings in which the bearing walls are of approved noncombustible material; in which the interior structural elements, including columns, floors, and roof construction, consist of heavy timber, with smooth, flat surfaces, assembled to avoid thin sections, sharp projections, and concealed or inaccessible spaces; and in which the structural members that support masonry walls have a fire resistance rating of not less than 3 hours. If structural members of steel or reinforced concrete are used in lieu of timber construction, they must have a fire-resistance rating of not less than 1 hour.

Ordinary.—Applies to buildings having exterior walls of non-combustible material, with a fire resistance rating of not less than 2 hours, and having structural elements that are wholly or partly of wood of smaller dimensions than are required for Heavy Timber construction.

---

[12] National Board of Fire Underwriters. *National Building Code* (1955 ed. and 1957 amendments). p. 68–88.

Wood frames.—Includes buildings having structural members wholly or partly of wood, or other combustible material, that can not qualify for heavy timber or ordinary construction.

Type of construction is an important factor in determining school fire safety, but compliance with the specific standards of a given type is no guarantee against loss of life by fire. There are other factors to be considered.

Height and Area Limitations

Although circumstances occasionally require that exceptions be made as to recommended heights and areas of buildings, the National Board of Fire Underwriters [13] suggests that buildings of various construction types conform to the height limits shown in table 7 and the area limits shown in table 8.

Table 7.—Building-Height Restrictions, by Type of Construction

Type of construction	*Height (limit in feet)*
Fire-resistive: Type A	(No limit)
Fire-resistive: Type B	*85
Protected noncombustible	75
Heavy timber	65
Ordinary	*45
Unprotected noncombustible	*35
Wood frame	35

*With some special considerations.

Table 8.—Floor-Area Limits (Square Feet) Per Story of Building

	Square feet	
Type of construction	*One Story*	*Over one story*
Fire-resistive: Type A	No limit	No limit
Fire-resistive: Type B	No limit	No limit
Protective noncombustible	18,000	12,000
Heavy timber	12,000	8,000
Ordinary	9,000	6,000
Unprotected noncombustible	9,000	6,000
Wood frame	6,000	4,000

Materials

An analysis of loss of life in buildings because of rapid fire spread and accumulation of noxious gases indicates the importance of prudent selection of building materials. The rate that an accidental fire

[13] *Ibid.*, p. 40–41.

will develop into a full-fledged one involving a whole building depends primarily on the following three features:

- The flame-spread properties of the interior finish
- The extent of compartmentization and the degree of ventilation
- The fuel contributed by, and the manner of distribution of, building contents.[14]

Ceilings should have fire-resistive qualities since fire spreads quickly in an upward manner. In multi-story buildings, if the ceiling fails, there will soon be a floor failure.[15] Many ceilings are covered with acoustical materials, and in some cases fire spreads more rapidly across lightly pressed acoustical material than across ordinary wood sheathing. It is important to know that wood ordinarily ignites at approximately 750° F, but that with long exposure to heat, a condition is produced whereby it may ignite at a temperature as low as 212° F. In some instances, certain types of insulating boards have been known to ignite at 170° F.[16]

Asbestos pipe, for example, has been known to crack when used for flues, and in rapid heat it may even explode. Foam rubber is a readily ignitable substance, will burn intensely, and will emit a smoke of disagreeable odor.[17]

The few specifics mentioned above indicate that much care should be exercised in the selection and use of finishing materials.

Another aspect to be considered in the selection of building materials is that the heat which may be released by them in case of fire may dictate whether the building will be saved or destroyed. Much study is being done in this area to determine the potential heat and flame-spread index ratings of a number of materials. (See appendix C.)

Knowledge of the performance of walls, columns, floors, and other building members under fire exposure is important and this performance is now being reflected in many codes. It is important to achieve balance in the various parts of a building. To do this the fire-resistive properties need to be measured according to a common standard. This standard is known as the "Standard Fire Test."[18]

It is important to have both an understanding of fire-resistiveness of materials and a knowledge of how fast flames progress down the surface of a given material, once they have started. The Underwriters' Laboratories developed a numerical scale which rates materials in comparison to asbestos-cement board and red oak flooring, with

---

[14] A. F. Robertson, D. Gross, and J. Loftus. *A Method for Measuring Surface Flammability of Materials Using a Radiant Energy Source.* Philadelphia 3: American Society for Testing Materials. 1956. p. 1437.

[15] "The Architects—and Fire Safety." *Journal of the AIA.* p. 41–42. May 1957.

[16] Theodore I. Coe. "Fire—Friend and Foe of Man." *Bulletin of the American Institute of Architects* (AIA File No. R9). January–February 1954. p. 6.

[17] The Architect—and Fire Safety. *op. cit.*

[18] National Fire Protection Association. *Building Construction and Materials* (NFPA No. 251). 1961. p. 2–3.

respective ratings of zero and 100 on the scale. The *Uniform Building Code* of the Pacific Coast Building Officials Conference[19] assigns an abbreviated flame-spread rating as follows:

Table 9.—Classes of Flame-Spread Rating

Class	*Tunnel test*	*Federal standard test*
I	0–30	Fire-retardant
II	31–75	Slow-burning
III	76–250	Combustible

The National Fire Protection Association's scale of flame-spread ratings for interior finish follows:

Table 10.—Classification of Interior Finish, by Number of Feet of Flame Spread

Classification	*Number of feet of Flame spread*
A	0–25
B	25–75
C	75–200
D	200–500
E	Over 500

In existing buildings where there may be doubt as to fire retardant qualities of interior finishes, the required flame-spread rating may be improved by applying flame-proofing paints or solutions. These applications need to be renewed, however, at intervals sufficient to maintain the required flame-proofing.[20] If decorative finishes are required for walls and ceilings, fire-retardant paints bearing UL approval and having a flame-spread rating of 15 or less, a fuel contribution factor of 15 or less, and a smoke-development factor of 5 or less, should be used. Recent developments in the paint industry have led to the manufacture of finishes of high quality and aesthetic appeal that both retard fire spread and limit their fuel contribution to fires.

Occupancy and Utilization

The National Fire Protection Association[21] indicates that ratings of buildings should be done by those having authority, and that the degree of hazards, based on occupancy, may be defined as follows:

- *Ordinary-hazard* occupancy buildings are those having contents which are liable to burn with moderate rapidity and give off a considerable volume of smoke, but from which neither poisonous fumes nor explosions are to be feared in case of fire.

---

[19] The Architect—and Fire Safety. *op. cit.* p. 42.
[20] National Fire Protection Association. *Building Exits Code.* p. 200–01.
[21] *Ibid.* p. 20–21.

- *High-hazard* occupancy buildings are those having contents which are liable to burn with extreme rapidity or from which poisonous fumes or explosions are to be feared in the event of fire.
- *Low-hazard* occupancy buildings are those having contents of such low combustibility that no self-propagating fire therein can occur; consequently the only probable danger requiring the use of emergency exits will be from panics, fumes, or smoke of fire from some external source.

A school building would ordinarily be classified as a low-hazard occupancy, but an entire building should be classified from the standpoint of its most hazardous area, unless this area is segregated from the rest of the building.

Administrators responsible for the way in which a building is utilized should be cognizant of the hazards that occur because of use. They should know not only the occupancy hazards of the building but also its inherent fire hazards. If a building is an overall fire hazard and is a menace to the lives of its occupants, immediate steps should be taken to correct the situation. The National Board of Fire Underwriters[22] emphasizes that unless corrected, conditions such as the following would warrant the abandonment of a school:

- Either walls or ceilings of exit corridors are surfaced with highly combustible finish, such as readily combustible wallboard.
- Pupils on upper floors have no means of exit except down stairs which are open to lower stories having combustible wall or ceiling or combustible contents, such as storage of combustible material, wood-working shops, etc.
- There is ordinary construction (wood-floor construction with masonry walls), in which pupils above the second story have no means of exit except down stairs which are open to lower stories—unless the building is completely protected with automatic sprinklers.
- There is wood-frame construction in which pupils are housed above the second story—unless the building is completely protected with automatic sprinklers.
- Faulty heating equipment is liable to cause fire or explosions or to discharge combustion gases into the building.
- There is unventilated space under the grade floor in which flammable gas could by some possibility accumulate.
- Exit doors to the outside cannot be readily opened from the inside.

Because of occupancy and utilization, some parts of a building may be potential fire or life safety hazards. Classrooms and special- and general-use areas may become dangerous because of design and use.

Regular Classrooms

Classrooms are used by many people for various reasons. The occupants of any classroom or any place of assembly should not exceed

[22] National Board of Fire Underwriters. *Fire Safe Schools.* p. 5–6.

the number that can be safely evacuated within a reasonable time. The speed of evacuation depends on room capacity, and the size, number, condition, and location of exits and escape routes. The Building Research Advisory Board [23] has reported that 20 square feet per person is frequently used as an arbitrary figure for computing capacity of a room. Some States require a higher figure.

In elementary schools, it is especially important that kindergarten and lower elementary classrooms be located on the floor nearest ground level and close to exits, or have independent exits to the outside from each room. Classrooms for handicapped pupils, such as the blind, the physically handicapped, and the mentally retarded, should be similarly located, and should be equipped with ramps, wide doors, handrails, and such other aids as are needed by the students for safe exit from the building.

Some activities performed in a classroom, such as those associated with Christmas festivities requiring a lighted tree, may create fire hazards. These and similar activities which create fire hazards should be recognized, and precautions should be taken to eliminate or minimize their danger.

Administrators should schedule classes and other school activities so that a balanced pattern of pupil traffic always exists. Should there be an excessively heavy concentration of students in a given building area at one time, this concentration may constitute a hazard to life safety.

General Use Areas

General use areas, such as auditoriums, cafeterias, gymnasiums, and multi-purpose rooms, constitute essentially the same problems in regard to quick and safe evacuations of large numbers of people. In gymnasiums, both permanent and folding seats should be spaced to provide aisles. Loose seating should be arranged in definite blocks, and there should be wide front-to-back aisles as well as cross aisles. Safety codes generally require that the rows of seats in auditoriums be open at both ends, with each row between aisles limited to 14 seats; or, if a row opens into an aisle at only one end, it should be limited to 7 seats. The minimum space between the back of one seat and the front of the seat immediately behind it, as measured between plumb lines, is 12 inches. The main floor aisles may slope, unless the gradient exceeds 1 foot rise in 10 feet. All main aisles should terminate at exits. The minimum aisle width is 30 inches where not more than 60 seats are served by it. If more than 60 seats are served by an aisle, its minimum width is 3 feet. Wider aisles are required for larger

[23] Building Research Advisory Board, Committee on Fire Research. *op. cit.* p. 30.

numbers. Cross aisles should be provided at intervals of 20 traverse rows, and unless railed away from seats fronting them, should be at least 44 inches wide; if railed away, cross aisles may have a minimum width of 36 inches. If steps are provided in main aisles to overcome difference in level, cross aisles at intervals of 10 rows of seats, or at intervals of not more than 12 feet in rise, are usually recommended.

Multiple exits from gymnasiums and auditoriums should be clearly visible, identified by illuminated exit signs, and should lead directly outdoors. In addition to the exits at the rear of these areas there should be exits directly to the outside at the front, both left and right; but they may open into a short hall that is protected from fire. In large assembly areas, additional exits may be necessary in side walls; if balconies are provided, they should have two separate means of egress. The electric current for illuminated exit signs should be provided by separate circuits originating ahead of the main line switches. Stand-by emergency lighting is often provided in places of assembly.

Special Areas

Shops, kitchens, science laboratories, and home economics rooms are building areas which may have multiple fire hazards because of the type of equipment used and the kinds of activities which take place in them.

Shops.—Equipment for welding, grinding, sawing, forging, and painting (some of it provided with electric motors) is a potential point of origin for fires in school shops. Spray painting is especially hazardous; it should not be conducted in a school building except in a room designed for that purpose, equipped with an approved system of automatic sprinklers, and separated from other areas by construction having a fire-resistance rating of not less than 2 hours.[24]

Kitchens.—The use of gas, electricity, coal, and other sources of heat in kitchens, as well as the collection of grease on ventilation hoods and in other inaccessible areas, creates fire hazards.

Science laboratories.—Daily use of gas and electricity in any science laboratories where chemicals are regularly stored, makes the laboratories especially vulnerable to fire is they are not properly planned, well maintained, and carefully operated.

Home economics suites.—The many electrical appliances (stoves, refrigerators, sewing machines, washers, dryers, irons, mixers, and other types of equipment) in home ecenomics suites may cause multiple fire hazards, both through use and through neglect after use.

Storage room.—Adequate rooms are needed for storage of custodial

[24] National Fire Protection Association. *Spray Finishing* (NFPA No. 38). 1961. p. 7.

and maintenance supplies, instructional materials and equipment, chemicals for science instruction, and school records. Lack of ample, well-planned storage space is generally a major problem for schools. If adequate storage rooms are provided, there will be less tendency to store things in such areas as plenum chambers, fan rooms, attics, and under-stairs spaces. Storerooms that are in disarray or contain flammable materials in large quantities are always hazardous. Proper storage of flammable liquids in reasonable amounts can improve fire safety. Flammable liquids stored in schools should be limited to the amounts required for maintenance, demonstration, treatment, and laboratory work, and should be placed in UL or other approved containers, preferably not larger than one quart in size.[25]

School records do not create particular fire hazards, but they are of economic (and may be of historic) value. They should be protected against fire in fireproof vaults.

Furnace and boiler room.—The hazards of fire and explosion are ever present in the furnace and boiler room. It should be of fire-resistive construction, and should be located apart from the building or buildings it serves and maintained adequately. Its equipment should be inspected regularly and should be operated by competent personnel. Automatic safety controls that afford maximum protection against human error or neglect should be installed on all heating equipment. In addition, it should have manually controlled shut-off valves on gas and oil supply lines for use in emergencies. Boiler rooms should not be used for the storage of volatile liquids or burnable supplies.

Stage and stage wings.—If old scenery, paint, and other combustibles are stored indiscriminately on the stage and in the wings, danger spots are created. The stage itself is potentially dangerous if scenery, curtains, and drapes are not of fire-resistive materials. Smoking on or back stage and temporary wiring for lights and stage equipment may be extremely dangerous and should usually be prohibited.

Incinerators.—Since their chimney screens burn out, incinerators cause a number of fires, allowing the escape of large pieces of burning material or sparks which start them. Housekeeping practices which allow the collection of combustible materials near the incinerator often cause fires. Commercial and industrial incinerators should have spark arrestors with openings no greater than ¾″, and preferably ½″. Clearances on the sides of incinerators should be allowed and no wall of an incinerator should serve as a structural wall of a building.[26] If an incinerator is located inside a building, provisions should be made so that refuse does not go directly into it from waste chutes.

---

[25] National Fire Protection Association. *Flammable Liquids Code* (NFPA No. 30). 1961. p. 28.

[26] National Fire Protection Association. *Incinerators, Rubbish Handling* (NFPA No. 82, 82A). 1960. p. 13–20.

Community Use

Community use of school buildings often creates safety problems, according to the Building Research Advisory Board.[27] Adults meeting in shops, or classrooms, for example, are not likely to be familiar with the building and may not respond to regular fire drills. Hence, these adults may require clearly marked, immediate, and convenient exit routes, from any building areas which they use, if these areas are not on grade or if they present difficulties for escape.

When large community groups are congregated in a school building, teachers might well be authorized to help direct any necessary emergency evacuation. It is good practice to prohibit both standing and seating in aisles or near exits at public assemblies. It is also desirable to obtain the cooperation of the fire department and other local agencies to help enforce regulations during community events.

A school building designated as a community shelter in a Civil Defense plan will need to be designed to house large numbers of people day and night, perhaps for 2 weeks or more. If a school building serves this function, careful consideration should be given to fire safety measures.[28] This should be done in cooperation with Civil Defense authorities. Every area of the building will need to be appraised critically in relation to capacity, the number and type of occupants, their probable activities, and other special problems expected.

Mechanical and Electrical Systems

Mechanical and electrical systems by their operative nature are potential sources of fire. For safe performance, they should be kept under constant surveillance. Heating, ventilating, and air-conditioning systems can be particularly hazardous in that they circulate heat and air, and may circulate smoke and toxic gases from one room to another through intake and exhaust ducts. The central air-supply systems should be installed with automatic heat- and smoke-detector control units at both the intake and exhaust sides of each system. When these units detect heat and smoke, they automatically stop all fans that bring in, circulate, and exhaust air through the system's ducts.[29]

Heating

Heating equipment is known to cause many school fires. Every reasonable precaution should be taken to reduce the number of fires

[27] Building Research Advisory Board, Committee on Fire Research. *op. cit.* p. 31.
[28] *Ibid.*
[29] National Safety Council. *Findings of the Coroner's Jury.* Chicago 11 : The Council, 425 N. Michigan Avenue. 1959. p. 6. (Mimeograph).

originating from this source, but each type of heating system may require certain safeguards not pertinent to some other systems.

Central heating of boiler systems.—Steam and hot water systems are hazardous if the equipment is improperly installed. The National Board of Fire Underwriters' *Code for the Installation of Heat Producing Appliances*, or the standards on installation developed by other nationally recognized organizations, should be followed when steam or hot water heating systems are installed. Some important standards are that steam or hot water pipes should have a minimum of 1-inch clearance from all combustible materials, unless otherwise specified in the Code. If these pipes pass through walls or stockrooms, they should be properly insulated. Temperature-limit controls should be of an approved type, with temperature adjustments that cannot be set higher than those specified for safety. All central heating and auxiliary equipment should be regularly inspected and maintained by qualified personnel.

Central warm air heating system.—Hazards may arise from central warm air heating systems under certain conditions: malfunctioning of fire-stop dampers, lack of automatic dampers, faulty motors, excessive dust accumulation inside duct work, and inadequate clearance between ducts and building structure.

