# FIRE SAFETY AND PROTECTION
# AS RELATED TO THE INDUSTRIAL ARTS SHOP

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Bachelor of Science

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Tahlequah, Oklahoma

1951

Submitted to the School of Industrial Arts

Education and Engineering Shopwork

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

1952

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## ACKNOWLEDGEMENT

The writer of this thesis expresses deep appreciation to Doctor DeWitt Hunt, Head, School of Industrial Arts Education and Engineering Shopwork, Oklahoma Agricultural and Mechanical College, for his constructive criticism and guidance which led to the completion of this problem.

Gratitude is sincerely extended to my wife, Yvonne L. McQuigg, for her inspiration, encouragement, and able assistance in the preparation of this thesis.

M. L. M.

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# CHAPTER I

## INTRODUCTION TO THE PROBLEM

The purpose of this study is to establish fire protection as a phase of all industrial arts shopwork. Fire protection should be a year around job and not stressed only during Fire Prevention Week. The objectives of fire protection in the order of importance are:

1. To prevent fires from starting.
2. To prevent loss of life and property in case a fire starts.
3. To confine a fire to the place of origin.
4. To extinguish the fire.

As a rule, the motivation for fire fighting and extinguishment is adequate because of the action and dramatic appeal involved, but it is the problem of the instructor to make fire prevention measures more appealing since these involve restrictions and prohibitions that interfere with individual human rights.

Need for the Study: In reviewing statistics on the loss of life and property each year by fire, there is an urgent need to make fire safety education an integral part of the learning experiences of all American youth. The school shop is an ideal location to present this material to future citizens because about twenty-five per cent of the boys are enrolled in industrial arts courses. If fire safety education is presented in such a manner as to instill proper attitudes and habits in students regarding fire protection measures, then progress will be made in the reduction of loss of life and property due to fire.

Methods of Research and Investigation: The methods of research used in this study include extensive use of the library facilities at Oklahoma Agricultural and Mechanical College. Letters were written to national fire protection organizations for available literature and information. Visits were made to the Office of the Insurance Department and the Office of the State Fire Marshal in Oklahoma City and to the Texas Fire Insurance Department in Austin, Texas. Phases of the thesis were discussed with industrial arts instructors and fire protection personnel.

Definitions of Selected Terms: For purposes of mutual understandings, it is desirable to include at this point, definitions of many terms used frequently in this thesis. The definitions quoted here shall be the meanings implied when these terms are used as the thesis progresses.

> Approved means acceptable to the inspection department having jurisdiction. (32, cover page.)
>
> Combustible is used referring to a material or structure which can burn. The term combustible is not related to any specific ignition temperature. (38, page xxii.)
>
> Flammable and inflammable are identical in meaning. Flammable refers to any material which is very easily ignited and burns with unusual rapidity. (38, page xxiii.)
>
> Fire prevention refers primarily to measures

directed towards avoiding the inception of fire. (38, page xxii.)

Fire protection includes everything related to the prevention, detection and extinguishment of fire, and other matters covering safeguarding of human life and the preservation of property. (38, page xxii.)

Flash point of a liquid is the lowest temperature at which it gives off enough vapor to form flammable mixtures with the air which are capable of propagating flame when ignited. (44, chapter 16, page 2.)

Ignition temperature is the lowest temperature at which a flammable gas or vapor-air mixture will ignite solely by heat. (44, chapter 16, page 2.)

Safety education and training is the term applied to all planned programs of study and activity in which children (and adults) are taught to avoid having accidents in which materials and items of value are destroyed or as a result of which the individual may be injured or killed. (73, page 3.)

Spontaneous ignition is the heating and ignition involving a combustible material or combination of materials is described as "spontaneous" if the inherent characteristics of the materials caused an exothermic (heat producing) chemical action to proceed without exposure to external sources of fire, spark or heat. The process is known as "spontaneous heating", and as "spontaneous ignition" or "spontaneous combustion" if ignition occurs. (38, page 430.)

Review of Graduate Studies and State Bulletins: In examining the publication Studies in Industrial Education, which is a bibliography of graduate studies in Industrial Education prepared by a committee of the National Association of Industrial Teacher Trainers, no treatises of fire safety were included in any of the studies listed, and, for this reason, there were no similar studies ordered for review in the preparation of this problem. (See Bibliography Item 3)

State and city bulletins dealing with school shop safety were studied in the preparation of this problem. These bulletins, which are included in the bibliography, treat general safety in the school shop and usually in specific phases of safety in woodworking, printing, sheet metal work, and other areas. See bulletins numbers (5, 8, 10, 11, 13, 14, 21, 26, 41, 42, 45, 46, 50, 51, 53, 61). There was no major emphasis on fire protection in these bulletins with the exception of the bulletins of the Bureau of Vocational Curriculum Development and Industrial Teacher Training, and Viles, School Fire Safety. (10, 11, 61). In these bulletins fire prevention and fire extinguishment were included.

Available Literature: Literature available for this problem includes: books, information bulletins, circulars, codes, posters, pamphlets, periodicals, reports, and shop safety manuals which may be found listed in the bibliography. Valuable information was obtained from fire prevention organizations which is treated in chapter five.

Predicted Views in This Investigation: There are many phases of fire protection education that may be dealt with in the shop. It is hoped that this study may be an aid in determining the fire hazards found in the various school shops and ways to avoid these hazards. After eliminating hazards, there are still possibilities for fires. Students should be trained in ways to conduct themselves during fires and in the proper first-aid fire extinguishment procedures.

The modern trend is towards more adequate safety programs in the schools, and these must include fire protection.

The industrial arts instructor must become acquainted with safety procedures in order to introduce these procedures into the shop program. The philosophy of this study is based upon safety, which includes fire protection, as an objective in industrial arts.

# CHAPTER II

## PHILOSOPHICAL VIEW OF INDUSTRIAL ARTS

In establishing the philosophy of industrial arts it is necessary to determine the place of industrial arts in the curriculum of the school program. Industrial arts is a phase of general education and cannot be considered separately. The primary purpose of general education is to help youth in developing desirable attitudes and habits which are necessary traits for happy, useful, and successful citizens. The industrial arts curriculum helps to fulfill the purposes of general education by offering young people the opportunity of working with materials, processing the materials into useful products, and dealing with problems of life and industry involved in these pursuits. Industrial arts has evolved as a phase of general education in America through "manual training", and "manual arts", and into the present concept of "industrial arts".

<u>The Manual Training Movement</u>: "Manual training" is defined by Bollinger in <u>The Terminological Investigation of Professional and Scientific Terms</u> as follows: (63, page 29-30.)

> Manual training is a historical term describing education of the mind through the hand based on handwork instruction in the elementary industrial processes and the theory of formal discipline. It was offered originally for general educational values without regard

> to vocation and usually applied to the training of boys. The work was usually offered during the 7th, 8th, 9th, and 10th year of school for the purpose of forming habits of thought before action; will; patient, careful appreciation; educating the mind through the hand; developing skill of hand and eye; appreciation of the dignity of labor; and developing the "powers" of observation through the senses. Manual Training usually consisted of woodworking and "mechanical" drawing but occasionally included printing, metal working, and other units.

This movement was introduced in America about 1877 by Runkle and Woodward who were pioneers in manual training. Woodward advocated a system of occupational activities beginning in the lower grades through high school, and he established the first Manual Training High School, which was a part of Washington University in St. Louis, Missouri, in 1879. Woodward's untiring efforts helped to spread the manual training movement throughout the United States. Manual training was an organized program of teaching tool processes and consisted mainly of producing exercises by the students under the formal discipline theory. The need for a broader concept of manual training was felt; hence, the manual arts philosophy developed.

The Manual Arts Movement: In 1894 this development was named "manual arts" by Bennett. In Industrial Arts Its Interpretation in American Schools, (59, page 13), it was indicated that the emphasis was still on skill, but the manual arts philosophy extended to the inclusion of making useful and well designed articles mainly by hand. Bollinger defines "manual arts" as: (63, page 29.)