Individual room heaters.—The three customary types of individual or unit heaters are electric, gas, or oil-burning. These heaters may be installed in a variety of ways; but to minimize fire hazards, they should not be installed within 18 inches of wood or other combustible material, nor attached to a warm air duct unless specifically approved for such an installation. The combustion chamber of gas and oil-fired units should be enclosed; should have adequate intake ducts to provide outside air for combustion; and should have approved vents to discharge smoke, gases, and unburned fuel to the outside. Individual room heaters should be inspected by competent personnel for proper shielding from combustibles; for adequate venting, fuel control, and maintenance; and for safe fuel storage if bottled gas or oil is the fuel used. Stoves are a special hazard, and except in unusual cases, should be eliminated as a means of heating school rooms.

Heat pumps.—When installed in accordance with recommended standards, heat pumps require the type of maintenance usually accorded electric motors, coils, fans, and compressors. From the standpoint of fire safety, it is always important to maintain all controls in a satisfactory condition, so that if trouble develops the unit will automatically stop its production of heat.

Central ventilating and air-conditioning equipment can compound fire safety problems in schools if it is not installed, maintained, and operated in accordance with nationally recognized standards. These systems circulate air throughout a building, and in the process may move fire, heat, smoke, and gases from one part of the building to another.

Extinguishing fires in ducts is especially difficult. Ducts should therefore be of noncombustible material, preferably with acoustical control to reduce transmission of noise. Coils containing refrigerants should not be placed in air ducts or passages.[30] In old buildings, ducts which circulate the air through combustible attics should be blocked off or extended in a standard manner through the roof. The passage of ducts through firewalls should be avoided, but where they must pass through, approved automatic fire doors should be placed on each side.[31] The air from any space which has questionable quantities of flammable vapors should not be recirculated. Air filters should be of material that will not burn freely or emit large quantities of smoke. Operating equipment for both systems should be provided with manual emergency stop controls located at accessible and convenient points.

In some instances, stairwells of both new and existing buildings are unfortunately used as plenums. This constitutes a hazard because smoke and gases from fire may readily enter the stairwells, making exits unusable.[32]

Water cooling towers for air-conditioning systems are becoming more common in school buildings. A significant number of fires occur in towers constructed of combustible materials and exposed to sparks from incinerators, smokestacks, or other exposure fires. If cooling towers are of combustible materials, they should be located 100 feet or more from such exposure hazards as chimneys and incinerators.[33]

Electrical Service

Of an estimated 890,200 fires in all classes of occupancies in the United States during 1960, electricity caused an estimated 129,900, or about 15 percent.[34] Each electrical installation or service by its nature is a potential fire hazard. To insure maximum safety, all elec-

---

[30] The Architect's Responsibility for Fire Safety. *op. cit.* p. 11–13.

[31] National Fire Protection Association. *Air Conditioning and Ventilating Systems of Other than Residence Type.* (NFPA No. 90A). 1961. p. 11–23.

[32] National Board of Fire Underwriters. *op. cit.* p. 11–13.

[33] National Fire Protection Association. *Water Cooling Towers* (NFPA No. 214). 1961. p. 2–8.

[34] National Fire Protection Association. *Fires and Fire Losses Classified* (NFPA Q 55–4). 1960. p. 7.

tric wiring and installation should comply with standards of the *National Electrical Code*, and all electrical equipment, appliances, and cords should be of the type approved by the Underwriters' Laboratories.

Transformers.—Major transformers may be placed on utility poles located some distances from school buildings; if so located, they create no serious fire problem for the building they serve. In some instances, however, these transformers are placed inside buildings, and where this is true, they should be segregated in fire-resistive vaults having walls and doors thoroughly insulated to prevent damage by explosion or by transmission of electric current to other objects in case of transformer failure.

Service entrance.—The electric service entrance for school buildings may be under or above ground. If the service enters a building through ground cables, these cables should be thoroughly insulated and encased in waterproof conduits that resist deterioration from chemical action when covered by soil. If the entrance is through overhead cables, these cables should enter through an outside conduit properly shielded by an approved weatherhead to prevent water from entering the conduit, a danger which might short the circuit and rot the insulation. The point at which this service entrance is attached to a building should be not less than 10 feet above ground, preferably at the rear of a building. Unusual circumstances may require exceptions, but generally only one service drop should be attached to a given building.

Wiring.—Electrical wiring in school buildings should conform to standards established by the *National Electrical Code*. Any attempt to economize on costs by substituting lower standards can jeopardize lives and property. Much electrical wiring is hidden in concealed spaces where overheated wires may not be discovered until too late. This makes it imperative that wire sizes and their ampere ratings be ample to carry any anticipated load. Furthermore, every building should have a sufficient number of circuits, each with outlets appropriate in number and location, to carry, without overloading any circuit, all electrical equipment contained in the building. Even though all precautions are taken to insure safe wiring, complete inspections of all electric installations in all school buildings should be made periodically by competent electricians.

If an inspection reveals that the electrical wiring in any school building, new or old, is substandard or hazardous, immediate steps should be taken to correct whatever deficiencies are found. This is an essential "first aid" for safety from fires of electrical origin, particularly in old buildings where the wiring may be obsolete, thus causing overloads when additional equipment is installed.

Panels, circuits, fusing.—Every electrical system needs to be adequately grounded and properly controlled so that the danger of arcing or shock is reduced. The panel which holds the circuit breakers or fuses is a hazard unless it is the dead-front type, where there is little possibility of shock. The panel or cut-out box is generally placed at or near the point where electric power enters the building. Circuit-breakers and fuses are designed to protect the wiring from overloading by allowing only a predetermined amount of electrical current to pass through the circuit. The fuse contains a low melting point metal called "the link." This link is calibrated to carry a specific rated current. Should a greater current occur, the link will melt and the electrical circuit will be broken. Fuses with an amperage rating greater than the amperage which the wire size can carry safely should never be inserted for any circuit; nor should any fuse be by-passed by any device whatsoever. The circuit-breaker functions as a fuse, operating as an electromagnet. When excessive current passes through, the electromagnet opens, breaking the electrical circuit, just as the metal link in a fuse breaks the circuit. The circuit-breaker may be reset manually after the original trouble is corrected. In summary, the fuses and the circuit-breakers act as safety valves, reducing the possibilities of electrical overload, usually a dangerous conditions.

Switches.—Faulty switches are hazardous since they may cause electricity to arc or jump. Three main types of switches are the snap or toggle, the flush or push button, and the knife switch. Any type may be dangerous if it is:

- **heated from overload**
- **pitted, burned, or has corroded contact points which cause arcing**
- **faulty, defective, or unenclosed, and is located in areas where flammable fumes are present.**

Outlets, grounds, static electricity.—Sufficient outlets should be included in the original installation so that temporary extensions do not become necessary. Additional outlets to circuits not wired for them cause overloads. The current edition of the *National Electrical Code* should be followed in all electric wiring jobs and in the installation of electrical outlets.

The specific requirements of the *Code* for grounding electrical circuits should be followed. However, a recent practice is to install three-wire outlets, the third wire being used for a ground to carry off excessive electrical currents.

Static electricity is less serious in schools than in some other establishments. However, such hazards do exist in schools, and grounds should be provided to help drain off excessive charges. Areas where flammable liquids are agitated or stored become especially hazardous and vulnerable since uncontrolled electricity could ignite escaping fumes. The development of the electrical charge itself is not dangerous, but a sudden discharge may ignite some other substance.

Extension cords.—Since flexible extension cords are subject to a certain amount of normal wear they should be checked frequently. Defective ones should be repaired or replaced. The extension cord, if needed temporarily, should be kept as short as possible to lessen damage from use, since it is subject to more injury from mechanical manipulation than are fixed wires. The outer covering may become worn and the copper strands may break. The useful life of the extension cord may be lengthened by keeping it away from moisture, heat, and oil; and if its outer sheath is of rubber, by keeping it out of strong sun light. Also, these cords should not be placed under rugs, door jambs, or radiators. When a plug is removed from an outlet, the plug itself should be pulled—not the extension cord.

Controls and thermostats.—Safety controls and thermostats not properly installed or not regularly inspected and maintained may be dangerous. These devices should be of the type that discourages tampering or indiscriminate resetting, preferably the locking type that cannot be set beyond safe maximums. This type of device is especially necessary if the temperature or level of water, the steam pressure, or the heater and boiler fuel supply is regulated by automatic controls.

Fire detection and alarm system.—Fire detection and alarm systems may themselves constitute fire hazards if they are installed in obscure places and are energized and controlled by regular electric current. These systems should be installed in accordance with the National Fire Protection Association's *Standard for Proprietary, Protective Signaling Systems* and the electrical wiring should comply with standards of the most recent edition of the *National Electrical Code.* It is desirable that these systems be so designed that tampering with them either purposely or inadvertently, will cause a signal, for a system that is not known to be inoperative is a hazard.[35]

Intercommunication systems.—When planned and installed as a part of new construction, intercommunication systems usually present no problem from the standpoint of fire safety—only one of adequate and satisfactory maintenance. In new construction, conduits and raceway for the concealment of cables are built in. Telephone companies maintain a telephone planning service, with expert communications engineers to assist in planning conduits and duct facilities for telephones which will be expertly installed by company-trained technicians in accordance with standards that meet or exceed those of the *National Electrical Code.* Also, in new construction, other types of communications equipment are installed in accordance with the manu-

[35] National Fire Protection Association. *Proprietary, Protective Signaling Systems* (NFPA No. 72). 1961. p. 1–40.

facturer's specifications, often under the direct supervision of factory-trained technicians.

It is in older buildings, constructed without regard to needs for internal communication, that serious installation problems arise. In most of these installations it is not practical to try to conceal conduits and raceways. Often local officials wish to install internal communication systems, such as telephones, not connected to a central station, but using similar type of equipment; audible and visual signals; and centralized public address or intercommunication systems. Most of these systems require an array of connecting wires and cables. Specific points to watch for when installing these wires and cables are number of circuits, number of stations, size of cable, junctions and connections, insulation, grounding, fusing, and lightning arrestors. Standards of the most recent edition of the *National Electrical Code* should be followed carefully when installations such as these are made in existing school buildings.

Gas Services

When piped into a building gas should have a distinct odor so that it may be easily detected if a leak occurs. Gas supply lines which serve buildings should not run long distances under them, because gas leaks under buildings may not be readily detected, thus creating an explosion hazard.

Controls and cutoffs.—The main gas supply line into a building should have an automatic shut-off valve that closes when the gas pressure in the line falls below a point that would cause pilot lights to go out. This valve should be designed so that it must be re-opened manually in order to restore gas service when pressure in the mains is at a safe level.

Connections, union, jets.—All gas installations should conform to standards recommended by the National Fire Protection Association,[36] and the entire system for a building should be checked for leaks by the use of inert gas before the system is used. Gas systems should be inspected regularly, since jets, valves, unions, and connections are especially susceptible to leakage. For gas appliances, it is important that automatic ignition devices and pilot lights function properly.

Venting.—Where gas heating devices are used, proper venting to, and air intake from, the outside are important features for life safety. Applicable standards of the National Fire Protection Association should be met concerning these venting devices.

Bottled gas.—If bottled gas is used for any purpose, containers for its storage should meet safety requirements of the industry and should

[36] National Fire Protection Association. *Installation of Gas Appliances and Gas Piping* (NFPA No. 54). 1959. p. 21–27.

be located in accordance with accepted safety standards. The usual safety standards applicable to other gas installations should be observed.

Equipment

A wide variety of equipment is needed to operate a modern school plant. This equipment is made useful by energy derived from coal, oil, gasoline, gas, or electricity. All equipment energized by electricity should be installed, and electrical service should be provided, in accordance with the standards of the current edition of the *National Electrical Code*. Where applicable, equipment should be of the type approved by the Underwriters' Laboratories (UL). Also, heating equipment should meet standards listed in the current code for *Heat Producing Appliances* by the National Board of Fire Underwriters.

Refrigeration

Refrigerators or deep freeze units with electric motors should be inspected regularly to ascertain that lint or other combustible materials have not collected in, on, or near their motors; and to make sure that all bearings and moving parts requiring oil are properly lubricated. Other check points requiring an occasional inspection are plugs, terminals, and insulation.

Food Preparation Services

Food preparation equipment in schools is usually of the restaurant type, such as ranges, ovens, broilers, steam tables, deep-fat fryers, and mixers; it should be installed in compliance with the National Board of Fire Underwriters' *Standards for Heat Producing Appliances*. Floor-mounted equipment should be mounted on fire-resistive materials, and should not be installed in alcoves. Space required around such equipment is dependent on its source of energy. Counter-type appliances, which include such things as hot plates, griddles, and hot water immersion sterilizers, should be set on noncombustible materials and should have a specified amount of clearance.[37]

Water Heaters

Water heaters generally produce a rather high water temperature. Some are heated by gas; others, by electricity. Combustible materials should never be placed near the heating unit. All gas units designed for continuous or intermittant operation should be equipped with

[37] National Board of Fire Underwriters. *Heat Producing Appliances*. 1955. p. 18–21.

pilot lights; those not designed for continuous operation should be turned off at the end of the day. All units should be provided with adequate pressure-relief valves and thermostatic controls.

Laundry and Drying Equipment

Many schools find it desirable to own and operate laundry and drying equipment. Drying equipment, because of the intense heat required, is especially dangerous. Both the laundry and the drying units should be installed according to national standards, particular attention being given to allowing ample space for air circulation, inspection, maintenance, and removal of collected lint or other combustible materials.

Ceramic Ovens or Kilns

High temperature kilns for baking stoneware, earthenware, and porcelain, produce oven temperatures up to about 2500° F., require wiring to carry 220-230 volts, and may be in continuous operation for several hours. These units should be UL approved and equipped with a pyrometer for reading firing chamber temperature at a glance. They should have a pilot light to indicate when the kiln is operating, should have safety switches and should be equipped with an automatic cut-off.

Electric Power Tools

Electric motors and power tools should be of the type approved by the Underwriters' Laboratories. This equipment should be used only on circuits that are designed to carry the demanded load. The motors and tools should be kept free of grease and should have approved service cords. Tools which create sparks or produce a waste of wood shavings, dust, or bits of hot metal while operating should have adequate waste-collection systems or should adequately shield the sparks and hot metals from combustible materials. Grounding for such equipment is essential.

Portable Electric Appliances

In general, only portable electric appliances that meet all safety requirements should be used in schools and these should be kept at a minimum. Temporary wiring should never be used when fixed enclosed wiring for such appliances is needed. Extension cords for hand lamps, portable electric tools, and other electric appliances should be well insulated, and motor-driven appliances should be grounded.

Radio and Television

Radio and especially television are recognized tools of the instructional program. Both are electrical and hence may constitute fire hazards. The installation of antenna, cables, and outlets for television receiving and telecasting and for radio receiving and transmitting equipment should be in compliance with the *National Electrical Code.* Some important points to observe are the following: (1) The materials for outdoor antenna, counter-poise and lead-in conductors should meet rigid specification. (2) Supports for these should be secure, but never attached to poles or structures carrying electric light power, or trolley wires; nor should they ever cross over or under electric light or power circuits, but should be kept well away from such circuits in order to avoid the possibility of accidental contact. (3) All masts and metal structures supporting outside antennas should be permanently and effectively grounded; and each lead-in cable from an outdoor antenna should be equipped with an effective lightning arrestor, or if this cable is in a metal shield, the shield should be permanently and effectively grounded. (4) Television sets should not be placed near combustible materials, nor should they be placed in damp areas.

Projection Equipment

Only cellulose acetate safety film should be used in school motion picture projectors, and the older hazardous cellulose nitrate film should never be permitted in the building except when the projection room conforms to the fire-proof and safety standards for projection rooms.[38]

Projectors should always be fused according to the manufacturer's recommendations, and the circuits which supply electricity to them should be adequate to meet their power requirements without overloading. Projectors in operation should never be left unattended.

Operation and Maintenance

Operation and maintenance of a school plant affects its safety and freedom from fire hazards. Operation is concerned with day-to-day services and activities that are necessary to keep the plant open, comfortable, usable, and safe; maintenance is concerned with those services, activities, and procedures that are required to preserve, protect, and keep the building, grounds, and the equipment in a satisfactory state of repair. To some extent, each function overlaps the other, but

[38] National Fire Protection Association. *Storage and Handling of Cellulose Nitrate Motion Picture Film* (NFPA No. 40). 1953. p. 4–7.

in a broad sense they are complementary, mutually supplying each other's lack. Of particular interest from the standpoint of the relationship of operation and maintenance to fire safety are heating plants, electrical services, electrical motors and appliances, gas and oil lines, and building repairs.

Heating Plants

Most heating equipment requires close attention for satisfactory and safe operation. Persons responsible for it should be familiar with the manufacturer's manuals and should follow the instructions on operation and maintenance. The heating plant should be inspected regularly by competent engineers. If defects or flaws are found, defective parts should be replaced and the plant restored to a safe condition.

Efficient and safe operation of coal, gas, or oil-fired steam or hot water heating systems can be expected and achieved only if flues and chimneys are kept clean of soot, fly ash, and other deposits; and if all motors, burners, valves, controls, gauges, and other components are checked at frequent intervals and maintained in a satisfactory condition. Pressure-relief valves should be set at a safe level, tested frequently, and tagged. Draft and other control devices should be kept in first-class operating condition. When gas is the fuel, it should pass through an approved pressure-regulating device, and the supply line should have an *automatic valve to shut off* the gas if the pilot light goes out; but this valve should require *manual operation to reopen.* The air supply or draft control should be interlocked with a stack temperature measuring device to preclude overheating of furnace and boilers. The water supply for automatic heaters and boilers should be maintained at all times unless heat for these units is discontinued.

A quick daily inspection of all heating equipment (including water-heating devices, valves, and tanks) by the building engineer or a responsible staff member at the close of each day is an added assurance that each item will be safe overnight.