> A term used to describe such subjects as woodworking,

> mechanical drawings, metal work, printing, leather work, jewelry making, clay work, book-binding, etc., when taught as a form of general education having for its chief purpose that of developing within the pupil, through work in the school shops, manual skill and an appreciation of good design and construction by practice with a variety of exercises and practical projects of personal value.

In Boston about 1888 Swedish Sloyd work was introduced by Larsson. Through Swedish Sloyd work arts and crafts were developed and met with approval. The manual arts movement did not include any phase of industry. A strong need was felt for training in industrial processes to acquaint students with the technological world in which they lived.

<u>The Industrial Arts Movement</u>: Richards, Russell, Bonser, and others included industry and industrial processes in a new philosophy which was termed "industrial arts" (1906-10). (59, page 14,) Newkirk's article, "Teaching Aims of Industrial Arts" in the <u>American Vocational Journal</u>, explains the development of industrial arts. (80, page 12.)

> The term, "industrial arts" or "industrial arts education" has evolved over a period of years from the older terms, "manual training" and "manual arts". Manual training emphasized the manual objective and was based on the theory of formal discipline. Manual arts emphasized the manual but also art principles. The term "industrial arts" designates a curriculum area from grade one through college and emphasizes construction with tools and machines, understanding of industry, drawing and design, consumer education, handyman abilities, objectification of learning, crafts for leisure, and social understanding with adaptations to meet the needs and interests of children at different grade levels.

All the leaders in the field of industrial arts agreed that the good elements in the manual arts movement should be retained but that certain new concepts should be considered as of major importance. Wilber in Industrial Arts in General Education defines "industrial arts" as: (64, page 2.)

> . . . those phases of general education which deals with industry--its organization, materials, occupations, processes, and products--and with the problems resulting from the industrial and technological nature of society.

Industrial arts today begins in the elementary grades and continues as a general education course in secondary education and college. Industrial arts is appropriate for boys, girls, and adults because of the wide variety of activities offered. Industrial arts ceases to be an exploratory course as a phase of general education when extensive specialization in a certain area is undertaken; it then becomes a vocational subject.

Objectives in Industrial Arts: Objectives are the tools used by teachers to attain desirable traits in students, and any worthy objective may become the basis for organized educational effort. The objectives of industrial arts should not be intangible hopes and dreams but definite goals to be reached, and definite steps should be devised in order to realize these objectives. Mays correlates the aims of leaders of the past and present in the article "New Demands Upon Industrial Arts" in the American Vocational Journal. (76, page 11.)

> . . . the fundamental aims of Dr. Woodward and the leaders of his day were little different from those of present day leaders. Industrial arts today, as in the 1880's and 90's, is concerned with the intellectual and aesthetic culture of youth, with the release and development of their creative powers, and with their adjustment to the life of an industrial

civilization. Modern psychology offers a more solid basis for such aims than did the unsound faculty psychology of the earlier years and industrial arts stands today unchallenged as a vital phase of modern education.

One of the worthy and desirable aims or objectives of industrial arts is that of safety, which includes fire protection. This is only one phase of industrial arts objectives, but due to the nature of this study, it will be treated at length.

<u>Safety as a Phase of Health in Industrial Arts Objectives</u>: In an industrial arts adaptation of the "Seven Cardinal Principles of Secondary Education" in a state course of study available from the Minnesota State Department of Education, health was included as one of the objectives. Schweickhard lists these adaptations of health through industrial arts in saying that the pupils should: (49, page 137-138.)

> . . . (1) become better acquainted with health needs; (2) acquire better health habits; (3) make wise selection and proper use of food; (4) understand, and apply as far as possible, the appropriate selection of clothing as it affects health; (5) be more intelligent about cleanliness and sanitation around the home; (6) learn how to conserve and gain strength and muscular control thru manual activities; (7) become familiar with occupational dangers and health hazards; (8) learn occupational safety and precautions; and (9) take account of personal health possibilities in the selection and pursuit of a vocation.
>
> The collective statement as it appeared in the State course of study indicated that industrial arts should: "Develop and establish in the lives of the pupils the methods and processes of performing manual activities which are in greatest accord with the conservation of human strength, the gaining of muscular skill and control, and the assurance of safety to life and health."

Safety was classified as an objective by the State of

Minnesota Department of Education in the 1920's.

Health and Safety as an Objective: Nine objectives in Improving Instruction in Industrial Arts by the Committee on "Standards of Attainment in Industrial Arts Teaching" of the American Vocational Association are: (2, page 51.)

1. Interest in Industry
2. Appreciation and Use
3. Self-discipline and Initiative
4. Cooperative Attitudes
5. Health and Safety
6. Interest in Achievement
7. Orderly Performance
8. Drawing and Design
9. Shop Skills and Knowledge

The goal of objective number five is to develop in each pupil desirable attitudes and practices with respect to health and safety, which are treated equally. In the publication, Improving Instruction in Industrial Arts, the following recommendation is made for implementing objective number five: (2, page 56.)

> Encourage participation in school activities for accident and fire protection, as preparation for more worthy and active acceptance of similar programs in the community and at places of work.

Safety, Including Fire Prevention, as an Objective: The only inclusion of fire prevention as a part of the safety objective, in any statement of industrial arts objectives studied, is that found in the Oklahoma State Department of Education bulletin, Industrial Arts in Oklahoma. The objectives as included in this bulletin are: (47, page 24.)

(1) Industrial Arts is complementary to other school subjects and provides opportunities to apply knowledge learned in other school subjects.

(2) Develops an appreciation of applied knowledge and skills.
(3) Provides a knowledge of industrial drawing, the language of industry, and methods of expressing ideas by means of drawings.
(4) Contributes to later vocation efficiency.
(5) Stimulates students' knowledge and appreciation of good design.
(6) Instills a satisfaction in personal creative achievement.
(7) Develops the ability to analyze a job into its processes and organize them into correct procedure.
(8) Contributes to consumer knowledge and induces an appreciation of the value of industrial materials and the need for their conservation.
(9) Trains in industrial and home safety (including fire prevention).
(10) Acquaints students with industrial information and induces a recognition of the standards of industrial attainment.
(11) Develops avocation interests.
(12) Trains individuals to be more resourceful in dealing with the material problems of life.
(13) Stimulates correct attitudes toward an orderly shop and home and their environment.
(14) Aids in making vocational choices.
(15) Develops qualities of leadership.
(16) Develops cooperative attitudes in work habits.
(17) Develops an appreciation of the dignity and importance of the occupation of one's neighbor.

In this bulletin it is suggested that the instructor should: (47, page 8.)

> Make a study of fire losses and causes of fires in the shops and homes. Work up plans for shop-keeping or house-keeping which will eliminate causes of nearly all fires, and carry out these plans as they apply to the school shop.

Fire prevention can be integrated into the industrial arts safety program through demonstrations, films, posters, and by other means. Children of school age are interested in the aspects of fire prevention and extinguishment, and while this interest is felt, the shop teacher may instill proper attitudes and habits pertaining to fire prevention that may be applied in the future.

## CHAPTER III

## FIRE AS A FRIEND OF MAN

Without fire man would only be slightly above the animal stage and subject to the same limitations. Even with a knowledge of fire and the means of its control, man would not have progressed very far without the development of the modern fuels, such as petroleum, gas and coal.

The early man was restrained to the more temperate and tropical areas before he learned to utilize fire for warmth. These early men could not have inhabited much of the world because of the lower temperatures. The homes would have been crude stone, wood, and mud structures or would have been limited to caves and trees. Without fire the food of primitive man would have been eaten raw. Clothing would have consisted mainly of animal skins. There would be no artificial light and means of protection other than the crude weapons that were made by hand.

Man could never have realized the use of wood, oil, coal, steam, or electricity without the knowledge of fire. There could have been no modern industry. There would have been no progress in transportation beyond the animal drawn cart, animal riding, and water. Without the discovery and control of fire plus the utilization of modern fuels, agriculture, industry, transportation, and communication could never have developed and reached the height of modern civilization.