Electric Services

Electric wires, connections, switches, and junctions tend to deteriorate with age and may become potential fire hazards in old buildings. These items should be replaced when inspections reveal indaequacies. A qualified electrical inspector should check electrical systems for such things as frayed or worn insulation on wires, untaped joints, plugged or by-passed fuses, high limit fuses in low-amperage circuits, and size of wiring in relation to voltage carried. Electrical switchboards, fuse boxes containing high-voltage connections or bare or noninsulated connections, and electrical panels should be kept under lock and key by the principal and custodian. All electrical devices should be checked periodically to ascertain whether or not they are in good order. Since electrical fires are usually attributed to arcing and overheating, the causes of arcing and overheating should be known, and if detected, removed. Some of the more common causes are:

- Dirty equipment—fixtures, appliances, motors
- Deteriorated insulation or bare wires
- Missing covers for junction boxes, switches, cabinets, outlets
- Deteriorated conduits or raceways
- Poorly made or loose wire splices
- Excessive heat too near the wiring
- Poorly insulated splices
- Moisture penetration of switch and panelboards
- Excessive moisture around motors
- Defective sockets
- Loose connections
- Loose conduits
- Overloaded circuits
- Improper grounds
- Loose terminals.

Electric Motors and Appliances

Electric motors and appliances need to be checked regularly by competent and qualified electricians. Grease or combustible materials should not be allowed to accumulate on or around the equipment, and frayed or improperly fastened wires and cords should be replaced. If the protective shell on an appliance or a motor is cracked or damaged, repairs should be made.

Gas and Oil Lines

Escaping gas due to faulty controls, valves, connections, or lines is an immediate hazard and must be corrected upon discovery. If periodic inspections are followed by good maintenance, this type of hazard need not develop.

Gas installations must be readily accessible for maintenance and routine daily checking by the custodian. The distributing system for gas is composed of piping, tubing, valves, and fittings. These should be of suitable materials and properly supported to protect the system from mechanical injury and physical damage due to settlement, vibration, expansion, and contraction. All threaded joints and connections should be made tight with suitable lubricants or piping compounds. All normal distribution pipes should be properly painted or marked to indicate that they contain gas, and if these pipes are subject to extreme corrosion, whether above or below ground, they should be protected by painting. When a new system is installed, a common practice is for the appropriate agency or official to issue a certificate showing that the system has been inspected and that it does or does not meet required tests. Thereafter, valves and cutoffs should be tested at regular intervals to ascertain whether they are functioning properly. If repairs or changes are required, they should conform to applicable State or national standards, such as those listed in the following codes:

- *Gas Appliances and Gas Piping* (NFPA No. 54)
- *Gas Appliances and Gas Piping* (NFPA No. 54)

Building Repairs

A building properly maintained and safely operated will present fewer fire hazards and contribute more to the life safety of its occupants than one lacking maintenance and improperly operated. In renovating or remodeling old school buildings it is good practice to observe all applicable local laws and standards as well as those of the State. This is good practice also for minor repair work.

Broken plaster, wall and ceiling panels.—Broken plaster and broken or cracked wall and ceiling panels may permit flame to enter hidden and enclosed space, where fire is especially difficult to control. Then, too, if fire gains access to wall or ceiling cavities, it will spread more rapidly into adjoining rooms, the attic, and other parts of the building. In some circumstances, cracked or broken plaster may indicate that foundations have settled; in others, that more serious structural defects exist. In any case, if cracks appear in walls or ceilings, gas and fuel lines should be checked for damage.

Floor and ceiling openings.—Often concealed from view and extending from ground level to the attic, floor and ceiling openings are common in buildings more than 25 years old.[39] These openings may have been designed to serve as exhaust ducts, plenums, or dumb-waiter or elevator shafts; or they may have been left after the removal of old heating and ventilating systems. Any openings which extend vertically between rooms or floors can conduct fire, smoke, and gases from lower to upper levels and hence should be closed or blocked off.

Stairways and fire escapes.—The importance to safety of fire-resistive stairways, adequately maintained, cannot be overstressed. They should have adequate width, be designed without winders, have treads and landings with nonslip surfaces, have standard width for treads and height for risers, be provided with handrails securely fastened at appropriate heights, be adequately lighted, be enclosed with fire-resistive materials, and lead directly to the outside. If fire escapes

---

[39] Building Research Advisory Board, Committee on Fire Research. *op. cit.* p. 33.

are necessary for safety in older buildings, they should be painted before and after erection, inspected at least annually, and kept clear of all encumbrances and obstructions. They should permit the rapid and safe transfer of people to the ground.

Exits, doors, and hardware.—Proper functioning of exits, doors, and hardware is essential to safety. Exit doors and all supporting hardware must be well maintained and kept operable at all times. Chaining of exterior doors for security, a poor practice at any time, should never be permitted when the building is occupied. The custodian should check each day before children arrive to see that all doors are unlocked and that the anti-panic hardware is operable. Door latches should release with a pressure not to exceed 15 pounds; anti-panic hardware should be made of bars or panels that extend not less than two-thirds the width of the door and should be mounted at a height of not less than 30 nor more than 44 inches above the floor.[40]

Generally, double doors which butt against each other are hard to maintain and keep in alignment, and are easier to "jimmy" than single doors. Multiple doors with removable mullions between them are often recommended; but some State Codes do not permit mullions, either movable or stationary, at main exits.

Locks on doors that lead from classrooms (and other places of assembly) to corridors should be designed to open from the inside at all times without the use of a key. Daily checking and good maintenance are as essential to these doors as to major-exit doors.

Fire doors.—Fire doors must be kept free of any debris or other obstacles which might interfere with their operation. Blocking or wedging fire doors in an open position should not be allowed. Hinges, catches, latches, and stay rolls on fire doors are especially subject to wear. Guides and bearings should be well lubricated. Fire doors are subject to tears in the metal or to dry rot underneath. The fusible links or heat-activated closing devices should not be painted. Fire doors that do not close quickly when activated are a waste of time and money and are dangerous because they give a false sense of security. If a fire door and its equipment are improperly located so that smoke and gases are permitted to pass before heat activates the door, harmful results may occur. A door which does not fit tightly will permit gas to pass under pressure and hence is a hazard.[41] Fire doors should be checked at frequent intervals to insure proper operation.

Lighting.—Proper lighting of a building—especially the exitways—is important to fire safety. Illuminated signs indicating exitways should be on at all times. Combustible materials should be shielded from all lights. Adequate corridor, exit, and landing lights are necessary, especially with evening use of school facilities. All lights and

[40] National Fire Protection Association. *Building Exits Code.*
[41] The Architect's Responsibility for Fire Safety. *op. cit.* p. 59.

power systems should have suitable controls and safety devices; and in some cases, auxiliary power should be provided. The lighting system should be designed so that it is expansible, safe, and easily repaired. Dead light bulbs should be replaced immediately. Switches, fuses, wires, and shields should be checked regularly, and corrections should be made when and where needed.

Chapter IV

Housekeeping

GOOD HOUSEKEEPING, undoubtedly one of the most prudent precautions against school fires, is an activity or a series of activities usually performed by school plant operating personnel under the direction of the building principal or other school officials. Those responsible for supervising these activities should work cooperatively with operating personnel to plan procedures, develop work schedules, and follow practices that will insure maximum safety against fires.

Elements affecting the standards of school housekeeping in relation to fire safety are (1) types of housekeeping duties, (2) community use of school buildings, (3) inspections, (4) reporting and correcting hazards, and (5) custodial utilization of special information and materials on fire safety.

Housekeeping Duties

The importance of good housekeeping in relation to fires is illustrated by the fact that of 100 fires in all occupancy classifications, 6 occur as a result of poor housekeeping.[1] This figure, while not applying to schools alone, justifies the concern and interest that school authorities usually show in regard to the capable performance of such housekeeping duties as cleaning, waste and rubbish removal, incineration, storage, care of decorations, handling of ashes and clinkers, thawing of frozen pipes, and handling of flammable liquids.

Cleaning

Cleaning, an integral part of the housekeeping program, is the process by which soil or dirt, grease, litter, and other types of obnoxious rubbish are removed from the school premises. Some cleaning duties must be performed daily; others, periodically. Some duties affecting fire safety which must be performed daily are removal of waste paper, sweepings, dirty rags, and other types of litter and rubbish; cleaning of shop areas and disposing of wood shavings, sawdust,

[1] Federation of Mutual Fire Insurance Companies. *Is Your Student Housing Fire Safe?* Chicago: The Federation, 20 North Wacker Drive. 1960. p. 17–18. (2nd ed.).

and other wastes of a combustible nature; and, where coal-fired furnaces or boilers are used, removal during the heating season of clinkers and ashes from the firebox and ash pit and fly ash and soot from flues and tubes. Cleaning activities which must be performed periodically for safety include inspection and cleaning of heating and ventilating systems, plenum chambers, and exhaust hoods.

The importance of keeping heating and ventilating ducts clean, free of waste material, and operable at all times cannot be overemphasized. Where air filters are used, either in air-conditioning equipment or in air-circulation ducts, they should be cleaned or replaced when an accumulation of dirt in them increases their resistance to air flow to five times their resistance to it when new.[2] Automatic dampers and other controls must be kept clean if they are to function properly. Plenum chambers should be inspected monthly, cleaned as inspection reveals need, and placed off bounds for storage of any kind. Exhaust fans and hoods, usually located in science laboratories, home economics departments, and kitchens, collect and hold dust, lint, grease, and other types of air-borne particles that make them hazardous if not thoroughly cleaned periodically. These hoods and the ducts leading from them serve as natural flues for any fires that might originate in them.

Waste and Rubbish Removal

Paper of various kinds is essential in the process of education, is usually supplied in generous quantities, and is often discarded as waste in unbelievable amounts. Not only paper, but also other types of discarded materials such as broken pencils, crayons, cardboard, excelsior, and cuttings from pencil sharpeners, contribute to daily accumulations in waste baskets and other containers for refuse. Since the accumulation of such material can be, and often is, a contributing factor to the origin and spread of fire, it should be removed daily from all rooms of a school building, hopefully to be carted away from the premises. Where daily carting away is not possible, provision should be made for temporary storage in covered metal drums (not cardboard boxes), placed in a room of fire-resistive construction other than the furnace room. If there are oil- or paint-soaked cloths, or wax applicators no longer usable, these should be placed in covered metal containers separate from those holding paper and other rubbish.

---

[2] National Fire Protection Association. *Air Conditioning and Ventilating Systems of Other than Residence Type* (NFPA No. 90A). Boston: The Association, 60 Batterymarch Street, 1961. p. 18–20.

Incineration

Open, frequently used incinerator pits on school premises are both objectionable and hazardous: objectionable from the standpoint of aesthetics and odor; hazardous, because they attract children and emit fly ash and sparks, when in use. A community or municipal incinerator is probably the best solution to the problem of disposing of burnable waste; but if there is no community incinerator for school use, the next best solution is the installation in each school of incineration equipment which meets NFPA standards.

Instead of burning waste paper, some schools prefer to bale and sell it as salvage, thereby conserving resources and securing needed school funds. If this is done, temporary accumulations (preferably not more than one day's supply) may be permitted if the accumulation is kept in covered metal drums stored in a fire resistive, segregated area under custodial control. If, after baling, the paper must be kept on the premises for sufficient time to permit an accumulation that can be profitably hauled to salvage dealers, the baled paper should be stored in a fire-resistive room with sprinkler protection, segregated from the rest of the building.

Storage

School buildings constructed within the past decade usually have a generous amount of space alloted for storage; many of those constructed earlier either are lacking in storage space or have undergone remodeling changes which converted much of this space to other purposes. In the absence of adequate storage facilities in a particular school, or for the entire school district, principals, teachers, and custodians are placed in a dilemma regarding the storage of furniture, equipment, materials and supplies on hand but not in use. Regardless of the amount of storage space available to them, they should never use corridors, vestibules, halls or other passageways, or stairs (or the space under them) for storage purposes.

Some common practices that should be avoided without hesitancy include (1) the use of attics, basements, or other obscure places for furniture or equipment that is used infrequently, is broken, and awaiting repairs, or is beyond salvage; (2) the storage of scenery and other equipment in stage wings; and (3) the use of hooks along corridor walls for hanging pupil's clothing in the open. Furniture and equipment awaiting repairs should be carted to the maintenance shop; items beyond salvage should be destroyed; and stage scenery should be stored in "prop" rooms designed for that purpose. Housekeeping in "prop" rooms is paritcularly important, and periodic cleanout of all storage space is recommended. In elementary schools a desirable practice is to provide enclosed space, as a part of each classroom, for pupil's wraps; in high schools, either cloakrooms or metal lockers with doors should be provided. If these metal lockers are placed in corridors, corridor width must be sufficient to accommodate both pupil traffic and the lockers.

Decorations

Decorations for schools should be chosen, used, maintained, and stored with care. Among the types of decorations having particular significance for fire safety are drapes, curtains, valances, rugs, framed works of art, lamp shades, lanterns, objects made of papier-mâché, and special types of decorative materials used for various holidays and seasons of the year. Most of these decorations are available in flame-resistive materials. Any objects that are not of this quality, whether purchased or produced in the arts and crafts departments of schools, should be given appropriate flame-proofing treatment before they are installed, used, or stored.

Paper decorations, such as jack-o-lanterns and shades illuminated by open-flame gas jets, candles, or incandescent lamps, should be prohibited unless they are fire-proof. Trees and other types of plant life used for Christmas and other festive occasions probably should be prohibited also. If they are permitted, they should be thoroughly flame-proofed, located away from any type heating unit (fireplace, radiator, space or unit heater, electric heater, or stove), decorated without using flammable materials, electric lights, or candles. Costumes for plays, operettas, and other performances should be of the type that will not readily ignite when exposed to flame.

Even though decorative materials used by schools may be of the flame-proof variety, they *will* burn if exposed to intense heat, thus contributing fuel to any fire that reaches them. For this reason, they should be stored with utmost care when not in use.

Ashes and Clinkers

The handling of ashes and clinkers from power and heating plants is a housekeeping problem recognized as a serious one by safety engineers, insurance officials, fire marshals, school authorities, and others interested in fire prevention and safety. The number of school fires caused by hot ashes and clinkers is not a matter of record, but the National Fire Protection Association's study of 300 school fires revealed that 25 (more than 8 percent) originated in furnace rooms (See table 1, p. 7). A safe assumption is that a high percentage of school fires can be attributed to exposed ashes and clinkers.

When live ashes, coals, or clinkers are removed from boilers, furnaces, stoves, or other types of coal-burning equipment, they should be placed in metal containers. These containers should never be deposited on, under, or near wood platforms, floors, or other combustible materials; nor should they ever be left in coal bins, whether the bins contain coal or not. Maximum safety can be assured only if these containers are removed from the building immediately after the deposit of refuse in them.

Thawing Frozen Pipes

Mechanical blow torches or devices heated by electricity are frequently used to thaw frozen water pipes and mains. If these tools are used for this purpose, workmen handling them must exercise extreme caution. Water pipes are not usually insulated, are often in contact with wood joists or other combustible material, and may become overheated if flame from blow torches or heat generated by electricity is applied to them. These heated pipes can ignite the combustible materials with which they are in contact. Furthermore, if open-flame blow torches are used in close places, there is always a danger that any combustible materials present may be ignited by the flame. For this reason, it is advisable to keep a fire extinguisher of appropriate type near the scene of operations for use in case of an emergency.

Flammable Liquids

The National Fire Protection Association recommends that in educational institutions the storage of flammable liquids and gases be limited to minimum requirements for maintenance, demonstration, treatment, and laboratory work; that safety cans holding no more than one quart each be used; and that these cans be stored in metal cabinets.[3]

Metal cans are considered better than either glass or plastic bottles for storing and dispensing most liquids, for glass is easily broken and plastic will burn when exposed to heat. Fire safety cans bearing the Underwriters' Laboratories approval have self-closing covers, which minimize evaporation and the likelihood of spillage. These spring-controlled covers also serve as relief valves to prevent explosions if the cans are exposed to intense heat or fire.

If large quantities of flammable liquids must be stored in school buildings, they should be kept in well-ventilated, fire-resistive rooms

[3] National Fire Protection Association. *Flammable Liquids Code* (NFPA No. 30). 1961. p. 38.

with self-closing fire doors that are kept locked when not in use. "NO SMOKING" signs should be posted both on the outside facing of the door and in a conspicuous place inside the room.

Pumps are the best means of removing flammable liquids from tanks and drums, but gravity-flow faucets are often used. If the latter is used, it should be of the spring-closing type, which will permit the flow of liquid only when manually held in an open position.

Community Use of School Buildings

School buildings used for community purposes other than school are exposed to prolonged fire hazards more often than those utilized strictly for day-school purposes. This extra utilization, desirable as it may be, creates additional housekeeping problems, necessitates greater storage facilities, often prompts the installation of more electrical equipment, requires prolonged use of the heating plant (or the air-conditioning system) in season, and places a heavy load on plant operating personnel. If multiple areas of the school plant are used simultaneously by various community groups, additional custodial help may be required to handle the increased work load. This extra work load would consist of the usual cleaning duties, performed after the adults vacate the premises, prolonged daily operation of the heating plant during the heating season, additional services required by the continued operation of electrical systems, checking the switches of electrical appliances and motors to see that they have been left in an "OFF" position, inspecting portions of the building used by community groups to see that nothing has been done there to interfere with school activities on the following day, and performing other routine duties as they arise.

Duties other than those pertaining to building care may, on occasion, fall to custodians as a result of community use of school facilities. Some community activities undertaken in schools by adult groups may not require the attendance of professional personnel normally assigned to those schools. Responsible people in these groups need to know regular and alternate exit routes from all areas of buildings occupied by them; they need to know where telephones are located, where alarm stations are located and how to operate the system, and where fire extinguishers of various types are mounted. Providing information on these points and giving instructions in fire drill procedures to groups not familiar with the premises may consume custodial work time not provided for in the regular schedule.