<u>History of Fuels</u>: As man learned to control fire, new fuels were discovered. The first fuels used were in the solid state. Later, with the advancement in civilization, gases and liquids were introduced as fuels. First came wood and coal, and then came gas and petroleum. These products are used for fuel because they are cheap and plentiful, give off much heat, and are safe if properly handled.

<u>Wood as a Fuel</u>: Wood was the first and oldest fuel. It became kindled by chance ignition with lighting or molten lava from volcanoes. Man saw this happen and feared it at first. Later man used this example to help kindle fires of his own using similar wood fuel. For thousands of years it was the principle fuel.

Wood was very abundant in many areas of Europe and also in the early United States. (23 page 32.)

> When the first settlers landed on the Atlantic Coast, no less than 900 million acres of the United States were rich timber lands, far richer than any of which the white man had ever dreamed. But to find room for themselves and their families, these early colonists had to become our first lumbermen. The forests were both friends and foes, for though they supplied fuel for cooking and warmth as well as wood for shelter, they also blocked progress. Thousands and thousands of acres of the finest timber were destroyed in order to make room for additional farms and buildings.

It was used for cooking and heating in the home, and industry depended upon wood solely as a source of heat for manufacturing. The first steam engines were fired with wood and the first locomotive also used it as fuel. Wood does not make the extremely hot fire needed for the industries of today. Parker states that: "Oak wood, for example, gives off less than two-thirds as much heat per ton as hard coal, and less than half as much as fuel oil." (48, page 24.) As time went on, wood became less practical for fuel purposes and more valuable for other uses. However, man owes much to wood as a fuel for the developments that it has made possible.

Coal as a Fuel: The substance known as coal began its formation about 250 million years ago. The earth was hot and humid, and there was abundant and rich vegetation growing along the waters. The ferns grew to heights of one hundred feet. Water, sand, and mud covered these areas and formed what is known as peat bogs. Gradually the sediment grew deeper, and the pressure became greater on the rotting vegetation. Heat was formed and pressure caused the gaseous matter to escape. This developed what is known as coal.

There are several stages of development from very soft, or smoky burning coal, to the hardest and slow burning anthracite coal. Soft coal, or bituminous coal, contains sixty to seventy-five per cent solid carbon, while the hard coal contains ninety-five per cent carbon. Hard coal produces more heat and less smoke when burned, but it is harder to kindle.

Coal has been used for many centuries as a fuel. Greenwood, in his book, Prometheus, U. S. A., said: (23, page 41.)

Coal was mined in China long before the Christian

> Era and there is much evidence that it was used by the Britons previous to the Roman invasion in 54 B. C. The first known record of its use in England, however, is in the year 852 when the Abbey of Petersboro gave a receipt for "twelve cort loads of coals." The Bishop of Durham gives an account of mining operations in 1180 and the first shipment of coal to London occurred in 1240. Marco Polo, the famous Italian traveler, mentions its use in Cathay in 1275. In 1612, it was first used in a blast furnace for the production of iron.
>
> Coal was first discovered in the United States in 1673 by the Jesuit missionaries Joliet and Marquette.

By 1795 coal was being mined and used in some early American trades such as blacksmithing and foundry work, but the use of coal in domestic life was still undiscovered. John and Abijah Smith, two brothers who settled in Pennsylvania, formed the first coal company in America in 1805-6. It was necessary for these two men to conduct an educational program in order to convince prospective buyers that coal was usable as a domestic fuel. Wilson noted that in Great Britain: (65, page 21.)

> . . . The demand for coal increased considerably when in 1803 coal gas commenced to be used for lighting purposes, and the introduction of the blast furnace in the ironworks of Scotland about 1828 gave a still greater impetus to the industry.

At the present time coal is an essential material in industrial production. It is irreplaceable in iron ore smelting, however, power production, hydroelectric plants, and petroleum fired plants are replacing coal burning installations. The use of coal as a fuel has contributed significantly to the rapidly expanding American industry.

<u>Gas as a Fuel</u>: Greenwood relates, (23, page 49), that

many centuries ago when natural gas was discovered at Baku on the Caspian Sea, the gas became ignited and burned and the people worshiped it. In one area in Greece it caused the shepherds and their sheep to act peculiarly after breathing it, and they thought it possessed some supernatural power. Such beliefs as these slowed the development of the use of gas for practical purposes. However, the Chinese used gas for lighting purposes many years before its discovery in Europe. It was piped through bamboo poles, but its use was not popular.

John Baptist van Helmont, a Dutch chemist, accidentally discovered what is now referred to as manufactured gas about 1609. Natural gas discoveries were made in England and written about by Thomas Shirley in 1667. John Clayton, a Yorkshire minister, made experiments from 1660-1670 one of which was the heating of coal in a closed vessel and collecting the gas given off in bladders. He then pricked holes in the bladders and ignited the gas given off.

Murdock distilled coal in an iron retort and conducted the gas through copper tubes and successfully lighted his home in England in 1792. In 1798 he built a large scale apparatus and lighted a factory in England. The first gas company in the world was the London and Westminster Gas Light and Coke Company established in 1812.

The first city streets lighted by gas in the United States were in Baltimore in 1816. Paris streets were lighted with gas in 1820. Gas for lighting the homes in New England was not used until 1865. Gas was first used for cooking purposes in England about 1832, but it was not until 1859 that it was used very extensively in the United States. At that time the people in America were cooking on gas stoves imported from Europe.

Today gas is used for cooking and heating, and it is used extensively in industrial processes. The electric light has completely replaced it in the field of illumination.

Petroleum as a Fuel: Several Biblical references were made to oil. It is stated in Genesis, 11:3, that some forms of petroleum were used in building the Tower of Babel. In Deuteronomy, 32:13, reference is made to "oil of the flinty rock". Job, 29:6, wrote ". . . the rock poured me out rivers of oil". Other early oil discoveries were made in western Asia and the eastern part of Europe. One of the most famous and richest supplies was in the area of Baku on the Caspian Sea where the Fire Worshipers worshiped "the everlasting flame". Marco Polo referred to it in his writings and told of some of its uses. He said it was not good for food, but it was good to burn and for application to camels for the mange.

The Seneca Indians in the area of New York are given credit for discovering the first petroleum in the United States in the early seventeenth century. They recognized its many uses and began to collect it by dipping blankets into pools and squeezing it out in timbered pits.

While visiting in western Pennsylvania in 1753, George

Washington learned about the existence of petroleum and immediately recognized its importance. Later, he purchased oil land and listed it in his will as being one of his most valuable possessions.

In 1865 the idea for drilling wells to secure oil was conceived by George A. Bissell, a New York lawyer. He engaged Colonel E. L. Drake as superintendent for drilling. After drilling several unsuccessful ventures, a well near Titusville, Pennsylvania, was finally drilled that produced twenty barrels of oil a day. This led to the successful completion of many other wells, some of which produced up to three thousand barrels a day. Drake discovered that oil could be produced in large amounts from drilled wells, and this is the foundation of the modern oil industry.

With the production of larger amounts of petroleum, advancements were made in refining. Crude oil was refined by the distillation process. By this method the following compounds were obtained: benezine, gasoline, kerosene, distillate fuel oil, heavy lubricating oils, paraffin, and asphalt. Still later, the cracking process, which is applying heat under pressure, was introduced. This made it possible to produce gasoline from kerosene and heavier oils.

In the twentieth century man has harnessed fire as a servant to meet his vast needs and desires. Almost everything used has been made possible with the help of fire, from the utensils on the breadfast table to the transportation used. Most of the uses can be grouped under three headings: uses of fire in the home, uses of fire in transportation, and uses of fire in manufacturing. In the first group, fire is used mainly for cooking, heating, and lighting, since steam generators are used in many instances. In the second group, transportation, fire transforms fuel into power which moves locomotives and steamships. Automobiles and airplanes are operated with fuel which is burned inside the cylinders of the engines. And thirdly, fire furnishes the energy for operating most factory machines and is used directly in the manufacturing of iron, steel, rubber, glass, and other materials too numerous to list. The newest and greatest discovery, still only in the infancy of its possibilities, is that of atomic energy supplied by the splitting of the atom. It could become man's greatest and most perfect servant. These instances are due to controlled fire, but man's worst enemy can easily be that same fire uncontrolled.

## CHAPTER IV

## FIRE AS AN ENEMY TO MAN

Fire has been an enemy to civilization since its inception. It has rained destruction on human habitations for centuries, and it has only been within the twentieth century that man has begun to deal with fire on a more equal basis. Lessons have been learned only through experience with the loss of thousands of lives and billions of dollars in damages.

### PART A

### Conflagrations and Disastrous Fires

Before the turn of the century fires were considered almost inevitable, and little effort was expended to avert disasters even when strong warnings were given by a few safety minded individuals. After each disaster or conflagration people would persist in the same careless habits and practices. It was only after several such destructive and costly fires that the citizens began to formulate steps to invent, install, and enforce new equipment and laws to help protect human lives and property against any future fires.

The Great Chicago Fire: This conflagration began in Chicago on October 9, 1871. The cause is unknown, but the situation was ideal for the tragic fire. The weather was very hot and dry, and the numerous wooden buildings were clustered together and extremely combustible. The losses reached staggering proportions. It was estimated that 250 people lost their lives. Goodspeed made this statement in his book, History of the Great Fires in Chicago and the West: (22, page 397.)

> The best authorities concur in estimating the total loss at from $198,000,000 to $215,000,000, taking the total insurance to represent one-third of the total loss. This may be divided as follows, on a rude approximate:
>
> | | |
> |---|---|
> | Loss on buildings and property . . . . . | $106,590,000 |
> | Loss on stock and plant . . . . . . . . . | 74,560,000 |
> | Loss on furniture and personal property | 24,850,000 |
> | Total . . . . . . . | $206,000,000 |

The loss was so great that sixty underwriting firms were forced into bankruptcy due to insufficient funds. A year later much of Chicago was rebuilt with the same combustible wooden construction. Brick and stone could have been used, but they were believed to be too expensive. The citizens did not learn the lesson well as no apparent corrective measures grew out of this conflagration.

The Boston Conflagration: Only one year after the great Chicago catastrophe, Boston was swept by fire on November 9, 1872. The fire began in a basement of a building and spread quickly to the roof through the elevator shaft. An alarm was not turned in immediately because everyone watching thought someone else has turned it in. The fire horses were ill at the time. As a result, sixty acres of the city were leveled with the damage amounting to $75,000,000. Of the total loss $56,000,000 was covered by insurance. Only thirty-six million was collected on the insured property. Masters states in his book, Going to Blazes, that: (29, page 21.)

> Coming so close together, the Chicago and Boston fires made a deep impression on the insurance companies which survived--if on no one else. It led to a thorough overhauling of the risk rating system. But, more than that, the National Board of Fire Underwriters was formed to do research, investigate fires, and establish customs for the entire group of insurance companies which cooperated in its support. The Board's first studies were of conflagration hazards, and these revealed that practically every American city's building laws needed revising. Rows of fireproof structures in closely-packed business districts had to be built to act as barriers against conflagrations. Streets needed widening where ever possible. Underground water systems and high pressure mains were necessary for efficient fire fighting. As for alarms, the telegraphic system of fire boxes gave fastest service; this system was expensive and complicated to install, and that was why only 75 cities in the whole country were using it at the time.

The National Board of Fire Underwriters was a pioneer in the field of fire prevention, and, through its influence, the National Fire Protection Association and Underwriters' Laboratories were established. These organizations have promoted fire protection by the services rendered.

The Fire in Baltimore: On Sunday, February 4, 1904, the people were aroused by a terrifying explosion. The fire began when a cigarette was carelessly dropped through a sidewalk grating beside a building which burst into flames when firemen opened the doors to enter the building. It spread up the elevator shaft and reached some stored celluloid novelties. The celluloid caused an explosion that hastily spread the fire that burned for two days.

It was necessary to call for help in fighting the fire. Companies were called from New York, Washington, Wilmington, Philadelphia, and Chester. Some of the companies arrived, but only after they had a great deal of trouble in transporting the equipment. On arrival it was found that the hose couplings were of various sizes and did not fit the Baltimore hydrants. This rendered the equipment of the visiting fire departments totally useless until the fire reached the docks on the second day. This enabled the visiting companies to pump from a natural water supply, and these events eventually led to the control of the fire. As a result of the fire, 2,500 buildings were destroyed on two hundred forty acres. The evaluation of loss was $50,000,000. Most of the insurance companies had sufficient capital to help cover the loss with only a few going out of business. This fire led to the standardization of hydrant and hose couplings.

<u>The San Francisco Conflagration</u>: The worst fire in America's history began with an earthquake in San Francisco on April 18, 1906. There were four hundred fifty-two lives lost as a result of this disaster, and $350,000,000 worth of property was destroyed.

The conflagration had been predicted by the fire prevention engineers on the National Board of Fire Underwriters only six months before it occurred. The citizens ignored all of the Underwriters' recommendations except that of maintaining a fire department. The same conditions existed here as in previous great fires. No protective or preventive measures were taken until after the disaster occurred.

The Collinwood School Fire: On March 8, 1908, in Collinwood, Ohio, a school fire took the lives of 175 children, all under fourteen years of age. There was a defective flue below the front stairs that caused the fire to start. The younger children from the first floor marched out safely. The front entrance had always been used for fire drills, and when the front doors became blocked by flames, the teachers and children turned to the rear door only to find it locked. Eventually the weight of the bodies against the door broke it open, but only a few survivors managed to get to safety. Children retreated to the third floor, but the fire ladders were not long enough to reach that high, and the water pressure was ineffective. The victims were trapped on the third floor. As a result, public buildings erected since that fire are equipped with fire safety doors which can be opened from the inside while locked on the outside.

Babb's Switch School Fire: The Babb's Switch School fire near Hobart, Oklahoma, occurred during a Christmas celebration on December 24, 1924. Thirty-six men, women, and children were burned to death as a result of the fire. Over two hundred adults and children were crowded into a small one room schoolhouse that was a highly combustible wooden structure. A fire started when a candle on the Christmas tree ignited some paper decorations. In an effort to extinguish the fire the tree was overturned and panic reigned. There was only one exit, and all windows were covered with very heavy wire screens to keep transients out. The first survivors tried to remove these screens with no success. The Babb's Switch School fire is an example of the destruction and loss of life that can result from the neglection of fire prevention facilities in a school building.

As results of these disastrous fires, many fire prevention measures have been introduced which include:

1. More and better fire exits.
2. Fireproof fixtures and scenery.
3. Fire safety doors.
4. Automatic sprinklers.
5. Caged-in lights.
6. Standpipes with hoses on every floor of buildings.
7. Limited number of people to occupy a given area.
8. Strict building regulations for tall structures such as hotels and office buildings.

Organizations have been established for the sole purpose of preventing fires before they start by recommending protective measures and enforcing them with laws.

## PART B

### Statistical Record of Fires and Fire Losses in the United States

This section is devoted to a statistical record of fires and fire losses in industry, schools and colleges, and dwellings from 1941 through 1950 and deals with the number of lives lost yearly from fires in the United States from 1932 through 1950. The estimated number of fires and statements of fire losses are taken from volumes of the National Fire Protection Association Quarterly. The estimates of the number of lives lost from fires are taken from the National Safety Council publication, Accident Facts, 1951 edition. The number of school fires and fire losses in the State of Oklahoma are excerpts from the State Fire Marshal's Report.