Inspections

The daily inspection of a school building for safety is a responsibility primarily assigned to the building principal and his custodial force, but teachers and other school employees, as well as the pupils themselves, should be observant of conditions in areas of the building occupied by them and should report any condition that appears dangerous. For example, a teacher might discover a short in a light switch or in an electrical outlet or fixture; the home economics teacher might discover that fuses are blown when she tries to operate an electrical appliance; a cafeteria employee might get an electrical shock when she starts to use the mixer; the science teacher might discover a leak in the gas line located in the science laboratory; the art teacher might find that the upper-limit controls on the ceramic oven have suddenly gone bad; the industrial arts teacher might find that an electric motor smoked when he turns the switch to start it; and the pupils might discover defective electrical switches in toilet rooms, dressing rooms, or other areas not constantly supervised by teachers. Any or all of these observations and discoveries should be reported to the principal or through him to the head custodian.

Many specific housekeeping responsibilities of custodians have been mentioned earlier. They need not be repeated here, but in his daily inspection of the building, the principal (or an assistant designated by him) should accompany the head custodian to ascertain that all custodial duties relating to fire safety have been discharged. They should check to see that all exit doors are operable; that all corridors and stairs are free of obstructions; that there is no accumulation of waste and rubbish in the furnace room, in basement areas, or under stair landings; that conditions in furnace rooms and other danger spots appear to be normal; that fire detection and protection devices have not been tampered with since the previous inspection; and that no unusual conditions appear to have developed since the previous inspection. All custodians should be alert to potential fire hazards as they make the rounds throughout the building during their work periods.

Reporting and Correcting Hazards

School officials should use every reasonable resource available to them for detecting school fire hazards. The day-to-day efforts of principals, teachers, other school employees, and students were mentioned earlier. In addition to these efforts, outside assistance can be and often is secured, usually without cost, from such organizations as the State Insurance Inspection Bureau, the Parent Teacher's Association (among whose members there often are safety engineers or others with special training in safety and fire prevention), the local fire department, the State Fire Marshal, and in some cases local insurance agencies. The services of these organizations should be sought periodically for two purposes: to inspect school properties for the purpose of *detecting* and *reporting* fire hazards, if any are present; and to assist in training school personnel in procedures and methods they can use to detect hazardous conditions. A Coroner's Jury, reporting on a particularly disastrous school fire, expressed a strong conviction that school personnel at times may not know that certain conditions are fire hazards and that they need assistance in being informed regarding these hazards.[4] This is a regrettable situation, if true, and should be corrected by training at the earliest possible moment.

Whenever hazardous conditions are found, whether or not they violate any code, they should be reported to appropriate local officials who should proceed to make corrections without delay. If there is no State or local code to cover the particular situation, persons having authority to revise or amend the appropriate codes should be informed.

Special Materials for Custodial Use

The school custodian has an immense responsibility for school fire safety. In order for him to discharge this responsibility effectively, he should have an understanding of the operational functions of the various mechanical systems of his building; should know how and where to store all supplies, materials, furniture, and equipment assigned to his building; should be able to test periodically—and use if necessary—all of the portable fire extinguishers and other fire-protective equipment provided; should know the location of every fire alarm station inside or outside his building; and should have a thorough knowledge of evacuation plans or alternates covering all exit routes from the building. Booklets containing instructions on the operational functions and maintenance of mechanical systems can be secured from the manufacturers of the various components of those systems. Literature on storage safety can be made available through the principal's office. The local fire department or fire marshal will instruct custodians as to testing, using, and maintaining all types of fire-protective, alarm, and detective equipment. Custodians should have had a part in the cooperative development of evacuation plans; but in cases where plans were developed before their employment, the principal should assume responsibility for placing copies of these plans in their hands and instructing them as to their application.

---

[4] National Safety Council. *Findings of the Coroner's Jury.* Chicago 11: The Council, 425 North Michigan Avenue. 1959. p. 7. (Mimeograph)

In addition to these types of information, custodians should have available for immediate use (preferably posted on their bulletin boards) the following:

Telephone number of—

- Fire and police departments
- Gas company
- Electric company
- Local ambulance services
- Water company
- Local doctors
- The Principal's residence
- Public Health Office.

A chart showing—

- Location of street cut-off for gas
- Location of street cut-off for water
- Location of nearby hydrants
- Location of driveway entrances to building.

A floor plan showing—

- Location of sprinkler shut-off valves
- Location of main electric switches
- Shafts or other vertical openings
- Main exits
- Secondary exits
- Fire escapes (if any)
- Storage areas for combustibles.

Special equipment that should be available to custodians for use in case of fire should include:

- 50 or more feet of rope (for roping off dangerous areas)
- Flashlight with batteries
- First-aid kit
- Wrench for gas cut-off valve
- Gas mask
- Asbestos coat and helmet
- Fireman's ax.

Chapter V

Safety Devices

THE BEST PROTECTION against loss of life and property from School fires is to prevent them, but despite our knowledge of preventive techniques and of the basic requirements for safety, they do occur. Some fires originate because of negligence and carelessness, a failure to observe principles of fire prevention and safety; others, because of fortuitous circumstances. In either event, once a school fire starts, life safety and property preservation depend upon four things: early detection, an effective alarm system (preferably integrated with detection), rapid evacuation without panic, and the availability of appropriate equipment to extinguish the fire or to keep it under control until local fire department equipment reaches the scene.

Detection Equipment

With the exception of conflagrations originating at, near, or in highly flammable materials and fed by them, most fires pass through four discernible stages: incipient, smoldering, flame, and heat. In the incipient stage, invisible combustion gases, without smoke or flame, are released, but no appreciable heat is present. During the smoldering stage, appreciable heat is still absent, but combustion gases become visible as smoke. The flame stage produces actual fire, with heat following instantaneously. The heat stage produces uncontrolled heat and rapidly expanding air, completing a very dangerous combination.

The foregoing discussion implies that nearly all big fires start as small ones. Much more time is usually required for them to pass through the first two stages than the last two, but once flame and heat are combined—as they are in the last two stages—fire develops at a fantastic speed, creating extremely dangerous conditions. Successful evacuations usually must precede the final stage, should preferably precede the third stage. Many fire detection devices on the market today are activated only by smoke, heat, or flame, conditions prevalent in the final stages of a fire, and hence have questionable value from the standpoint of early evacuation. A fire detection system that is activated by invisible combustion gases, as well as by smoke, heat, or flame, usually allows a few extra minutes for evacuation and affords an opportunity for building personnel to bring the fire under control before it reaches the destructive stage. When this system is integrated with a building alarm system which is also connected with the local fire department, it is to be preferred over other systems that depend on flame, heat rise, or heat-rate-of-rise methods of detection.

Purpose

The purpose of an automatic detection system is to *detect* fires. It may be extensive enough to provide fire surveillance throughout a building, day and night and year around, or its operation may be limited to high-hazard areas of the building, or simply to the activation of a switch that will stop an overheated motor. In order to be most effective a detection system should be integrated with an alarm system that can be heard over the entire building and with a control system that is activated at the point of detection. The value of any detection system depends upon its reliability, and since most things mechanical fail occasionally, a supervisory system that will reveal a detector failure is desirable.

Types

A properly installed, functioning fire detection and alarm system requires careful consideration of the types of fire hazards, the construction and layout of the building, and the spaces to be protected. Four types of automatic detector or annunciating devices are on the market. They are classified according to the particular product (or products) of combustion to which their detector heads are sensitive, namely: *gas*, *smoke*, *flame*, *heat*.

Gas.—Microscopic, often invisible, air-borne products of combustion, such as gases and smoke, activate the gas-sensitive device or system. Its detector head has a sensing element that utilizes alpha particles emitted from a minute source of radium to ionize air molecules into positive ions and negative electrons. When a voltage is applied across its ionization chamber, a minute electric current is caused to flow. Any products of combustion entering the chamber become ionized but, because of their relatively large size, they move more slowly than air molecules, thereby reducing current flow. The mechanism is so designed that this reduction in current increases the voltage at the trigger electrode, activating relays for signals and alarms.

The system uses a standard 2-wire circuit enclosed in a thin-wall conduit and is supervised by a 2-microampere closed circuit which activates a trouble alarm in case there is failure in the system. It has no moving parts, and an installation in a large building consumes no more power than a 25-watt electric bulb. The system can be adapted to a wide range of response sensitivity, and can be utilized to close doors, stop motors, and actuate alarms. One dectector head can protect up to 3,600 square feet; and where multiple spaces are protected by more than one head, the system indicates the exact location of any fire originating in a protected area.

Smoke.—The principle of control by a photoconductive cell operates the smoke-sensitive detector. A beam of light is directed on the cell, and any smoke interfering with the beam reduces its intensity on the cell. This reduction in light energy causes the cell to activate the signal. Any other interference with the light source, such as excessive dust or moisture in the air, a film deposit on the electric eye itself, or any accidental interruption of the light beam, can also actuate the system, causing a false response. The sensitivity of the system can be adjusted to compensate for any of these stimuli, but if they then disappear or become less intense, it will produce a delayed response. Both the false and the delayed response can create undesirable circumstances—the former, inconvenience; the latter, disaster.

The smoke-sensitive detection system is usually installed for special purposes such as closing dampers and stopping fans in ventilating ducts, and closing fire doors to high-hazard areas when smoke is present at these points.

Flame.—Radiation causes an element in flame-sensitive detection devices to react. The effectiveness of the device depends upon the total building area that can be "seen" by it. Since radiation travels in straight lines, instrumentation must be such that the entire area needing protection must be "visible." This type of detection system is probably used more extensively in manufacturing concerns, particularly those having high-hazard areas, than in school buildings.

Heat.—There are perhaps five types of heat-sensitive detectors. (1) The first type functions when heat causes unequal expansion of laminated parts of a bimetal disc whose operating temperature is fixed (usually at 135° Fahrenheit). When the temperature at the point of the detector reaches this level, the disc changes shape, making a contact that closes an electric circuit to actuate the signal. (2) Another type depends upon a fixed temperature setting of its thermostat (usually at 135° to 140° Fahrenheit) with a mechanism that is sensitive to a limited rate-of-rise, or rate anticipation, in temperature. A special switch enclosed within an anodized-aluminum tube closes the circuit to actuate the signal. (3) A third type combines the pneumatic and rate-of-rise in temperature principles by the use of a diaphragm unit connected to tubing designed with vents to dissipate normal rise in temperature. Continued abnormal rate-of-rise in temperature cannot be dissipated by these vents, resulting in a pressure increase on the diaphragm causing it to make electrical contacts that activate the signal. (4) The fourth type operates on a thermoelectric principle. The detecting elements respond to both radiant and convected heat. Each detector has two sets of thermocouples, one directly exposed to radiant and convected heat; the other, insulated from them. Any rapid increase in temperature results in a current increase that starts the alarm. (5) The fifth type combines both rate-of-rise and fixed-temperature principles. The rate-of-rise sensitivity is accomplished by air pressure within a hemispherical chamber that has vents to dissipate pressure changes due to normal rates of temperature rise. Abnormal rate-of-rise in temperature increases pressure on a diaphragm, resulting in diaphragm changes that cause electrical contacts which produce the signal. The fixed-temperature feature is based on a thermostat with a fusible element having a rating of 136° Fahrenheit. When heat in the area protected by this device reaches 136°, the element is broken, thereby releasing the thermostat to make an electrical contact to produce the signal.

Operation

In 1959, the Los Angeles Fire Department, using an abandoned school building with an open stairway, conducted a series of fire tests, one of which was to determine the effectiveness of automatic fire detection equipment under special test conditions. Among other things, these tests revealed that: [1]

- **Automatic heat detection devices detected the presence of fire at about the same time that untenable smoke conditions were reached within the building.**
- **Automatic smoke detection devices detected the presence of fire before untenable smoke conditions were reached, but not in sufficient time to allow complete evacuation of the test building.**

The report covering the series of tests explains, however, that if detection equipment (both heat and smoke) is located *directly over the test fire*, prompt notification of fire is experienced. Fire detection devices spaced at maximum recommended distances will operate in 2 minutes or less when subjected to standard fire test conditions used by testing laboratories; but under test conditions used by the Los Angeles Fire Department, a fire signal in 2 minutes would not allow enough time for the safe evacuation of the test building. The report also points out the need for a better means of classifying the sensitivity of fire and of classifying smoke-detection equipment in relation to response time for the protected area. Finally, the report suggests that further research is needed on automatic detection equipment actuated by smoke.

---

[1] Los Angeles Fire Department. *Operation School Burning*. Boston 10: National Fire Protection Association, 60 Batterymarch Street. 1959. p. 29–30.

In an effort to find answers to these and other problems on fire safety, the Los Angeles Fire Department in 1960 and 1961 conducted a second series of tests in the same school building. In order to determine whether the automatic detection devices tested would respond early enough to permit safe evacuation, 14 test fires (typical of many types that could occur in school occupancy) were set in different locations throughout the building under various conditions. They were permitted to burn until untenable conditions were reached or until the fire had subsided. Among other things, these tests revealed:[2]

- In four fires, automatic smoke and heat detection devices did not provide an alarm in sufficient time to evacuate the building safely, but untenable conditions developed so rapidly that instantaneous detection would have been inadequate. (Flammable liquids, although used in relatively small amounts, were involved in three of the four fires.)
- In 10 fires, the automatic smoke and heat detection devices responded in sufficient time for safe evacuation. (In 5 of these 10 fires, untenable smoke conditions were developed in corridors and stairways, but the detection devices operated with a sufficient margin of time to evacuate the building safely.)

The Los Angeles Fire Department also set a series of 33 fires in order to determine response time as affected by location, spacing, and other physical factors for automatic detection devices tested. From these tests, the following observations were made:[3]

- Smoke detectors respond faster than heat detectors when both types are located within a room or area of fire origin, but not significantly faster when both types are located outside the room or area of fire origin.
- Rate-of-rise and rate-anticipation type detectors respond faster than the fixed-temperature type.
- Line-type (pneumatic tubing) rate-of-rise detectors installed with a "U" loop within each room respond considerably faster than a single straight line of tubing passing through each room. (Adding from 50 to 100 percent more tubing to the single "U" loop does not appreciably speed up the response time.)
- Both the fixed-temperature and the rate-of-rise type heat detectors respond as fast when mounted on side walls 4 inches and 12 inches below the ceiling as they do when mounted on the ceiling 6 inches from the side wall.
- Neither the fixed-temperature nor the rate-of-rise type detector is of any value in detecting fire when mounted on side walls 5 feet above the floor.
- All types of detectors tested show considerably slower response time when ceiling heights are increased from 11.5 feet to 19 feet or to 26.5 feet.
- Heat detectors respond as rapidly under draft conditions as in closed rooms. Smoke detectors respond slower under draft conditions than in closed rooms, though still faster than heat detectors.

---

[2] Los Angeles Fire Department. *Operation School Burning* (No. 2). 1961. p. 26.
[3] *Ibid.*

✦ **Reducing the spacing of any given detector below the maximum recommended by Underwriter's Laboratories results in a faster response time, but the improvement is not significant from the standpoint of life safety.**

Installation, Location, Spacing

When used in schools, fire detector systems should be installed in accordance with standards prescribed by State and local codes, or in the absence of these codes, with those recommended by the National Fire Protection Association. Individual detector heads installed in high temperature areas, such as boiler rooms and poorly ventilated attics, should be designed or adjusted so that the high temperatures usually present there will not "trigger" them. Manufacturers whose equipment is being installed can furnish special engineering services to cover this and similar situations.

It may not be desirable or practical to install detector heads at every conceivable location in a building, and if not, those areas of a building considered high-hazard, "hot-spot", obscure, and perhaps rooms that are infrequently used should be given first priority. Among these, any independent or segregated area of 16 or more square feet should be considered as a separate subdivision for purposes of detector installation. Attics, lofts, furnace rooms, basement space, storage rooms, shops, and rooms where spray painting is done are samples of first-priority building areas for detector heads. Whether located in these areas alone, or in these and other sections of a building, heat detecting devices should be placed on ceilings or on side walls near the ceiling.[4] An engineering survey which will analyze the special features of the area under consideration will be required to determine the location of smoke detector heads. Air velocity, location of air intake and exhaust vents, presence or absence of air-conditioning equipment, and ceiling height are some of the special features which must be analyzed in order to determine the number of detectors required, as well as where to locate them to prevent false signals from normal air movement or other activity in the given area.

Heat detecting devices should not be spaced at distances exceeding linear maximums recommended by the Underwriters' Laboratories, Incorporated, or by Factory Mutual Laboratories, based on tests of these devices conducted by these concerns. For details concerning spacing of various types of detection equipment, the reader is referred to *Fire Protection Equipment List.*[5] The series of fire tests, conducted by the Los Angeles Fire Department and referred to previously,

---

[4] National Fire Protection Association. *Proprietary, Protective Signaling Systems* (NFPA No. 72). 1961. p. 22.

[5] Underwriters' Laboratories, Inc., Chicago 11: The Laboratories, 207 East Ohio Street. 1961.

revealed that if the space between detectors is reduced below the maximum recommended by the Underwriters' Laboratories, Incorporated, detection response is faster, but not significant as to life safety.[6]

Maintenance and Testing

Money spent on installing detection equipment without providing for its maintenance is a foolhardy expenditure. To be of value, it must be operable at all times. Dependability can be assured by adequate maintenance and by means of an electronically controlled supervisory system which gives a warning if anything goes wrong or if any component fails. Adequate maintenance requires periodic inspections, followed by testing, under the supervision of authorized personnel, with tests conducted in accordance with standards recommended by the National Fire Protection Association.

Alarm Equipment

The main purpose of an alarm system is to warn of an existing emergency by means of a distinctive sound. A fire alarm system should be used for no other purpose than to alert building occupants to evacuate the building and to summon professional fire fighters to the scene. Properly planned, adequately designed, suitably placed fire alarm equipment must provide one or more approved audible signaling devices on each floor of a building, located so that their distinctive sound can be heard clearly, regardless of the maximum noise level produced by any machinery or other equipment under normal conditions of occupancy. Each section of a floor enclosed by fire walls should be considered as a separate floor for the purpose of this protection.

Types

There are two main types of fire alarm equipment in relation to method of activation: manual and automatic. The *Findings of the Coroner's Jury*,[7] mentioned in chapter IV, led to a recommendation that school buildings should be equipped with a system that is both manual and automatic. It is further suggested that a system which warns building occupants and the fire station simultaneously is desirable. If a building is protected by sprinklers, an automatic alarm system that activates the sprinkler system at the same time that it

[6] Los Angeles Fire Department. *op. cit.* p. 27.
[7] National Safety Council. 1959. p. 3. (Mimeograph.)

warns occupants and alerts the local fire department has certain advantages.

Some types of automatic alarm systems also provide supervision over sprinkler and other extinguishing equipment, where this function is not performed by fire detector devices. This type of supervisory control gives a signal if there is some reason, such as an electrical short or the collection of water in an air valve, that might cause the sprinkler to function improperly.

Fire alarm systems activated by manually pulling a lever or throwing a switch are more common in schools than are automatic systems. Boxes housing activating levers or switches should be of an approved type, clearly marked, and strategically located. As in the case with automatic alarm systems, it is desirable that manual systems be wired directly to the local fire department in order to initiate an alarm there. However, it is practical to install a cut-off so that the local fire department will not be alerted and need not respond when fire tests or evacuation drills are under way.

Some authorities suggest that, in addition to an electrically activated alarm system, schools should have a complete mechanical standby system for use in case of electric failure (either AC or DC).

Installation

All fire alarm equipment, whether manual, automatic, or a combination of the two, should be of an approved type.[8] All wiring, location of activation boxes, regular and standby electrical requirements, and other phases of instrumentation should conform to State or local codes or to applicable national standards.

Testing and Maintenance

Immediately after an alarm system is installed, it should be given a thorough and complete test in accordance with recognized national standards for such tests under the authority and supervision of the local fire marshal, the fire chief, or other responsible officials having jurisdiction. This initial test should be followed by others at regular intervals, probably not less often that monthly. Maintenance requirements of fire alarm systems should always be determined by competent personnel who follow manufacturers' instructions and specifications when making repairs.

---

[8] Further information on fire alarm equipment may be obtained from *Fire Protection Equipment List*, identified on p. 92.

Distribution and Location

Fire alarm boxes should be readily accessible, easily identified, strategically distributed throughout the protected area, and located along the normal path of exit, as follows:[9]

> One box should be provided on the first floor and on each succeeding alternate floor, except that one box should be provided for *each* floor where the maximum fire area is 10,000 square feet or more.
>
> Additional boxes should be provided on each floor wherever necessary to make the maximum horizontal travel distance from any point on the floor to the nearest box not more than 200 feet.

It is considered good practice to provide an alarm box near any point of hazard. Both an alarm box and a sounding station should be provided in custodial quarters and in the furnace room.[10]

Authorities differ as to the wall height at which fire alarm boxes should be mounted, but a minimum of 4 and a maximum of 6 feet from the floor, depending on age and size of occupants, seems to be a safe range.

Use and Sound

The fire alarm system should never be used for any other purpose than to sound an alarm, either for a drill and test or because of an actual fire. Regardless of the purpose for which used—drill, test, or fire—alarm equipment should be restored to service immediately following each use.

The audible signal produced by an alarm system should be consistent throughout a building, should be distinctive from signals used for other purposes, and should be emitted from instruments so located that the signal can be heard throughout the building. Some experts on school fire safety have suggested that there should be a uniform warning signal (sound) for fires throughout the country. The suggestion has merit, and like some other regulations concerning safety, may some day have universal approval.

Extinguishing Equipment

Fire extinguishing equipment for schools that is properly installed, strategically located, well maintained, periodically tested, and skillfully handled when needed can be of inestimable value in the control of fires. There are many types of fire extinguishing equipment, but all fit into one or another of three major classifications: portable, standpipe and hose, and sprinkler.

---

[9] National Fire Protection Association. *op. cit.* p. 20.

[10] John H. Herrick and others. *From School Program to School Plant.* New York; Henry Holt and Company. 1956. p. 409.

Portable extinguishers are those devices which can be hand-carried from their places of storage to the point of an incipient fire for the purpose of putting out the fire, or at least keeping it under control until professional fire fighters arrive.

Classification.—There are numerous types of portable fire extinguishers, but in general they are classified according to the class of fire they are designed to extinguish. Class "A" fires are those fed by paper, wood, excelsior, rubber, and trash, and require cooling and quenching for extinguishment. Class "B" fires are those fed by liquids (gasoline, paint, oil, grease, etc.), and demand a smothering action for quick extinguishment. Class "C" fires are live electrical fires (motors, switches, appliances, etc.), and require a nonconducting extinguishing agent.

Extinguishing agents most frequently employed by portable extinguishers are *water* (as stored pressure, as cartridge-operated, as water pump tank, or as soda acid) *foam*, *carbon dioxide* (CO_2), and *dry chemical.*

Only extinguishers bearing the approval of the Underwriters' Laboratories or the Factory Mutual Laboratories should be selected and purchased. These will have a plate on which is indicated the class and the size of fire which the equipment is designed to handle. This is accomplished by the use of a numeral and a letter. The numeral indicates the approximate relative fire-extinguishing potential; the letter indicates the class of fire on which the extinguisher is to be used. For example, "4–A" indicates that the extinguisher is to be used on a class "A" fire, and can be expected to extinguish twice as much fire as a "2–A" extinguisher. Likewise, extinguishers for "B" and "C" class fires are labeled with appropriate letter classification, but the "C" label does not have a numerical designation for the reason that class "C" fires are essentially either "A" or "B" involving energized electrical wiring and equipment. The numerical designation used with "B" extinguishers refers to the approximate square-foot area of deep-layer flammable liquid fire which an average operator can be expected to extinguish. For example, "10–B" means that an average operator can be expected to extinguish approximately 10 square feet of deep-layer flammable liquid fire with the particular extinguisher.

Extinguishers that can be used effectively against more than one class fire have appropriate numerical and letter designations. For example, a foam extinguisher rated "2–A, 4–B" is rated to extinguish twice as much class "A" fire as a "1–A", and four times as much class "B" fire as a "1–B" extinguisher. Also, the "2–A, 4–B" extinguisher should handle 4 square feet of fire in a deep-layer flammable liquid.

A dry chemical extinguisher rated "6-B, C" should extinguish approximately six times as much class "B" fire as a "1-B" extinguisher, and should successfully extinguish a deep-layer flammable liquid fire of 6 square feet. This designation also means that it is safe to use this extinguisher on electrical fires.[11]

The importance of understanding the type of extinguisher that can be utilized most effectively against a specific class of fire cannot be over-emphasized. It is also important to place extinguishers designed to fight specific class fires in building areas where fires of that class are most likely to originate. The significance of this is that if the wrong extinguisher is used, the fire may not be brought under control; or if the wrong extinguisher is employed against an electrical fire, the operator may suffer serious physical damage or death from electrocution. Chart 1, (p. 98) "How to Select a Fire Extinguisher"[12] and chart 2 (p. 100), "Know Your Fire Extinguisher"[13] present valuable concise information for purchasing, servicing, and using school fire extinguishers. Also, "The A B C's of Fire Extinguishers,"[14] given in appendix D, presents an exceptionally good summary of facts which should be understood about fire extinguishers.

Location.—Extinguishers should be placed at all hazardous locations and at various convenient places throughout a building. Portable units may be mounted on walls, but usual preference is for them to be placed in cabinets recessed far enough so that the front of the cabinet, or its door, is flush with the face of the wall, with no projecting parts. *Findings of the Coroner's Jury.*[15] previously mentioned in this and the preceding chapter, recommended that portable extinguishers should be conspicuously marked, mounted at waist height, and so located that they will not be bumped by anyone passing along. Most authorities suggest that an extinguisher of appropriate type be located near each fire alarm station.

Distribution.—The number of portable fire extinguisher units and best places to install them should always be determined by the authority having jurisdiction, usually the local or State fire marshal. This determination is often made on the basis of the occupancy classification of a building. With the exception of those offering trade courses and utilizing shops, schools are usually classified as "light hazard occupancies." According to the National Board of Fire Underwriters, buildings with this classification require fire extinguishers for Class A fires, with one unit for every 2,500 square feet of floor space and the units so spaced that it would not be necessary to

---

[11] National Fire Protection Association. *Portable Fire Extinguishers* (NFPA No. 10). 1959. p. 4-5.

[12] Used by permission of Fire Equipment Manufacturers' Association, Inc. Suite 759, One Gateway Center, Pittsburgh 22, Pa.

[13] Used by permission of the Federal Fire Council, Washington 25, D.C.

[14] Used by permission of the National Fire Protection Association, Boston, Mass.

[15] National Safety Council. *op. cit.* p. 4-5. (Mimeograph.)

Chart 1.—How to Select a Fire Extinguisher

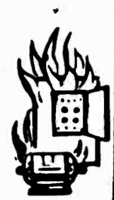
	CARBON DIOXIDE	DRY CHEMICAL	VAPORIZING LIQUID
CLASS A  Paper, wood, excelsior, rubber and general combustible fires requiring cooling and quenching.	Small Surface Fires Only	Small Surface Fires Only	Small Surface Fires Only
CLASS B  Burning liquids, (gasoline, paint, oil, grease, etc.) demand a smothering action for quick extinguishment.	**YES** Has no ill effects on food and leaves no residue.	**YES** Chemical smothers fires	**YES** Vaporizing liquid is converted into a gas—which smothers the fire.
CLASS C  Live electrical fires (motors, switches, appliances, etc.). A non-conducting extinguishing agent must be used.	**YES** Carbon dioxide is non-conductor; will not damage costly electrical equipment or leave residue.	**YES** Dry chemical is non-conductor of electricity.	**YES** Liquid is non-conductor, and will not damage equipment.
SUBJECT TO FREEZING	No	No	No
EXTINGUISHING AGENT	Carbon Dioxide	Dry Chemical	Heavy vapor formed from liquid by heat.
RANGE	5-10 feet	10-25 feet	20-30 feet
EFFECT ON FIRE	Smothers and Cools	Smothers and Cools	Smothers and Cools

Chart 1.—How to Select a Fire Extinguisher (continued)

	FOAM	SODA ACID	WATER	LOADED STREAM
CLASS A Paper, wood, excelsior, rubber and general combustible fires requiring cooling and quenching.	**YES** Foam clings to vertical surfaces, wets and smothers.	**YES** Soda-Acid is economical protection . . . quenches and cools.	**YES** Water is excellent protection; it cools and quenches.	**YES** Water with chemical additive gives good protection; cools and quenches.
CLASS B Burning liquids, (gasoline, paint, oil, grease, etc.) demand a smothering action for quick extinguishment.	**YES** Heavy foam blanket on surface of burning liquids smothers.	**NO** Basic water content will spread liquid fires.	**NO** Water will spread fire, not put it out.	**YES** Provides smothering action on small fires.
CLASS C Live electrical fires (motors, switches, appliances, etc.). A non-conducting extinguishing agent must be used.	**NO** Foam is a conductor and should not be used on electrical equipment.	**NO** Should not be used on live electrical equipment; basic water content will conduct.	**NO** Water, a conductor should not be used on live electrical conductor.	**NO** Should not be used on live electrical equipment.
SUBJECT TO FREEZING	Yes	Yes	Yes, unless chemical is added.	No
EXTINGUISHING AGENT	Foam Bubbles	Soda Water Solution	Water	Mineral Salt Solution
RANGE	25-35 feet	30-40 feet	35-50 feet	45-60 feet
EFFECT ON FIRE	Smothers and Cools	Cools and Quenches	Cools and Quenches	Cools and Quenches

Chart 2.—Know Your Fire Extinguisher

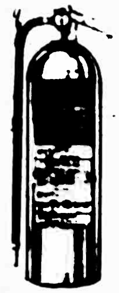
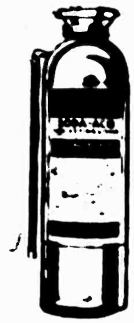
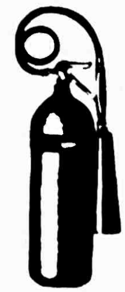
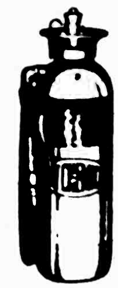
	WATER TYPE			
	 STORED PRESSURE	 CARTRIDGE OPERATED	 WATER PUMP TANK	 SODA ACID
CLASS A FIRES wood, paper trash-having glowing embers	YES	YES	YES	YES
CLASS B FIRES flamable liquids, gasoline, oil, paints, grease, etc.	NO	NO	NO	NO
CLASS C FIRES electrical equipment	NO	NO	NO	NO
USUAL OPERATION	Squeeze handle or turn valve	Turn upside down and bump	Pump handle	Turn upside down
RANGE	30'-40'	30'-40'	30'-40'	30'-40'
SERVICE BY	Check air pressure	Weigh gas cartridge add water if required	Discharge and fill with water annually	Discharge annually -recharge

Chart 2.—Know Your Fire Extinguisher (continued)

	FOAM  FOAM	CARBON DIOXIDE  CO_2	DRY CHEMICAL  DRY CHEMICAL
CLASS A FIRES wood, paper trash-having glowing embers	NO (but will control small fires)	NO (but will control small surface fires)	NO (but will control small surface fires)
CLASS B FIRES flamable liquids, gasoline, oil, paints, grease, etc.	YES	YES	YES
CLASS C FIRES electrical equipment	NO	YES	YES
USUAL OPERATION	Turn upside down	Rupture cartridge-squeeze release	Rupture cartridge-squeeze release
RANGE	30'-35'	2'-4'	6'-12'
SERVICE BY	Discharge annually -recharge	Weigh semi-annually	Weigh gas cartridge-check condition of dry powder

travel more than 100 feet from the point of any incipient fire to reach an extinguisher. Where there are special hazards in addition to the ordinary hazards of occupancy, additional and/or substitute units of suitable type should be installed. Specific requirements for buildings with other than light hazard occupancies may be obtained from standards prescribed in *Portable Fire Extinguishers.*[16]

Inspection, testing, maintenance, recharging.—The proper functioning of portable fire extinguishers depends upon their being inspected and tested periodically, maintained as needed, and recharged at regular intervals, these intervals being determined by the frequency of use for testing or for other purposes and by the extinguishing element employed by the unit. Manufacturers' directions[17] regarding maintenance and inspection of the various types of portable units should be followed assiduously. It is not unreasonable to ask the custodian, while making his daily rounds, to inspect each unit to see whether there is visible evidence of tampering, removal from regular storage places, or accidental discharge. Soda-acid extinguishers must be protected from freezing, must be recharged once annually (if not tested or used more often), and should be subjected to a hydrostatic pressure test once every 5 years.

Standpipe and Hose System

The National Fire Protection Association[18] indicates, that, next to automatic sprinkler equipment, a well-maintained, properly designed standpipe system constitutes the best means of extinguishing fires in buildings and furnishes the only reliable method of directing effective fire streams to the upper stories of high buildings in the shortest space of time. Also, standpipe systems are designed for use by both occupants of the building and by firemen.

It is sometimes felt that standpipe systems are not completely satisfactory for school use since these systems are subject to tampering, and may cause water damage in case of vandalism. In some instances, to prevent vandalism, school authorities remove the valve handles, thus making the equipment virtually useless.

Types.—Standpipe and hose systems may be divided into the following classes:

- The wet standpipe system which has water pressure maintained at all times.
- The system is so arranged that it admits water to the system automatically by opening a hose valve.

---

[16] National Fire Protection Association. *op. cit.* p. 6–11.

[17] Fire Equipment Manufacturers' Association, Inc. *FEMA Handbook of Safety Codes.* 1959.

[18] *Standpipe and Hose Systems* (NFPA No. 14). 1952. p. 3.

- ✦ The system which admits water through the manual operation of a remote valve.
- ✦ The dry standpipe system which has no permanent water supply.

Installation and location.—School officials need to study many points when they are considering the installation of a standpipe system. Of particular importance are such factors as water supply (source, pressure, supply); size of pipes, hose, and nozzles; type of construction; height of building, nature of occupancy; and accessibility of other types of fire control equipment. The authority having jurisdiction should be consulted on these and other pertinent factors relating to the feasibility of a standpipe system for a particular building. If there is a decision to install the system, standards recommended by the National Fire Protection Association in *Standpipe and Hose Systems* will be found useful.

In general, standpipe systems should be constructed only of approved components (pipes, connections, valves, hose, nozzles), and when installed, should be hydrostatically tested before being accepted. Standpipes should be located in building areas that afford them some protection against mechanical and fire damage. Hose stations should be located in readily accessible, conspicuous places that are not likely to be obstructed, and the cabinets housing the hose should be within easy reach of adults standing on the floor. Periodic inspection and regular maintenance of valves, hose, nozzles, and other parts are essential to satisfactory performance.

Sprinkler System

A sprinkler system may be described as a network of pipes, with sprinkler heads systematically spaced on them, usually installed on the ceiling throughout a building (or in certain portions of it), and connected to a water supply which is controlled by a series of valves. Sprinkler heads may be activated by fire or heat-detecting devices or by heat from fire.

The value of an adequate sprinkler system with an ample water supply as an effective tool for life safety and property protection from fire is seldom questioned. This is verified by the fact that there has been no loss of life in thousands of fires in fully sprinklered buildings. While savings in insurance costs will appeal to some, the saving of lives should take priority when considering a system that offers a way by which a fire may be discovered in its early stage, and provides the means by which it can be extinguished, or at least controlled until firemen arrive.[19]

[19] "The Architect—and Fire Safety". *Journal of the American Institute of Architects*, 28 : 40–41, May 1957.