TABLE I

ESTIMATED NUMBER OF FIRES IN SCHOOLS AND COLLEGES, MANUFACTURING INDUSTRIES, AND HOMES, AND THE TOTAL NUMBER OF FIRES IN THE UNITED STATES FROM 1941 THROUGH 1950

| Year | Schools and Colleges | Manufacturing Industries | Homes | Total No. of Fires in U. S. |
|---|---|---|---|---|
| 1941 | 2,700 | 30,800 | 345,000 | 736,000 |
| 1942 | 2,400 | 29,400 | 322,000 | 665,000 |
| 1943 | 2,500 | 30,450 | 330,000 | 668,000 |
| 1944 | 2,300 | 29,900 | 285,000 | 600,000 |
| 1945 | 2,200 | 28,500 | 276,000 | 585,000 |
| 1946 | 2,300 | 31,700 | 260,000 | 608,000 |
| 1947 | 2,400 | 31,600 | 250,000 | 538,000 |
| 1948 | 2,500 | 33,300 | 270,000 | 570,000 |
| 1949 | 3,100 | 30,100 | 282,000 | 580,000 |
| 1950 | 2,900 | 32,000 | 310,000 | 600,000 |
| Average | 2,530 | 30,775 | 293,000 | 615,000 |
| Per Day | 7 | 84 | 803 | 1,685 |

Data Showing Number of Fires: Table I shows that the number of fires for 1950 is less than the average number of fires in the United States from 1941 through 1950. This point is significant in that it shows progress has been made in fire prevention education, fire prevention facilities, and fire extinguishment. Progress is further emphasized in that construction of homes, industries, and schools has increased greatly in the past ten year period. In no instance does the number of fires in schools and colleges, manufacturing industries, and homes reported in 1950 exceed the largest number of fires reported in these catagories during the period from 1941 through 1950.

TABLE II

ESTIMATED FIRE LOSSES IN SCHOOLS AND COLLEGES, MANUFACTURING INDUSTRIES, AND HOMES IN THE UNITED STATES FROM 1941 THROUGH 1950

| Year | Schools & Colleges | Manufacturing Industries | Homes | Total Cost of Fires in U. S. |
|---|---|---|---|---|
| 1941 | $ 8,000,000 | $ 73,500,000 | $ 86,000,000 | $325,000,000 |
| 1942 | 7,300,000 | 63,700,000 | 80,000,000 | 315,000,000 |
| 1943 | 8,200,000 | 85,200,000 | 107,500,000 | 403,000,000 |
| 1944 | 6,000,000 | 98,000,000 | 104,000,000 | 456,000,000 |
| 1945 | 9,000,000 | 85,400,000 | 94,000,000 | 485,000,000 |
| 1946 | 11,000,000 | 107,100,000 | 129,500,000 | 580,000,000 |
| 1947 | 8,100,000 | 140,500,000 | 160,000,000 | 703,000,000 |
| 1948 | 11,000,000 | 147,000,000 | 174,000,000 | 714,800,000 |
| 1949 | 14,000,000 | 133,800,000 | 176,000,000 | 672,500,000 |
| 1950 | 17,000,000 | 155,750,000 | 188,700,000 | 699,600,000 |
| Av. | $10,760,000 | $108,995,000 | $129,970,000 | $535,390,000 |

<u>The Cost of Fires</u>: The estimated fire losses shown in Table II indicates that the cost of fires has risen in the period of 1941 through 1950. This increase in the cost of fires may be partly attributed to the decrease in the valuation of United States currency and greater cost of construction today. World War II and the current Korean conflict have caused a marked increase in construction in these groupings including schools and colleges, homes, and manufacturing industries.

Loss of Life from Fire: Fire takes an annual toll of about 7,000 lives in the United States according to the National Safety Council estimates. The annual loss of life by fire ranks third as the cause of accidental deaths. Casualties from fires are due mainly to burns and the inhalation of carbon monoxide and other gases of combustion. The first objective of all fire prevention should be the prevention of loss of life or personal injury.

TABLE III

BURN CASUALTIES IN THE UNITED STATES FROM 1938 THROUGH 1950

| Year | | Casualties |
|---|---|---|
| 1938 to 1942 | (Average) | 7,106 |
| 1943 to 1947 | " | 8,192 |
| 1948 | | 7,668 |
| 1949 | | 6,500 |
| 1950 | | 6,800 |
| Average | | 7,497 |

Statistics of Causes of and Losses from School Fires: The following is a statistical analysis of 1,116 school fires in the United States from 1930 through 1946 as quoted from the National Fire Protection Association Handbook of Fire Protection: (38, page 1270.)

Heating defects . . . . . . . . . . . . 18.0%
- Faulty equipment or improper operation . . . . 10.0%
- Defective or poorly installed chimneys or flues . . . . . . . . . 6.4%
- Careless disposal of hot ashes or coals . . . . 1.6%

| | |
|---|---|
| Misuse of electricity . . . . . . . . . | 17.0% |
| Smoking and matches . . . . . . . . . . | 12.1% |
| Spontaneous ignition of oily rags or material . . . . . . . . . . | 10.3% |
| Incendiary . . . . . . . . . . . . . . | 8.8% |
| Improper rubbish disposal methods . . . . . . . . . . . . . . . | 5.0% |
| Careless handling of flammable liquids . . . . . . . . . . . . . . . | 4.9% |
| Special hazards associated with manual training . . . . . . . . | 4.6% |
| Open flame devices in laboratories and kitchens igniting combustible materials . . . . . . . | 4.4% |
| Explosions (gas heating, chemical, and flammable vapors) . . . . | 3.0% |
| Lightning . . . . . . . . . . . . . . . | 3.0% |
| Exposure . . . . . . . . . . . . . . . | 2.7% |
| Miscellaneous . . . . . . . . . . . . . | 6.2% |
| Total . . . . | 100.0% |

As a result of the 1,116 school fires reported in the National Fire Protection Association Handbook, thirty-one of the fires caused 325 deaths. Of this representative sample the hazards in the shops account for only four and six-tenths per cent of the 1,116 school fires.

Table IV shows the number of fires reported to the Office of the Fire Marshal in Oklahoma during an eight year period. The majority of school fire losses can be attributed to one of the hazards of common occurance, such as defective installation or maintenance of heating and lighting appliances; careless use of matches; smoking, especially in the auditorium and gynasiums; accumulation of combustible rubbish in basements, attics, storage rooms, locker rooms, and boiler rooms; and failure to follow safe precautions in construction of flues, the removal of hot ashes, and the storage of oil mops. Most school buildings are unattended at night, Sundays, holidays, and usual vacation periods, and, for this reason, fires are sometimes beyond control before detection. Schools in rural or unprotected areas are total losses as a rule rather than an exception. School buildings are the center of many community activities, such as meeting places for civic organizations, Civilian Defense, social, and athletic

TABLE IV

TOTAL NUMBER OF FIRES, SCHOOL FIRES, AND INSURED PAID SCHOOL LOSSES IN OKLAHOMA FROM 1943 THROUGH 1950

| Year | Total Number of Fires | Number of School Fires | Amt. of Paid School Losses |
|---|---|---|---|
| 1943 | 576 | 10 | $ 363,073 |
| 1944 | 294 | 2 | 240,736 |
| 1945 | 356 | 5 | 112,745 |
| 1946 | 511 | 2 | 127,901 |
| 1947 | 5,992 | 15 | 190,606 |
| 1948 | 7,772 | 1 | 382,787 |
| 1949 | 8,176 | 8 | 550,656 |
| 1950 | 6,293 | 16 | 196,980 |
| Average School Fires per year 7.4 | | | |

events. Permission for any such meeting or event should carry with it adequate responsibility and experienced supervision. Following these meetings inspection should be made by competent persons to guard against latent fires.

The American people have learned through experience that fire can destroy entire cities, level magnificent buildings, and cause the loss of hundreds of lives. Following in the wake of these incidents, the need was felt for adequate fire prevention and protection facilities. Statistics prove that within the present century great progress has been achieved in fire prevention and extinguishment. Agencies and organizations, both governmental and private, have worked together toward the promotion of fire prevention education which, in turn, leads to the decrease in fire losses.