In 26 of 30 tests conducted by the Los Angeles Fire Department,[20] automatic sprinklers extinguished the test fires before untenable conditions developed. In four cases the fires were not of sufficient size to activate the sprinklers and therefore were not dangerous from the standpoint of life safety. Further tests in which the building was only partially sprinklered revealed that automatic sprinklers installed in corridors, stairways, and in some rooms, but not throughout the building, did not prevent untenable *smoke* conditions when the fire originated outside the sprinklered area, but did prevent untenable *temperature* conditions within the protected area. The installation of an automatic sprinkler in high hazard areas afforded additional protection when integrated with the school alarm system. However, such an installation should be done only on the recommendations of a fire protection engineer.[21]

Types.—On the basis of building areas protected, there are two major types of sprinkler installations: partial and complete. As the words imply, "partial" means a limited installation, while "complete" means one that is installed throughout the premises. More specifically, either of these installations may be one of several types of systems: wet-pipe, dry-pipe, pre-action, deluge, and limited water-supply.

In the wet-pipe system the pipes are filled with water, which is discharged immediately from the sprinkler heads upon being activated by fire. The dry-pipe system, does not have water in the pipes, which contain air under pressure to keep water from entering them until needed. Generally, the dry-pipe system is installed where the wet-pipe system is impractical because of freezing temperatures, making it unnecessary to cut off the system because of cold weather. In small, unheated spaces where it is not practical to install a dry system, a wet system may be used, with anti-freeze solution in the pipes. The pre-action and deluge systems may be either the wet or the dry type; but the former is designed to sprinkle only a specific area where valves have become activated, while the latter sprinkles an entire area upon activation. Limited water-supply systems employ automatic sprinklers as do other systems, but these sprinklers are supplied with water from a pressure tank of limited capacity.

Design and installation.—The authority having jurisdiction should be consulted for advice in regard to the installation of a sprinkler system. The equipment should have the approval of the Underwriters' Laboratories and should be installed in accordance with standards of the National Fire Protection Association.[22] The hazard classification of the occupancy should, to a great extent, determine

---

[20] Los Angeles Fire Department. *Op. cit.* p. 27–28.
[21] *Ibid.* p. 30–31.
[22] *Standards for the Installation of Sprinkler Systems* (NFPA No. 13). 1961.

the design of the sprinkler system, but special consideration should be given to its design if there is a doubt as to water supply. For example, if the system is designed to accommodate the simultaneous opening of 20 sprinkler heads and if 40 heads open at one time, the usefulness of the system may be nullified. Architects and engineers should see that sprinkler valves are properly placed and are plainly marked with warning, or are equipped with supervisory alarm to insure that the system has not been shut off and is in an operable condition at all times.[23]

Maintenance and inspection.—To be effective a sprinkler system must be properly maintained. The installing contractor should provide instruction charts, along with standards developed by the National Fire Protection Association, on the care and maintenance of the sprinkler system. The instructions should be assiduously followed.

Water Supply

Whatever the source of water supply for school fire extinguishing equipment, it must be adequate in volume and have satisfactory pressure if the equipment is to operate effectively. The amount of water needed will vary according to the hazard of the occupancy and the particular sprinkler or standpipe and hose system in use. The water supply should be tested according to accepted standards to determine its adequacy, both as to volume available per minute and as to constant pressure. Water supply for operating fire-extinguishing equipment for schools may be from the public water system, where pressure usually is adequate; or from a private system, owned by either the school or private individuals in the community. In some instances, booster pumps of various kinds are required to maintain a constant supply of water under correct pressure for fire-fighting equipment.[24]

Community Facilities

The National Board of Fire Underwriters has developed a rating system for cities, towns, villages, and other districts as to their ability to protect against fire. Three of the major elements of this rating system are concerned with an adequate water supply, an efficient fire department, and a fire alarm system. These elements, plus others, are essential in communities that wish to provide maximum fire protection for their schools.

---

[23] The Architect—and Fire Safety. *op. cit.* p. 40–41.

[24] For further information concerning water supply see *Standards for the Installation of Sprinkler Systems, op. cit.*

Water Supply

Adequacy of the public water supply at a given school building can be determined by flow tests or other reliable means. These tests should show the flow in gallons per minute, together with the static and residual pressure, in the water main. Street mains should be ample in size, in no case less than 6 inches, and should not terminate as dead ends near school buildings (or anywhere else). Connections to public water mains should be controlled by indicator post valves of a standard type located not less than 40 feet from the building protected.

Fire hydrants should have not less than 6-inch connections with water mains, and should be located so that no fire department hose line from any hydrant serving the school exceeds 500 feet in length. Two or more hydrants placed so that two or more streams can be played on a fire simultaneously provide added protection.

Water mains and hydrants should be tested periodically for water flow and pressure. Special hydrants designed to prevent freezing of water in them should be installed in sections of the country where temperatures fall below freezing for several hours.

Extinguishing Equipment

Adequacy of the community fire department's equipment is of special importance to school fire safety. Fire engines, trucks, and other equipment capable of handling the most serious fire in the district may mean the difference between loss of life and safety for school pupils. For example, ladders, nets, and other means of escape for trapped children can save lives. Equipment alone, however, is not the full answer. The equipment, no matter how adequate, must be manned by capable, professional firemen. These types of equipment, with trained personnel to operate them, become increasingly important in communities having multi-storied buildings.

Alarm Equipment

The importance of integrating a school's detector or sprinkler system with its alarm system is usually recognized; less frequently recognized is the fact that it is of utmost importance that these systems be wired to the public fire deparment. When a direct wire connects the school's alarm system with the fire department, there is a much greater possibility that a fire will be brought under control sooner than would be the case without such a system. All circuits and all equipment used in alerting the public fire department should be tested periodically for proper functioning.

Appendix A

Selected Bibliography

ABERCROMBIE, STANLEY, NORMAN KEY *and* MELVIN ENGLEHARDT. Safety in the School Plant. *Elementary School Buildings—Design for Learning* (vol. 34). Washington 6: Department of Elementary School Principals (NEA). 1959.

ADMINISTRATIVE BUILDING COUNCIL OF INDIANA. *School Construction Rules and Regulations* (vol. 5). Indianapolis 7: The Council, State Board of Health Building, 1330 W. Michigan Street. 1955.

AMERICAN ASSOCIATION OF SCHOOL ADMINISTRATORS (NEA). *Planning America's School Buildings.* Washington 6: The Association, 1201 16th Street, NW. 1960.

———. *Safety, Sanity, and the Schools.* 1959.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION. *Fire-Resistant Construction in Modern Steel-Framed Buildings.* New York: The Institute, 101 Park Avenue. n.d.

AMERICAN SOCIETY FOR TESTING MATERIALS. *Standard Methods of Fire Tests of Building Construction and Materials* (ASTM Designation: E 119058). Philadelphia 3: The Society, 1916 Race Street. Adopted 1958. (Reprinted from Copyrighted Book of ASTM Standards Part 5).

———. *Standard Method of Test for Surface Burning Characteristics of Building Materials* (ASTM Designation: 84–61). 1961.

THE ARCHITECT—AND FIRE SAFETY. *Journal of the AIA.* May 1957. p. 37–42.

THE ARCHITECT'S RESPONSIBILITY FOR FIRE SAFETY. *Bulletin of the American Institute of Architects* (AIA File No. R9), March–April 1956.

BAHME, CHARLES WILLIAM. *Fire Protection for Chemicals.* Boston 10: National Fire Protection Association, 60 Batterymarch Street. 1956.

BOND, HORATIO (*ed.*) *Research on Fire.* Boston 10: National Fire Protection Association, 60 Batterymarch Street. 1957.

BUGBEE, PERCY. Fire Protection Progress. *Safety Standards,* 10: 1–6. September–October 1961.

BUILDING RESEARCH ADVISORY BOARD, COMMITTEE ON FIRE RESEARCH. *School Fires—An Approach to Life Safety.* Washington: National Academy of Sciences—National Research Council. 1960.

CARROLL, CHARLES F. Fire Safety Through Sound Planning. *The Bulletin of the National Association of Secondary-School Principals,* '45: 101–106. February 1961.

COE, THEODORE I. Fire—Friend and Foe of Man. *Bulletin of the American Institute of Architects* (AIA File No. R9). January–February 1954.

COMMITTEE OF FIRE RESEARCH, DIVISION OF ENGINEERING AND INDUSTRIAL RESEARCH. *Directory of Fire Research in the United States* (Publication No. 904). Washington: National Academy of Sciences—National Research Council. 1961.

CONNECTICUT STATE DEPARTMENT OF EDUCATION. *School Sites, Selection and Acquisition* (School Building Economy Series No. 3). Hartford 15: The Department. 1960.

DEPARTMENT OF INSURANCE AND BANKING. *Statutes of Tennessee Relating to Arson and Fire Prevention.* Nashville 3: The Department. (Reprint from Williams' Tennessee Code Annotated and 1949 Cumulative Supplement).

DURHAM & BATES, INC. *Stop Fires—Save Lives.* Portland, Oreg.: The Corporation, 901 SW., Washington Street. n.d.

EDUCATIONAL FACILITIES LABORATORIES, INC. *Ring the Alarm.* New York 22: The Laboratories, 477 Madison Avenue. 1959.

FEDERAL FIRE COUNCIL. *News Letter* (vol. 2, no. 8). Washington 25: The Council, 19th and F Streets, NW. October 1961.

FEDERATION OF MUTUAL FIRE INSURANCE COMPANIES. *Is Your Student Housing Fire Safe?* Chicago 6: The Federation, 20 North Wacker Drive. 1960.

FIRE EQUIPMENT MANUFACTURERS ASSOCIATION, INC. *FEMA Handbook of Safety Codes.* Pittsburgh 22: The Association, One Gateway Center. 1959.

FIRE HAZARDS OF WINDOWLESS BUILDINGS. *Bulletin of the American Institute of Architects.* January–February 1955.

FLORIDA STATE DEPARTMENT OF EDUCATION. *Laws and Regulations Relating to School Building Construction in Florida.* Tallahassee: The Department. 1955.

——— *Regulations of the State Board of Education of Florida.* 1960. (Mimeograph).

GEORGE PEABODY COLLEGE FOR TEACHERS, Division of Surveys and Field Services. *Disaster Readiness in Undergraduate Education.* Nashville, Tenn.: The College. 1960. (Prepared for the Office of Civil Defense Mobilization).

GEORGIA STATE DEPARTMENT OF EDUCATION. *A Guide for Selecting School Sites.* Atlanta 3: The Department. 1953. (Mimeograph).

HAGER, CHARLES N., *and* JOHN TAMMERYN. *Basic Facts of School Safety.* Tampa 2: The Florida Association of Insurance Agents, 514 Franklin Street. 1959.

HEADQUARTERS, DEPARTMENT OF THE ARMY. *Repairs and Utilities, Automatic and Manual Fire Alarm Systems, Inspection and Prevention Maintenance* (TM 5–695). Washington: The Department. May 1958.

———. *Repairs and Utilities, Automatic Sprinkler and Standpipe Equipment, Inspections, Operations and Preventive Maintenance* (TM 5–696). August 1957.

HERRICK, JOHN H., *and others. From School Program to School Plant.* New York: Henry Holt and Company. 1956.

IDAHO STATE DEPARTMENT OF EDUCATION. *Manual of Regulations for School Building Planning and Construction.* Boise: The Department. 1958. (Mimeograph).

KEMPER INSURANCE, FIRE DIVISION. *Danger in Your School?* Chicago 40: The Division, Kemper Insurance Building. n.d.

KENTUCKY STATE DEPARTMENT OF EDUCATION. *Educational Bulletin: Planning School Plant Construction* (vol. 26, no. 11). Frankfort: The Department. 1958.

———. *Fire Prevention Manual—Course Study for Kentucky Boys and Girls.* Frankfort: The Department. 1949.

LAYMAN, LLOYD. *Attacking and Extinguishing Interior Fires.* Boston 10: National Fire Protection Association, 60 Batterymarch Street. 1952.

LOS ANGELES FIRE DEPARTMENT. *Operation School Burning.* Boston 10: National Fire Protection Association, 60 Batterymarch Street. 1959.

———. *Operation School Burning* (No. 2). 1961.

MCLEARY, RALPH D. *Guide for Evaluating School Buildings.* Cambridge 38: Mass.: Spaulding House, 20 Oxford Street. 1952.

MCQUADE, WALTER (*ed.*). *Schoolhouse.* New York: Simon & Schuster. n.d.

MICHIGAN STATE DEPARTMENT OF PUBLIC INSTRUCTION. *Fire Prevention Section* (School Bulletin No. 412). Lansing 2: The Department. 1959.

MORRILL, RADCLIFFE. *The School Superintendent's Responsibility for Fire Safety.* Boston 10: National Fire Protection Association, 60 Batterymarch Street. (An address to the Fire Marshals' Association of North America, presented June 1, 1959).

NATIONAL BOARD OF FIRE UNDERWRITERS. *Fire Prevention Code.* New York 38: The Underwriters, 85 John Street. 1960.

———. *Fire Resistance Ratings of Less Than One Hour.* 1956.

———. *Fire Safe Schools.* 1959.

———. *Heat Producing Appliances.* 1959.

———. *National Building Code.* 1955 edition and 1957 amendments.

———. *Fire Resistance Ratings.* 1959.

———. *Special Bulletin No. 294.* 1956. (Information concerning noncombustible materials.)

NATIONAL COMMISSION ON SAFETY EDUCATION (NEA). *Action for safety* (vol. 14, No. 9). Washington 6: The Commission, 1201 16th Street, NW. 1961.

———. *Checklist of Safety and Safety Education in Your Schools.* 1953.

NATIONAL COMMISSION ON SAFETY EDUCATION AND NATIONAL SCIENCE TEACHERS ASSOCIATION (NEA). *Safe Use of Electrical Equipment.* Washington 6: The Commission, 1201 16th Street, NW. 1951.

NATIONAL COUNCIL ON SCHOOLHOUSE CONSTRUCTION. *Giude for Planning School Plants.* Nashville, Tennessee: The Council, George Peabody College. 1958 ed. (Floyd G. Parker, current secretary-treasurer, 409 Education Building, Michigan State University, East Lansing, Mich.)

NATIONAL FIRE PROTECTION ASSOCIATION. *Air Conditioning and Ventilating Systems of Other Than Residence Type* (NFPA No. 90A). Boston 10: 60 Batterymarch Street. 1961.

———. *Building Exits Code* (NFPA No. 101). 1961.

———. *Fires and Fire Losses Classified.* (In October issue of the Association's *Quarterly*, 1957–1961.)

———. *Fire Doors and Windows* (NFPA No. 80). 1959.

NATIONAL FIRE PROTECTION ASSOCIATION. *Flammable Liquide Code* (NFPA No. 30). 1961.

———. *Gas Appliances and Gas Piping* (NFPA No. 54). 1959.

———. *Incinerators, Rubbish Handling* (NFPA No. 82, 82a). 1960.

———. *National Electrical Code* (NFPA No. 70). 1959.

———. *Occupancy Fire Record: Public Schools* (Fire Record Bulletin FR-57-1). 1957.

———. *Portable Fire Extinguishers* (NFPA No. 10). 1961.

———. *Proprietary, Protective Signaling Systems* (NFPA No. 72). 1961.

———. *Standards for the Installation of Sprinkler Systems* (NPFA No. 13). 1961.

———. *Spray Finishing* (NFPA No. 33). 1961.

———. *Standard Types of Building Construction* (NFPA No. 220). 1961.

———. *Standpipe and Hose Systems* (NFPA No. 14). 1952.

———. *Static Electricity* (NFPA No. 225). 1961.

———. Twenty-one Large Loss School Fires. In *Large Loss Fires of 1956*. 1957. (Reprint from NFPA *Quarterly*, April 1957.)

———. *Water Cooling Towers* (NFPA No. 214). 1961.

NATIONAL SAFETY COUNCIL. *Findings of the Coroner's Jury*. Chicago 11: The Council, 425 North Michigan Avenue. 1959. (Mimeograph).

———. *School Fires* (Safety Education Data Sheet No. 47). 1950.

NELSON, F. W., *and* Keith Royer. Why Mass Fire Deaths? *Iowa Custodians Newsletter* (29). March-April 1959.

NEW JERSEY STATE DEPARTMENT OF EDUCATION. *Schoolhouse Planning and Construction Guide*. Trenton 25: The Department. 1958 (with 1960 revisions).

———. *Smoke Signals*. n.d.

NEW MEXICO STATE DEPARTMENT OF EDUCATION. *Guide for Public School Construction*. Santa Fe: The Department. 1958. (Mimeograph).

NEW YORK STATE EDUCATION DEPARTMENT. *Planning for safety in School Buildings*. Albany: The Department. Division of Buildings and Grounds. 1958.

———. Bureau of Elementary Curriculum Development, Bureau of Secondary Curriculum Development. *Fire Prevention Education*. 1957.

NORTH CAROLINA STATE DEPARTMENT OF PUBLIC INSTRUCTION. *Fire Safety—North Carolina Public Schools* (Publication No. 316). Raleigh: The Department. 1957.

NORTH CAROLINA STATE DEPARTMENT OF PUBLIC INSTRUCTION AND COMMISSIONER OF INSURANCE. *Fire Safety—North Carolina Public Schools* (Publication No. 329). Raleigh: The Department. 1959.

NORTH DAKOTA OFFICE OF INSURANCE AND STATE FIRE MARSHAL. *North Dakota Fire Laws*. Bismarck: The Office. 1953.

OREGON STATE DEPARTMENT OF EDUCATION AND STATE FIRE MARSHAL DEPARTMENT. *Fire Safety in Oregon Schools*. Salem: The Departments. 1960.

PENNSYLVANIA STATE DEPARTMENT OF PUBLIC INSTRUCTION. *A Program of Fire Prevention in Schools* (Bulletin No. 399). Harrisburg: The Department. 1951.