# CHAPTER V

# ORGANIZED PROGRAMS FOR FIRE PREVENTION AND FIRE EXTINGUISHMENT

In reviewing the statistics on the loss of lives and property by fire each year in the United States, it can readily be seen that there is a necessity for organized programs for fire prevention and fire extinguishment. These programs encourage the participation of every individual and all organizations from a small community to the large industrial companies or civilian defense units on a national scale. The principle aim of all the organizations and agencies is that of fire prevention education. Through laboratory experiments and organized drills, fire extinguishment can become the insurance that is necessary to protect lives and property.

## PART A

## Governmental Fire Prevention Organizations and Agencies

In 1569 in early New York, or Nieuw Amsterdam as it was then known, the governor of the city outlawed thatched roofs and appointed fire wardens to inspect homes. The Dutch built sturdy ovens of stone, but the remainder of their homes were built of wood, even including the chimneys. Fire was a real enemy and all had to fight it at close range, but the preventive measures that were suggested met with great resistance. The wooden chimneys were ruled against the law, but the people refused to cooperate.

The main equipment used to fight fires at the time was the leather bucket. The residents were required to keep a leather bucket full of water in the house at all times and three buckets on the doorstep after sundown. The buckets of water were useless, however, unless the fire was discovered immediately. The other equipment used was a fire-ladder, fire-hook, and additional buckets installed at street corners. These were provided by taxing the home-owners in proportion to the number of chimneys in their homes.

Eventually the citizens realized that they needed more protection, and the first fire protection organization in America was formed. This organization consisted of eight men who in turn walked through the city streets at night and kept on the lookout for fire or smoke. These men were given the name of "rattle-watch" because they carried wooden noise makers to sound an alarm.

Some years later the English brought pieces of fire-fighting equipment to America. It was identical to that used in early Rome. New apparatus was invented in Europe, but the equipment was not readily accepted in this country. Though New York grew to twenty thousand population, the fire protection equipment and organizations were inadequate. These were the events and groups that influenced modern fire prevention organizations and agencies.

State Fire Marshal: The state fire marshal is primarily an enforcement officer who is responsible for fire laws. Although the fire marshal's staff is tecnically responsible for law enforcement, in many states the actual function is to act as an agent to sponsor and promote fire prevention activities. Georgia and Wisconsin have a fire marshal for the sole function of investigating fires. Thirty-six states have fire marshals with the authority to perform inspections and fire prevention work. According to the National Fire Protection Association Handbook of Fire Protection, the duties of state fire marshals are to enforce laws relating to: (38, page 50-51.)

1. The prevention of fires and compilation of fire statistics.
2. The storage, sale, and use of combustibles and explosives.
3. The installation and maintenance of fire extinguishing equipment, automatic sprinklers, automatic and other fire alarm systems, fire extinguishers, and similar apparatus.
4. Means and adequacy of exits in case of fire from factories, asylums, hospitals, churches, schools, halls, theatres, and all other places in which numbers of persons work, live or congregate from time to time for any purpose, and the construction, maintenance and regulation of fire escapes and other means of exit.
5. The suppression of arson and the investigation of fires.

In performing these duties authority is frequently delegated to the fire marshal to make regulations concerning inflammable material and protective devices. In several of the states these regulations have the effect of law.

In Oklahoma it is the duty of the state fire marshal to enforce the following legislation:

1. Arson law.

2. Fire protection of public buildings.
3. Fire protection of places of public assembly.
4. Inflammable liquid regulations.
5. Fire escape regulations.
6. Hotel regulations.
7. Liquefied petroleum gas regulations.
8. Removal of dilapidated buildings.

In addition to the enforcement of these laws, the marshal inspects all public buildings.

Organization of Full-Time Paid Fire Departments: Full-time paid fire departments are found in larger cities. The organization and administration of the local fire department depends upon the form of the local government, the activities to be sponsored, and the requirements of the underwriters. The activities of the fire departments in the larger cities do not vary widely. The usual activities include fire prevention, public education in fire safety, rescue work, fire fighting, fire alarm, protection of buildings, training, investigation of fires, salvage work, and repair and maintenance of equipment.

Some of the advantages of the full-paid fire department are: trained men are on duty constantly to answer calls; audible public alarms do not arouse spectators; there is continuous fire prevention inspection work that is necessary for the modern fire department; and men are not taken from other jobs to answer calls as in the volunteer units.

Organization of Part-Paid and Part-Volunteer Fire Departments: Fire departments in municipalities with populations of less than 25,000 may have men who are part-paid, paid-on-call, or unpaid volunteers, or a combination of these. The type of organization for each individual municipality depends upon the size of the community, the property to be protected, and the number of calls answered. Many cities furnish paid drivers to take the major apparatus to the fire in areas of 5,000 population or above. In cities of ten thousand to 25,000 population it is common to have two or three paid officers to go along with each piece of equipment. These men may be supplemented by paid-on-call men. The volunteers are usually paid one to two dollars per hour for each alarm and services rendered. They are also paid for attending meetings and drills. Approximately forty per cent of all volunteer firemen are paid on this basis. There are 15,000 volunteer fire departments in the United States and Canada as compared to approximately one thousand part-paid companies.

Volunteer Fire Departments: All fire departments whether paid or volunteer should be responsible to a reasonable degree to the tax payers and citizens of the community for fire protection of life and property. Cities with 5,000 population or less generally have volunteer fire departments. In the organization of the volunteer fire company there usually is a cooperative agreement or plan for mutual fire aid with neighboring communities.

Some towns, which are largely residential, have combined police and fire departments; the same men perform a dual function of fireman and policeman. Volunteer fire departments that have a definite plan of organization of rules similar to that of a full time paid department functions with optimum efficiency.

Civilian Defense Activities: The municipal fire department plays an important part in the protection of civilian life and property during modern warfare in cities that may be subject to aerial attack. The organization for civil defense is similar to any major disaster organization in operation during wartime as well as peace. Civil defense in time of war requires the provision of additional facilities. Auxiliary reserve forces of citizen groups are trained in addition to the regular organized fire department. Definite assignments are made as to the duty and placement of district fire watchers who constitute the first line of defense against incendiary aerial bomb attack. Various municipal departments plan for coördination of activities in time of war or attack which include auxiliary police forces, air raid warden service, utility repair squads, decontamination squads, rescue squads, and other private citizen groups which are trained for specialized tasks. The objectives of a civil defense program are: (54, page 165.)

> . . . to protect lives and property against air assault, sabotage, and other forces of attack. Civilian defense functions are similar in many respects to those carried on during some of the public disasters . . . control of movement of population during a raid, provision of

shelter, rescue of trapped persons, control of incendiary bombs, provision of first aid and hospitalization of wounded, repair of broken mains and utility lines, reopening of streets and restoration of communications, fighting fires, provision of food and shelter for the homeless.

The atomic bomb is the newest and most devastating threat to our national and personal security, but the dangers can be avoided to some extent by knowing the true dangers of the bomb, and knowing the steps that can be taken to avoid them. Six survival suggestions for atomic attacks are as follows: (72, page 3.)

1. Try to Get Shielded
   If you have time, get down in a basement or subway. Should you unexpectedly be caught out-of-doors, seek shelter alongside a building, or jump in any handy ditch or gutter.

2. Drop Flat on Ground or Floor
   To keep from being tossed about and to lessen the chances of being struck by falling and flying objects, flatten out at the base of a wall, or at the bottom of a bank.

3. Bury Your Face in Your Arms
   When you drop flat, hide your eyes in the crook of your elbow. That will protect your face from flash burns, prevent temporary blindness and keep flying objects out of your eyes.

4. Don't Rush Outside Right After a Bombing
   After an air burst, wait a few minutes then go help to fight fires. After other kinds of bursts wait at least 1 hour to give lingering radiation some chance to die down.

5. Don't Take Chances with Food or Water in Open Containers
   To prevent radioactive poisoning or disease, select your food and water with care. When there is reason to believe they may be contaminated, stick to canned and bottled things if possible.

6. Don't Start Rumors
   In the confusion that follows a bombing, a single rumor might touch off a panic that could cost your life.

In most cities there is a local fire prevention committee which is a part of the chamber of commerce, safety council, or other civic group. The objectives of the fire prevention committee is fire prevention education and the maintainance of a good fire record for the city. The committee coordinates its efforts with local and municipal fire fighting agencies. The committee acts as a clearing house and coordinating body of all local fire prevention efforts, campaigns, and educational activities. Municipal administrators and the fire chief appreciate such efforts on the part of the citizenry in promoting an understanding of the most elementary precautions to be taken in the prevention of fires.

PART B

## Fire Protection Associations

For individuals, groups, companies, or agencies, who desire recent or specialized knowledge of work or publications, the fire protection associations are indispensable. The laboratories connected with these associations can furnish reliable information on new equipment, inventions, and on scores of tests and experiments being made for those interested in fire prevention. The membership fee is insignificant in comparison to the wealth of information and values received from these associations.

National Board of Fire Underwriters: On July 7, 1866, a call was issued for a "Convention of the Insurance Companies of the United States". This convention assembled on July 18, 1866, and organized the National Board of Fire Underwriters; it was the first national association of any business established to promote public welfare. One of the objectives of the organization was to suppress incendiarism and arson. The National Board of Fire Underwriters is primarily a public-service institution.

In 1911 the Fire Marshals' Association of North America offered the resolution for a Fire Prevention Day to be observed on October ninth, the fortieth anniversary of the Chicago fire. The National Board of Fire Underwriters secured the cooperation of many state governors in the inauguration of this day. A proclamation made by President Harding in 1922 proclaimed Fire Prevention Week to be substituted for Fire Prevention Day. On September 8, 1922, the President of the Chamber of Commerce of the United States pledged support of Fire Prevention Week.

The National Board of Fire Underwriters is an engineering, statistical, and educational organization supported by 211 stock fire insurance companies. Through its Actuarial Bureau the board compiles fire statistics. It maintains an expert staff of engineers. Consultations are held with city officials concerning water supplies, fire departments, fire alarm systems, and various phases of municipal fire protection. The vast undertakings of the National Board of Fire Underwriters are described in the book, Pioneers of Progress. (33, page 100-101.)

> Prevention of fire is the board's watchwork. On that subject it is the world's leading authority. Its committee on incendiarism and arson has done as much as the police to curb one of the more contemptible crimes; its committee on laws has done some notable work in stiffening legislation against jerry-building and in enlightening State Legislatures on the relation of fire insurance to business as a whole; its committees on fire prevention, engineering and building construction maintain the finest testing laboratories of their kind in the world for the testing of new structural designs and materials, and their building code is generally accepted as a model of its kind.
>
> Only careful engineering tests can decide whether new building materials and designs are safe. By undertaking this beneficent and necessary work the National Board of Fire Underwriters relieves Federal and State government of an immense expense, places fire prevention on a sound basis and, what is more, gives a demonstration of the manner in which a great private enterprise can meet grave social responsibilities in the democratic way.

Today this board is constantly expanding new frontiers by modern developments in science, transportation, communication, and industry. The goal has been and always will be service for public safety and the preservation of a secure democracy.

The publications of the National Board of Fire Underwriters include several booklets on industrial fire hazards. (32) The board has some 250 special interest bulletins treating subjects, such as fire flow tests, maintenance of life safety in places of assembly, and small hose and other items that do not require full treatment given a standard. Typical publications are issued under the following headings: fire extinguishment appliances, fire extinguishment auxiliaries, inflammable liquids, combustible solids, hazardous gases, explosive dust, electrical equipment, and construction.

<u>National Fire Protective Association</u>: Largely through

the influence of the National Board of Fire Underwriters in an effort to enlist the support of industries, the National Fire Protective Association was organized in 1896 and incorporated in 1930. The association was organized for the following purposes: to promote the science and improve the methods of fire protection and fire prevention; to obtain and circulate information on these subjects; and to secure cooperation in establishing proper safeguards against loss of life and property by fire. This association is an international clearing house for information pertaining to fire prevention and fire protection. It is a non-profit organization with more than 12,000 individual and company memberships. (40)

The annual dues for members are sixty dollars and for associate members $12.50. This is the total expense; there are no initiation fees. Members are entitled to copies of the current association publications during the year of membership. A magazine, The National Fire Protection Association Quarterly, is published, also a journal for volunteer firemen, monthly news letter, special bulletins, handbooks, and technical reports. It also publishes numerous standards and special committee reports of importance to the safety engineers. Some of these are the Building Exits Code; Dust Explosions in Industrial Plants; Flame-Proofing of Textiles; Sprinkler Systems, Care and Maintenance; Spray Finishing Using Flammable Materials; and Flammable Liquids, Gases and Volatile Solids, Fire Hazard Properties.

The association has a Field Service Department for the purpose of organizing fire prevention committees and stimulating fire prevention activities. It holds a national meeting once each year. Participants in the national meeting are the Fire Marshals, Chambers of Commerce, Safety Councils, and Volunteer Firemen.

Factory Insurance Association: The Factory Insurance Association was organized in 1890. The purpose of the association was to provide stock fire insurance combined with the best of engineering, supervisory inspection, and loss adjustment services to owners of manufacturing plants with superior management, maintenance and construction, automatic sprinklers and other fire protection. The association maintains a staff of engineers with representatives in key industrial areas. There is a fire safety laboratory maintained by the association which contains various types of fire protection equipment for examination and demonstration under working conditions. This organization publishes the F. I. A. Sentinel, a monthly magazine, the underlying theme of which is loss prevention. Some 35,000 copies are distributed monthly.

Associated Factory Mutual Fire Insurance Companies: The Factory Mutual Engineering Division specializes in industrial fire protection. The companies operate with a staff of hundreds of trained fire protection engineers to minimize the danger of extensive property loss and to safeguard production in industry. Plant inspections are made three or four times each year at most insured properties by trained engineers. Inspection covers all phases of hazards including fire, lightning, explosion, and wind. Special visits may be arranged for when the necessity arises. Work has been done in the testing laboratories, some of which includes: spray nozzles, oven safety devices, flameproofing of wood, protection of oil transformers, flame arresters, and explosion vents. The policy membership comprises leading manufacturing concerns. Publications include the _Factory Mutual Record_, which is an illustrated monthly digest of current fire protection information and experiences, loss prevention bulletins that cover the latest practical methods of maintenance, special-hazard safeguards, and other fire protection features.

_Underwriters' Laboratories, Inc._: The Underwriters' Laboratories, Inc. was founded in 1894 and sponsored by the National Board of Fire Underwriters. It was chartered as a non-profit organization. This organization maintains and operates laboratories for the examination and testing of devices, systems, and materials as to their relation to life, fire, and casualty hazard, and crime prevention. Three testing stations are operated in Chicago, New York, and San Francisco, and adequately equipped laboratories are maintained for the testing and examination of electrical equipment, fire alarm, and signal apparatus. In addition to the laboratories, there are approximately 200 representatives in cities throughout the United States and Canada. The laboratories publish annually lists of manufacturers whose products have proved acceptable when tested under appropriate standards and which are subjected to one of the forms of follow-up service provided as a countercheck. All approvals by the Underwriters' Laboratories, Inc. bear the label Underwriters' Laboratories, Inc., Inspected. Other laboratory publications include lists of hazardous location of electrical equipment, fire protection equipment, gas and oil equipment, accident, automotive, burglary protection equipment, and bimonthly supplement to all lists.

To have a clear understanding of the municipal fire problem, it is necessary to have a knowledge of the nature and activities of the various organizations and agencies working in the field of fire prevention and protection. The resourses of these organizations and agencies may be divided into six groups: prevention and inspection agencies, legal agencies; fire fighting agencies, professional and technical organizations, educational and promotional activities, and literature. Everyone in a community has access to these resources to advance a relentless battle against fire. The school shop instructor should take advantage of the service and literature made available by these organizations and agencies to integrate fire safety into curriculum planning.