PLANNING FIRE SAFE SCHOOLS. *School and College Safety:* 23: 13–15. 1960.

POTENTIAL HEAT OF MATERIALS IN BUILDING FIRES. *National Bureau of Standards Technical News Bulletin* 44: 184–187. November 1960.

ROBERTSON, A. F., D. GROSS, *and* J. LOFTUS. *A Method for Measuring Surface Flammability of Materials Using A Radiant Energy Source.* Philadelphia 3: American Society for Testing Materials. (Reprinted from copyrighted materials of the Society, vol. 56, 1956).

SARGENT, D. KENNETH. School Safety. *School Plant Studies BT 1–11* (AIA File No. D1 & D2–R9). Washington 6: The American Institute of Architects, 1735 New York Avenue, NW. November-December 1953.

School and College Safety. *National Safety Congress Transactions* (vol. 23). Chicago 11: National Safety Council, 425 N. Michigan Avenue. 1960.

SOUTH DAKOTA STATE FIRE MARSHAL. *Rules and Regulations Covering Public, Private, and Parochial Schools of All Grades—Primary Through Adult Levels.* Pierre: The State Fire Marshal, 1959.

STREVELL, WALLACE H., *and* ARVID J. BURKE. *Administering the School Building Program.* New York: McGraw-Hill Book Company. 1959.

SUMPTION, MERLE R., *and* BASIL CASTALDI. *How Safe is Your School?—A Checklist of 100 Danger Points.* Urbana, Ill.: University of Illinois, College of Education, Office of Field Services. 1959.

UNDERWRITER'S LABORATORIES, INC. *Building Materials List.* Chicago 11: The Laboratories, 207 East Ohio Street. 1961.

———. *Fire Protection Equipment List.* 1961.

———. *Wood-Fire Hazard Classification* (C 60, Card Data Service No. 6E. 527). 1955.

United States Government Organization Manual 1959–1960. Washington: Office of Federal Register, National Archives and Records Service, General Services Administration, n. d.

VILES, N. E. *School Fire Drills* (Pamphlet No. 103). U.S. Department of Health, Education, and Welfare, Office of Education, Washington: U.S. Government Printing Office, 1954.

———. *School Fire Safety* (Pamphlet No. 13). Federal Security Agency, Office of Education, Washington: U.S. Government Printing Office, 1951.

VIRGINIA STATE BOARD OF EDUCATION, and State Corporation Commission. *Fire Inspection Guide for Schools.* Richmond 16: The State Board. 1960.

———. *School Planning Manual* (vol. 37, no. 7). 1954; *also, Vol. 42, no. 3. 1959 (rev.).*

VIRGINIA STATE CORPORATION COMMISSION. *Virginia Fire Safety Regulations.* Richmond: The Commission. 1953.

WEST VIRGINIA COUNCIL ON SCHOOLHOUSE CONSTRUCTION. *Standards for Schoolhouse Construction.* Charleston: Division of School Plant Planning, State Department of Education. 1951 (*rev.*).

WEST VIRGINIA OFFICE OF STATE FIRE MARSHALL. *Fire Prevention Rules and Regulations.* Charleston: The State Fire Marshal. 1959.

Your Fire Safety Education Program May Be Inadequate. *Safety Education.* 36:6–8. January 1957.

Appendix B

Fire Safety Checklists for School Buildings

I. Can Your School Answer These Questions Affirmatively?

Inspection and Reports

1. Are annual technical inspections conducted?
2. Are occupants at sometime included in the inspection procedure?
3. Is a system which encourages all occupants of the building to report dangerous conditions provided?

Site and Exterior Structure

4. Are all gas storage tanks at a safe distance from the school buildings, and are they properly installed and protected against physical damage and tampering?
5. Are school grounds and parking arranged so as to permit ready access by fire fighting equipment?
6. Are all exterior fire escapes secure, well maintained and checked regularly?
7. Are all windows immediately adjacent to outside fire escapes provided with fire-resistive sash and wired glass panes?
8. Are all cornices, windows, ledges, chimneys, belfries, and similar features plumb and solidly in place?
9. Are exterior walls of the building free from extensive cracks?

Corridors

10. Does the main corridor lead to at least two widely separated exits?
11. Are corridors free from obstructions which may impede the flow of traffic?
12. Are corridors constructed of fire-resistive materials?
13. Is there a fire-resistive stairwell or exit within 70 feet of all points in the corridor?
14. Are fire extinguishers, drinking fountains, radiators, and other materials in the corridors properly recessed?
15. Are stairways provided near the ends of each corridor?
16. If the building is not fire resistant, are smoke barriers provided so that smoke and gases cannot penetrate main corridors?
17. Is any point in the main corridor more than 100 feet from an exterior door? (In an unsprinklered building)

Stairways and Stairwells

18. Are the stairwells enclosed to prevent upward spread of fire and smoke?
19. Are doors to stairwells kept open with automatic releasing devices and not wedges?
20. Are any stairway doors missing?

21. Are stairways and stairwells constructed of fire-resistive materials?
22. Are stairways so located that they do not reduce the corridor width on the lower levels to less than 8½ feet?
23. If the building is not completely fire resistant (wood floors, trim, etc.), are stairwells completely enclosed and provided with self-closing fire doors?
24. Do stairways have well-maintained and secure handrails?
25. Do handrails project no more than 3½ inches?
26. Are handrails provided on both sides of stairways that are more than 42 inches wide? Is a center handrail provided in stairways of 88 or more inches in width?
27. Are handrails between 30 and 34 inches from the stair treads?
28. Are stair treads nonskid and free of excessive wear? Is there no more than 3/16 of an inch variation in stair risers in any one stairwell?
29. Are stair risers less than 7½ inches in height?
30. Are stair treads at least 10 inches wide?
31. Do stairways have more than two but less than 16 steps between landings?

Exits

32. Do all doors open outward with path of egress?
33. Are there at least two safe routes of escape from each floor?
34. Are doors to the exterior marked with exit lights?
35. Are outside doors equipped with emergency or anti-panic hardware?
36. Are exit openings sufficient to accommodate the number of occupants?
37. Are exits to the exterior provided with emergency lighting?
38. Are all main exits at least 36 inches in width?
39. Do occupants of each classroom have at least two widely separated means of exiting from the building?
40. Are all window as well as door screens easily opened from the inside?
41. Is each classroom door operable from the inside without the use of a key?
42. Do plate glass doors have centrally located bars, or a sufficiently decorated surface to be plainly visible?
43. Are all doors and closers in proper repair and operable?
44. Are vision strips provided in doors leading from classrooms to corridors?

Fire Alarm and Extinguishing Equipment

45. Is there an operable fire alarm system in the school?
46. Can the fire alarm be operated manually as well as electrically?
47. Are positions or stations for activating the fire alarm adequate?
48. Can the alarm be heard in all parts of the school?
49. Is the fire alarm system operable when the main electric panel is off?
50. Is the fire alarm system connected to the fire department alert panel?
51. If a telephone alarm is used, is the telephone number of the fire department posted by all telephones?
52. Are fire extinguishers of appropriate types strategically located in the boiler room?
53. Does the building have a fire protective system that is adequate for the degree of fire-resistiveness incorporated into the structure?
54. Are fire extinguishers of proper types so located that one is available within 100 feet of any point in the corridor?

55. Have all fire extinguishers been inspected, maintained, and recharged as required?

56. Have all fire protective devices such as sprinkler systems, fire hydrants and hose, and automatic fire alarms been inspected and tested within the past six months?

57. Are there fire hydrants on or just outside the school premises?

58. Are sprinkler systems provided for all basement areas?

59. If there is a sprinkler system, are all valves sealed in an "Open" position?

60. Are all sprinkler heads unpainted, unobstructed, and free to operate?

61. Are all valves and gauges in sprinkler systems checked weekly?

62. If there is a standpipe and hose system, are all hoses properly connected to operable water outlets, with workable nozzles?

63. Are extinguishers in the vicinity of electrical devices of the approved type for electrical fires?

Electrical and Gas Equipment

64. Have all electrical circuits and outlets been checked for defects within the past six months?

65. Are only approved electrical extension cords used?

66. Do all electrical appliances, fixtures, and cords have the Underwriters' Laboratories or Factory Mutual acceptance label?

67. Do all electrical installations comply with existing or recommended electrical codes?

68. Is temporary wiring done by a competent electrician in strict accordance with codes?

69. Are all electrical appliances and motors equipped with circuit breakers or cut-out switches?

70. Are all electrical appliances inspected regularly?

71. Would the main electrical power cut-off for the entire plant be accessible during a fire?

72. Are electrical power cutoffs provided for special areas?

73. Are electric circuits overloaded or over-fused?

74. Are extension cords hung over nails or metal projections?

75. Have all gas tubing and outlets been checked for defects in the last six months?

76. Is there a master shut-off valve in every room in which gas is used?

77. Are kerosene, gasoline, and other flammable liquids stored in approved containers in a fire resistive room or in a detached shed?

78. If gas is turned off in a building, are pilot lights and valves set before the main valve is opened?

79. Are all gas-fired appliances vented to the outside?

80. Are blueprints of gas and electrical lines kept up to date?

Boiler Room

81. Is the boiler room located so that it is not directly below spaces occupied by pupils and teachers?

82. Is the boiler room constructed of non-combustible materials?

83. Does the boiler room have at least two independent exits, one of which leads directly to the outside?

84. Is a self-closing, fire-resistive door located between the boiler room and the remainder of the school?

85. Is the furnace room provided with a fixed louver or other permanent opening to the outside to supply air for combustion?

Heating and Ventilating

86. Is the heating plant of sufficient capacity to heat the building comfortably without overloading in the coldest weather?

87. Are all heating or ventilating ducts equipped with automatic dampers?

88. Has the heating equipment been inspected and approved by a qualified person within the past 12 months? And is it well maintained?

89. If used, are portable heaters well protected, controlled by a thermostat and equipped with safety switches in case they are upset?

90. Are recommended steam pressure requirements complied with?

91. Are all exposed steam and hot water pipes properly insulated with heat and fire resistive materials?

Housekeeping, Storage, and Waste Disposal

92. Are such areas as the attic, basement, furnace-boiler rooms and fan-blower rooms, stage, upper-stage, under-the-stage, stairs, plenums, pipe alleys, and storage rooms free from waste paper, rubbish, old furniture, stage scenery, and other combustible materials?

93. Are accumulations of grease removed regularly from kitchen exhaust ducts, fans, and filters?

94. Are ashes placed in metal containers used for that purpose only?

95. Are combustibles such as lint, dust, shavings, or combustible fibers allowed to accumulate on machinery, shelves, walls, beams, or other surfaces?

96. Are students required to clean their lockers frequently?

97. Are cleaning agents noncombustible?

98. If the floors are of wood and cleaning compounds are used, do they contain oil or naptha?

99. If liquid floor sealer is used, is it approved with respect to flash point by the Fire Underwriters' Laboratories or a similar agency?

100. Is there a rubbish room with self-closing doors and automatic sprinklers?

101. Are old records and papers stored in steel cabinets?

102. Are oily rags kept in approved containers?

103. Are spaces used for storing combustible materials, such as cleaning agents, paints, thinners, and gasoline, enclosed by fire-resistive construction?

104. Are supplies stacked orderly and not closer than 2 feet to the ceiling?

105. Are adequate fireproof storage facilities provided for costumes, props, etc.?

106. Are areas under and in stairways free of stored materials?

107. Are flammable materials of any type stored near water heaters, boilers, or other heat producing units?

108. Are there automatic sprinkler heads in the custodial locker and store room?

109. Is waste collected daily and disposed of each night?

110. Are shavings and sawdust from shop rooms removed daily?

111. Are waste paper chutes constructed of fire-resistive materials and equipped with self-closing doors?

112. Is the incinerator in good repair? Does it have a fly-ash screen?

113. Are combustibles allowed to pile up around the incinerator?

Classrooms and Special Areas

114. Are classrooms located on only the first and second floors, if the building is not completely fire-resistive?

115. Is the auditorium stage equipped with fire curtains and flameproofed drapery?

116. Does the auditorium, gymnasium, and cafeteria have two or more widely separated exits of adequate width?

117. If the building is not fire-resistive, is it free from false ceilings which encloses space where fire may originate or travel?

118. Does each seating level in the auditorium have its own exist way which meet all standards?

119. Are aisles at least 3 feet, 6 inches in width?

120. If basement areas are used for a cafeteria, playroom, or for other pupil activity, are they provided with at least two adequate separate means of egress?

121. Are fire safety procedures followed during public assemblage?

Interior Finish

122. Does the building interior have any loose plaster or large cracks in the plaster?

123. Is wood trim painted with flame-retardant paint?

124. Are lockers of steel construction?

NOTE: *The following inspection checklists are available upon request.*

Inspection Blank for Schools

National Board of Fire Underwriters
85 John Street
New York 38, N.Y.

Monthly Report of Inspection of Schools

North Carolina State Department of Public Instruction
Raleigh, N.C.

School Inspection Short Check List

National Safety Council
425 N. Michigan Avenue
Chicago 11, Ill.

Self-Inspection Blank (P.I. Form No. 7)

This form is available from most casualty insurance companies

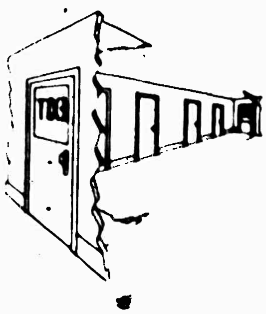
II. Short Checklist for School Inspection*

(If you can check all these items "yes", your school is reasonably safe.)

1. Stairways enclosed? Yes ☐ No ☐

Stairways must be enclosed in partitions to prevent upward spread of fire and smoke. Metal lath and plaster or wired glass in metal frames will suffice in existing buildings. All exit doors must swing with exit travel. Stair doors must be self-closing and should be kept closed. Mark "No" if doors are missing or if you find any stair door held open with a wedge.

2. Enough properly arranged exits? Yes ☐ No ☐



Are there two ways of escape from every room? A single room door entering a common corridor with an enclosed stairway at each end may be counted as two ways of escape. Direct passage outdoors is best. Is the capacity of exits adequate? A unit of exit width is 22 inches wide. To determine exit adequacy, figure one unit per 100 persons on level, one unit per 60 persons on stairs. Several floors may use same stair exits. Exit should be within 100 feet of any room door or within 150 feet in a sprinklered building. Mark "No" if uncertain as to adequacy or capacity of exits.

3. Interior finish safe? Yes ☐ No ☐

Much highly combustible interior finish has been used in schools, particularly schools of a temporary character. Any acoustical tile or fibreboard more combustible than wood is dangerous. Plaster is safe in corridors. Check the Underwriters' Laboratories Tunnel Test rating. Don't be misled by small-scale tests. Any normal interior finish is reasonably safe in a sprinklered building. In case of doubt, coat with flame-retardant paint. If uncertain as to combustibility, mark "No".

4. Are combustible waste materials safeguarded? Yes ☐ No ☐

It is not enough merely to collect wastepaper and rubbish daily. Where are these waste materials put? In a fire-resistive rubbish room with fire doors, or in burlap sacks at the bottom of the stairs? How are old papers of various kinds stored? How about manual training rooms and similar occupancies? Remember that any loose combustible material is subject to ignition by a chance spark.

---

*By the National Fire Protection Association (with slight adaptations to conform with requirements of the present bulletin).

5. **Proper fire-exit drills held?** **Yes ☐ No ☐**

To be of value, fire exit drills must come without warning. Advance notice that a drill will be held at a specified time, so that students can get their coats on and be prepared for the outdoor cold, nullifies the value of the drill. Everyone must participate. Drills must be varied to use different exits, on the assumption that any single exit may be blocked by smoke.

6. **Effective plan to call fire department?** **Yes ☐ No ☐**

Having the fire department there promptly may mean the difference between life and death. The situation varies in different localities. Thus, no universal plan can be specified. The recommended arrangement is a connection to the fire department attached to the school fire alarm system, so that if the alarm is sounded for fire, the firemen come (may be waived for drills). Don't hesitate to call the fire department in case of doubt—they would rather respond needlessly a hundred times than to lose one life because they have not been called in time.

Automatic sprinkler protection is often the one best safeguard for existing school buildings of ordinary construction.

In any complete inspection, many other features of school fire safety should be covered: construction, protection of heater rooms and shops, extinguishing equipment, safeguarding of hazards, automatic sprinklers, automatic and manual alarm equipment, etc. For details, see the *Building Exits Code* (NFPA No. 101).

Appendix C

Emergency Drill Checklist*

(Check the proper space to indicate how you evaluate the emergency evacuation preparation of your school system.)

QUESTIONS	ANSWERS		
	Satisfactory	Acceptable	Unsatisfactory
1. **Grass Roots** Are student observations used to perfect drill efficiency?			
2. **Individual and Group Cooperation** Do the attitude and general response of pupils indicate that they understand the significance of well-ordered exit drills?			
3. **Basic Understanding** Is the primary objective of each drill to train children for a complete understanding of the purposes behind each regulation?			
4. **Responsibility Development** Does the attitude of each child indicate readiness to act independently of close adult supervision, yet efficiently toward appropriate safety goals?			
5. **Leadership in Depth** Are all appropriate personnel (teachers, custodians, designated pupils, etc.), briefed to carry out drill responsibilities in the absence of the usually responsible administrative officer?			
6. **Scour Out** Is inspection planned to ascertain that every conceivable room in the building is evacuated?			
7. **Perfect Accounting** Do teachers carry classbooks to permit immediate location of all students before recall is sounded?			

*By the National Safety Council (with slight adaptations to conform with requirements of the present ulletin).

(Check the proper space to indicate how you evaluate the emergency evacuation preparation of your school system)

QUESTIONS	ANSWERS		
	Satisfactory	Acceptable	Unsatisfactory
8. **Help for Handicapped** Have special provisions been made to assist disabled or handicapped persons during exit drills?			
9. **Changing Conditions** Have "blocked exit" drills been used to give training in emergency use of exits and stairways other than the usual ones designated?			
10. **Surprise Alert** Would the building be vacated in prompt and orderly fashion if drills were held:			
a. on the first day of school?			
b. when pupils are in the auditorium?			
c. when pupils are in the cafeteria?			
d. when pupils are in the halls and stairways during intermission?			
11. **Equipment Readiness** Are fire escapes and exit facilities checked for safety frequently and regularly?			
12. **Progress Record** Are accurate records kept of the essential elements of each drill—speed, order, special emergencies, guidance given to particular groups of individuals?			
13. **Perfect Signal System** Is the drill signal unmistakable, heard everywhere, known to everyone, and free from mechanical imperfections which might render it inoperative?			
14. **Quickest Warning** Is there a bell switch at several convenient locations, and is it conspicuously labeled?			
15. **Substitute Signals** In the event that the electric fire alarm system were inoperative, have pupils been trained to respond to an emergency hand bell signal?			

(Check the prorer space to indicate how you evaluate the emergency evacuation preparation of your school system.)

QUESTIONS	ANSWERS		
	Satisfactory	Acceptable	Unsatisfactory
16. **All Hands at Stations** Are custodians trained to turn off ventilating fans and other drafts, to begin fire-extinguishing action (or see that it is in progress), and to direct fire-department personnel to the location of the fire?			
17. **No One Is Indispensable** Do engineers and custodians keep equipment (gas-main wrenches, etc.), charts (location of sprinklers, etc.), key telephone number (fire department, civil defense authorities, etc.), and all other appropriate information and equipment in readiness for their immediate use?			
18. **No Recall Mistakes** Is the recall signal one that could not possibly be mistaken for some other signal?			
19. **Control Outdoors** Are monitors, faculty members, or others assigned stations and duties to insure safety from traffic or other hazards outdoors?			
20. **Battle Is the Payoff** Could it be predicted that students would react in essentially the same manner as they do for practice drills in conditions of actual emergency, such as smoke, blocked exits, natural disasters, and some degree of student panic?			

Appendix D

ABC's of Fire Extinguisher Use*

THE NATIONAL Fire Protection Association has given advice on safe methods of fighting small fires with portable fire extinguishers. Of great significance is advice about safety precautions: when and how to use various types of extinguishers, and how to select, maintain, and mount portable extinguishers.

How to Fight a Small Fire Safely

- **Take *time to think*, quickly size up situation.**
- ***Get everyone out*, call Fire Department at once.**
- ***Keep near door*—so you can have an escape.**
- ***Stay low*—out of heat and smoke.**
- **Aim extinguisher at *base of fire*.**
- **Stay *outside small rooms*—shoot stream in.**
- **Ventilate only *after fire is out*. But if fire gets large—*get out*, close doors!**

For ordinary combustibles, use:

- **Pressurized water—operates usually by squeezing handle or trigger. Read instruction label. (Contains WATER or water with anti-freeze chemical.)**
- **Pump tank—operates by one hand pumping handle, while other holds nozzle. (Contains WATER or water with anti-freeze chemical.)**
- **Soda-acid—operates by turning extinguisher upside-down. Has handle on bottom for inverting. (Contains WATER, soda mixture, acid—no anti-freeze.)**
- **Dry chemical—multi-purpose—operates by squeezing handle or trigger. Read label. (Contains a POWDER commonly designated "A,B,C".)**

---

*By the National Fire Protection Association (with slight adaptations to conform with requirements of the present bulletin).

For flammable liquids, use:

- ✦ Carbon dioxide (CO_2)—operates usually by squeezing handle or trigger. See instruction label. (Discharges as a HEAVY GAS that smothers fire.)
- ✦ Dry chemical—operates usually by squeezing handle or trigger. See instruction label. (Contains one of two general types of POWDER—not to be mixed. One is for Class B, C fires; one for Class A, B, C fires.)
- ✦ Foam—operates by turning extinguisher upside down. (Contains WATER and ingredient to make a heavy foam that smothers fire.)

For electrical equipment, use:

Nonconducting extinguishing agent, such as—
- ✦ Carbon dioxide (CO_2)
- ✦ Dry chemical (B-C type)
- ✦ Dry chemical (multipurpose)
- ✦ Vaporizing liquid

DO NOT USE SODA-ACID, FOAM or other *water-type* extinguishers until electric power has been *shut off*.

Be Sure Your Fire Extinguishers Are Reliable

- ✦ Look for the Underwriters' Laboratories label or the Factory Mutual Approval Seal:

Underwriters' Laboratories, Inc.
INSPECTED
2½ GALLON HAND FIRE EXTINGUISHER
CLASSIFICATION A-1 NO.

FM

UNDERWRITERS LABORATORIES FACTORY MUTUAL

(These labels mean that each extinguisher has met exacting requirements of construction and performance.)

- ✦ Inspect extinguishers periodically. (Being mechanical devices, they should be serviced from time to time.) Refill immediately after *any* use.
- ✦ Keep extinguishers *within reach* for anyone to use—and practice how to use them *before* a fire starts.
- ✦ Have the right type of extinguisher handy at the right place.
- ✦ BEWARE! Don't risk your life on "beer can" size extinguishers (tin cans, "bombs," aerosol containers, plastic bottles) usually holding less than a pint of liquid or 12 to 16 ounces of dry powder. To depend on such gadgets of such small capacity, limited range, and unknown reliability is dangerous.

Appendix E

Potential Heat of Selected Building Materials, Together With Flame-Spread Index [1]

Material	Thickness (inches)	Density (lb/ft)	Potential heat: Weight basis (Btu/lb)	Potential heat: Volume basis (Btu/ft)	Potential heat: Unit-area basis [2] (Btu/ft)	Flame-spread index
Woods						
Douglas fir, untreated	¾	38. 0	8, 400	319×10	--------	69
Douglas fir (retardant treatment "A")	¾	37. 2	8, 290	308	--------	5
Douglas fir (retardant treatment "B")	¾	47. 2	7, 860	371	--------	3
Douglas fir (retardant treatment "C")	¾	38. 8	7, 050	274	--------	1
Maple, soft, untreated	1	39. 5	7, 940	314	--------	82
Hardboard, untreated	¼	59. 8	8, 530	510	--------	150
Plastics						
Polystyrene, wall tile	0. 075	65. 4	17, 420	1, 140	--------	335
Rigid, polyvinyl chloride, retardant treated	. 147	86. 0	9, 290	799	--------	10
Phenolic laminate	. 063	76. 4	7, 740	592	--------	107
Polycarbonate resin	¼	78. 7	13, 330	1, 050	--------	56
Insulation						
Glass fiber, semirigid, no vapor barrier	1	3. 0	3, 040	9. 1	--------	-------
Rock wool batting, paper enclosure	3	2. 4	1, 050	2. 5	--------	-------
Roof insulation board	1	10. 4	3, 380	35. 1	--------	61
Cork (reconstituted cork sheet)	¼	14. 8	11, 110	164	--------	174
Cellulose mineral board	2	47. 8	2, 250	108	--------	1. 3
Concrete						
Cinder aggregate	--------	93. 0	3, 080	286	--------	0. 0
Slag aggregate	--------	110. 1	80	8. 9	--------	-------
Shale aggregate	--------	80. 5	10	0. 5	--------	-------
Calcareous gravel aggregate	--------	133. 1	−250	−33. 1	--------	-------
Siliceous gravel aggregate	--------	166. 8	−40	−6. 7	--------	-------

See footnotes at end of table.

Material	Thickness (inches)	Density (lb/ft)	Potential heat			Flame spread index
			Weight basis (Btu/lb)	Volume basis (Btu/ft)	Unit-area basis [2] (Btu/ft)	
Cement Board						
Asbestos cement board	3/16	117.0	80	9.2	--------	.0
Asbestos cement board + 20 mil paint	3/16	159.2	390	62.4	--------	.7
Gypsum						
$CaSO_4 \cdot 2H_2O$, hydrated neat gypsum	0.41	137.9	−290	−31.3	--------	.0
Perlite aggregate plaster, 21-percent aggregate	1	53.2	70	4.0	--------	.0
Sand aggregate plaster, 68-percent aggregate	1	101.8	−50	−5.4	--------	.0
Vermiculite aggregate plaster, 15-percent aggregate	1	51.2	−90	−4.6	--------	.0
Gypsum board "A"	3/8	50.5	760	38.4	--------	14.3
Gypsum board "A" with paper removed	3/8	46.6	−270	−12.5	--------	.0
Gypsum board "A" + alkyd gloss paint	3/8	46.7	880	41.2	--------	8.0
Gypsum board "B"	1/2	51.2	650	33.0	--------	7.9
Lath						
Gypsum A	3/8	55.3	310	17.0	--------	--------
Metal diamond mesh	.025	405	1,230	--------	1,370	0.0
Metal diamond mesh, paint removed	.019	401	660	--------	420	.0
Metals						
Structural steel—unpainted	.060	489	230	--------	190	--------
Magnesium	.128	122	10,800	--------	5,400	--------
Aluminum	.004	165	30	--------	0.8	--------
Brass	.004	534	100	--------	8.9	--------
Copper	.024	556	60	--------	32	--------
Lead	.036	710	280	--------	278	--------
Zinc	--------	415	760	--------	2,390	--------
Miscellaneous						
Paint "E" (dried paint film)	.05	--------	3,640	--------	--------	30
Asphalt shingles (fire-retardant)	1/4	70.7	8,320	588	--------	123
Building paper (asphalt-impregnated)	.042	42.8	13,620	583	--------	385
Building paper (rosin-sized)	.018	23.6	7,650	181	--------	192
Linoleum tile	1/8	86.0	7,760	667	--------	106
Brick, red-face	2 1/4	139.1	20	2.2	--------	0.0
Charcoal, coconut	--------	--------	13,870	--------	--------	--------

[1] U.S. Department of Commerce, National Bureau of Standards. *Technical News Bulletin*, 44:186 November 1960.

[2] Based upon total exposed surface area.

NOTE: All weights and percentages refer to original air-dry weight.

Appendix F

Chronology of a School Fire

A FEW YEARS AGO a devastating winter-time fire (occurring in a school building constructed of ordinary combustible masonry materials) burned to death on the premises 3 teachers and 87 pupils. At the time of the fire many other pupils were seriously injured, and later in a hospital five more died as a result of burns and injuries.

The following chronology of the fire[1] demonstrates that when a building constructed of ordinary combustible masonry materials catches fire, precious little time is available for escape.

Time (P.M.)	*Incident*
2:25	Student leaves second floor classroom to carry waste paper to basement.
2:28	ESTIMATED START OF FIRE (not visible to student)
2:30	Student returns to second floor, thinks he smells smoke, tells teacher.
2:31	Rm. #206 teacher confers with Rm. #207 teacher in hallway.
2:32	Rm. #207 teacher runs to school office—no one there.
2:33	Rm #207 teacher returns, smoke is now definite. (Janitor outside has seen smoke, tells someone in adjacent building to call fire department.)
2:34	Rms. #206–07 pupils get ready to exit.
2:35	Rm. #207 pupils go down rear fire escape, quite smoky.
2:36	Rm. #206 pupils go down interior stairway, heavy smoke at head height.
2:37	Rms. #206–07 pupils marched to building next door.
2:38	Teacher returns from building where she left children, pulls the school building fire alarm. Rm. #210 teacher notes heat, opens door, heavy smoke rolls in.
2:39	Two janitors erect private ladders to second-floor windows.
2:40	Pupils march out of south wing of building OK.
2:41	FIRST ALARM TO FIRE DEPARTMENT via phone.
2:42	Engine, truck, squad en route on streets.
2:43	Pupils start to jump from second-floor windows.
2:44	Engine arrives, lays hose lines, erects two ladders, radios 2–11.
2:45	Police squad sees smoke, radios for help.
2:46	Truck ladders building, uses life nets. Battalion Chief arrives.
2:47	Clock in Rm. #212 stopped on account of the heavy fire.

[1] From a publication (with slight adaptations to conform with requirements of the present bulletin) by the Federation of Mutual Fire Insurance Companies—*Is Your Student Housing Fire-Safe?* 1960, 2d ed., p. 43).

2:48–2:56	**Rescue and firefighting.**
2:57	**Roof collapses, radio 5–11 alarm (maximum response for the city fire department).**
4:17	**Box 5182 struck out.**

At 2:25 P.M. no smoke was evident in the second-floor corridor—at 2:36 P.M. (11 minutes later) pupils encountered heavy smoke as they exited. There was an 8-minute delay in sounding the building fire alarm. There was an unexplained 8-minute relay in calling the fire department. The fire department took only 2 minutes to get there and go to work—when they arrived the second-floor corridor was 100-percent unusable, and pupils were already jumping from windows. This was the third worst school disaster in the history of the United States. THIS COULD BE REPEATED ANYWHERE!

Appendix G

Needed Research

ALTHOUGH much research has been done concerning the nature and growth of fire, fire-detective and fire-protective equipment, and the way in which materials are affected by fire, it still appears that much more research needs to be conducted in these and in other areas. More specifically, additional research is recommended in the following areas:

- The way in which an incipient fire starts and grows.
- The way in which building design, mass, construction, and even stairways affect fire growth.
- The use, effectiveness, and methods of opening large-size vents.
- Methods for opening and closing fire doors effectively, especially in terms of saving lives.
- Automatic fire-detection equipment, especially for smoke detection.
- Effective methods of classifying fire- and smoke-sensitive equipment.
- Sprinkler systems that will provide greater life-safety protection than the protection currently available.
- Smoke and heat conditions that affect the safety of lives.
- Building materials as they inhibit or contribute to fire spread.
- The smoke toxicity of various building materials.
- The subsequent effect of one building material upon another building material during the course of an uncontrolled fire.
- The cost of complete detection and protection equipment in light of reduced insurance rates and added life protection.

Appendix H

Materials for Further Study

I. Curriculum

1. **National Commission on Safety Education, 1201 Sixteenth Street NW., Washington 6, D.C.**

PUBLICATIONS

General

Checklist of Safety and Safety Education in Yourselves. 1953.
Guide to Selected Safety Education Films. 1961.
The Expanding Role of School Patrols. 1953.
The Teacher-Fireman Team. 1953.

Elementary

Fire Safety: For Teachers of Intermediate Grades. 1950.
Fire Safety: For Teachers of Primary Grades. 1950.
Other Schools Plan Safe Living. 1956.
Unit Guides for You: Safety in Intermediate Grades. 1960.
Unit Guides for You: Safety in the Primary Grades. 1960.

Secondary

Fire Safety: For Junior High Schools. 1950.
Fire Safety: For Senior High Schools. 1951.
Safe Use of Electrical Equipment. 1951.

College and University

Safety Education for Teachers. (Part I, 1946; part II, 1947.)
Fire Safety for College Residence Buildings. 1952.

CLASSROOM POSTERS

Keeping Your Home Free From Fire (a series). 1957.

FILMS AND FILMSTRIPS

Fire in Their Learning. 1954. 16 mm. sound. 19 min.
Preventing Fires in Your Home. n.d., 50 frames.
Preventing Fires in Your School and Other Public Buildings. n.d., 40 frames.

2. **Other Sources**

PUBLICATIONS

The International Association of Fire Chiefs, 232 Madison Avenue, New York 16, N.Y.

Fire Prevention for Secondary Schools, by the University of Southern California Laboratories. 1952.

National Board of Fire Underwriters, 85 John Street, New York 38, N.Y.

30 Selected Movies. n.d.

II. Equipment

The following is a list of publications available from the three sources indicated.

1. **National Board of Fire Underwriters, 85 John Street, New York 38, N.Y.**
   Dry-Pipe Valves (NBFU No. 13B). 1952.

2. **National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass.**
   Building Construction and Materials (NFPA No. 251). 1961.
   Carbon Dioxide Extinguishing Systems (NFPA No. 12). 1961.
   Code for Protection Against Lightning (NFPA No. 78). 1959.
   Foam Extinguishing Systems (NFPA No. 26). 1960.
   Method of Test of Surface Burning Characteristics of Building Materials (NFPA No. 255). 1961.
   Recommended Systems for the Identification of the Fire Hazards of Materials (NFPA No. 704). 1961.
   Standard for the Installation of Fire Doors and Windows (NFPA No. 80). 1961.
   Supervision and Control of Valves (NFPA No. 26). 1958.
   Materials (NFPA No. 255). 1961.

3. **Underwriters Laboratories, Inc. 207 East Ohio Street, Chicago 4, Ill.**
   Air-Conditioners, Central Cooling (UL 465). 1957.
   Branch-Circuit and Service Circuit-Breakers (UL 588). 1961.
   Christmas-Tree and Decorative-Lighting Outfits (UL 588). 1961.
   Control Units for Fire-Protective Signaling Systems (UL 864). 1950.
   Dry-Chemical Hand Fire Extinguisher (UL 299). 1959.
   Electric Lighting Fixtures for Use in Hazardous Locations (UL 844). 1950.
   Electric Oil Burner (UL 574). 1959.
   Fire Door Frames (UL 63). 1961.
   Fire Test of Door Assemblies (UL 10). 1957.
   Flame Tests of Flame-Resistant Fabrics (UL 214). 1955.
   Fuses (UL 198). 1955.
   Heat Pumps (UL 559). 1959.
   Hose Valves-Fire (UL 688). 1958.
   Hydrants, Private and Municipal Fire Department Services (UL 246). 1958.
   Oil Burners (UL 296). 1959.
   Outlet Boxes and Fittings (UL 514). 1951.
   Panic Hardware (UL 305). 1955.
   Radio and Television Receiving Appliances (UL 492). 1958.
   Snap Switches for Use in Hazardous Locations (UL 844). 1954.
   Standard for Alarm Valves (Subject 193). 1952.
   Standard for Waste Cans (Subject 32). 1954.
   Tin-Clad Fire Doors (UL 10a). 1956.

U. S. GOVERNMENT PRINTING OFFICE : 1962 O - 654284