# CHAPTER VI

## FIRE HAZARDS IN THE SCHOOL SHOP

A fire hazard is a condition that is conducive to fire, and in order to recognize the hazards in the school shop, there must be an understanding of the conditions that may cause fire. There are three factors or conditions that must be present before combustion will take place. These conditions are:

1. There must be a fuel or a combustible material present.
2. Oxygen must be present in sufficient quantity to support combustion.
3. Heat must be present of sufficient intensity and amount to vaporize and ignite the fuel.

When all three of these conditions are present and in the correct proportions, the results is the completion of the fire triangle which is necessary for combustion. By eliminating any one of these factors or conditions, the fire can be prevented. Air contains twenty-one per cent oxygen, which is sufficient to support combustion, and little can be done to control the oxygen supply. Therefore, the remaining two factors, heat and fuel, are the principle constituents to be controlled in fire prevention. The shop instructor must maintain constant vigilance to insure that combustible substances and heat necessary for chance ignition are never present at the same time in order to cause a fire.

Therefore, it is necessary for the shop teacher to be aware of the fire hazards that are related to the shop. In this chapter general and specific fire hazards will be discussed in their relations to the school shop.

## PART A

### General Hazards

The fire hazards that are common in all shops, but are not specifically related to any one shop, will be treated in this section. These hazards include the dangers of spontaneous ignition, electricity, flammable liquids and gases, improper housekeeping, and special hazards related to the use of gasoline.

Dangers of Spontaneous Ignition: Spontaneous heating usually starts with a slow chemical reaction or slow oxidation process. At the beginning, this process generates some heat which is dissipated as fast as it is formed. As the chemical oxidation takes place, gradually more heat is generated than is given off until the ignition temperature is reached. Special interest bulletin number 51 of the National Board of Fire Underwriters contains the following statement: (34, page 1.)

> There is little if any chemical reaction between most combustibles and the oxygen of the air at ordinary temperatures, but, when heated sufficiently, reaction begins and continues until the combustible reaches a temperature at which the reaction becomes self-sustaining. This temperature level is known as the "ignition point" or "ignition temperature".
>
> The source of heat may be a flame, spark,

> radiation, a hot surface, friction, or chemical action. When the primary source of heat is chemical action due to the combustible itself, or between the combustible and supporter of combustion, the process is known as "spontaneous heating", and if the ignition temperature is reached, as "spontaneous ignition".

The term "spontaneous combustion" is being replaced by "spontaneous ignition" because combustion refers rather to the act of burning after spontaneous ignition has occurred. Spontaneous ignition is feared as a fire cause since it usually occurs unnoticed and frequently when no one is present to detect it. Oily machine shop floors have been known to cause fires due to spontaneous ignition when new floors have been layed over the oily ones. Polishing cloths containing linseed oil and turpentine have caused fires as a result of spontaneous ignition. Sawdust in ice houses and cold storage plants has been known to ignite spontaneously when moist.

Materials that may foster spontaneous ignition are oil clothing, oil fabrics, oil rags, oil silk, oil treated scrap leather, and wood waste. Most wood wastes contain oil and are liable to heat in storage. Wet wood wastes are liable to spontaneous heating and possible ignition. Fires may begin in piles of iron and steel borings and turnings, also in aluminum, magnesium, zinc, and other combustible metals by spontaneous ignition. The most common causes of spontaneous ignition are rags containing vegetable oils, such as turpentine, linseed oil, and pine oil, which are found in the school shops. Rags containing oil waste and paint residue are often found in woodworking and finishing rooms.

Even clean cotton waste or wiping rags may be considered mildly hazardous because of its flammability when not baled. The instructor should handle clean waste in the same manner as dirty waste, although the fire hazard is relatively small. There is always the likelihood that dirty rags may become mixed with clean ones, and discarded rags and waste are the breeding places for fire due to spontaneous ignition. All used rags should be placed in safety cans. Safety cans are made of, not less than, 26-gauge galvanized iron, well riveted or double seamed and soldered, set up on legs or rims, and equipped with self-closing covers. These cans are made so that the inside diameter of the can is no less than ninety per cent of the height, legs are not included. The safety cans are made in 6, 8, 10, 14, and 25 gallon capacities and should be approved by Underwriters' Laboratories and Associated Factory Mutual Insurance Companies. The cans are sold by:

> Justrite Manufacturing Company
> 2063 North Southport Avenue, Dept. C-5,
> Chicago 14, Illinois
>
> The Protectoseal Company
> 1968 South Western Avenue,
> Chicago 8, Illinois

Safety waste cans should be used only for oily waste, rags, and all kinds of flammable materials which include oily papers. The teacher should give instructions as to the purpose of the safety waste cans and see to it that other materials are not stored in them. These waste cans should be emptied every day and the contents burned in an approved incinerator.

<u>Unsafe Practices in the Use of Electricity</u>: Fires are frequently classified as electrical in origin, but the major causes of electrical fires are probably due to improper maintenance of electrical wiring or equipment, the overloading of equipment or wiring, and the improper use of electrical equipment. Electrical equipment, when it is properly installed, used and maintained, presents virtually no fire hazard. Blake lists the following causes of fire as a result of an electric arc caused by: (7, page 330.)

> . . . a break in the insulation, partial grounding of a curcuit, poor contacts on switches, poor splices and connections, overheating of electrical equipment due to overloading, temporary wiring improperly insulated or improper fusing. A limited number of so-called "electrical fires" have resulted through the contact between incadescent lamps and flammable materials.

Other unsafe practices in the use of electricity are caused by the following conditions:

1. Defective, faulty or inferior wiring.
2. Inexperienced workmen failing to work to safety "codes".
3. The use of unsuitable materials for the wiring job.
4. The use of cheap or unapproved electrical cords and equipment.
5. The tampering with fuses, and the use of make-shift fuses such as pennies.
6. The failure to maintain electric equipment in good order.

These hazardous practices contribute greatly to electrical fires. Electrical fires are started by arcs, sparks, and overheating. It is of great importance that all electrical services and equipment be installed in accordance with standards of the National Electrical Code. Master switches should be installed and locked off each night. Care should be taken that temporary wiring is not allowed to become permanent wiring. Portable electrical equipment should be properly equipped, inspected, and maintained in accordance with accepted codes. Portable lamps constitute a fire hazard unless of a standard approved type. The fire hazard may result from a defective cord or lamp breakage in the presence of flammable vapors or gases.

Electrical Equipment for Hazardous Locations: An explosion, like fire, requires that the three components of the fire triangle exist simultaneously. Where electric motors, lights, or other equipment must be located in a hazardous area, the first step is to determine the nature of the hazard, whether it is due to the likely presence of explosive gases or vapors, or conducting or explosive dusts. The National Electrical Code delineates three classes of occupancies for which special precautions and equipment are required. Article 55 of this code lists the following three classes:

> Class I locations are those in which flammable vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. (37, page 186.)
>
> Class II locations are those which are hazardous because of the presence of combustible dust, or dust of an electrically conducting nature. (37, page 188.)
>
> Class III locations are those which are hazardous because of the presence of easily ignitable fibres or flyings, but in which such fibres or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitable mixtures. (37, page 189.)

Classes I and II are further divided into groups from A to G. Those pertaining to conditions in the school shop may be atmospheres containing acetylene, manufactured gas, gasoline, naptha, alcohols, acetone, lacquer solvent vapors, natural gas, and dust. Electrical equipment for operation in these atmospheres should be of the type approved for this specific condition by Underwriters' Laboratories or Factory Mutual Insurance Companies. Lists of approved equipment are published by the Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago 11, Illinois.

It is the duty of the shop instructor to see that all students are properly instructed in the safe use of electrical equipment. In case of an electrical fire, the pupils should be instructed in the special precautions to be exercised, such as cutting off electrical current, and extinguishing the fire with carbon dioxide, a non-conducting extinguishing agent.

Dangers from Use of Flammable Liquids: "Flammable liquids", as used in this section, shall mean and include all liquids which have a flash point below 200 degrees Fahrenheit as determined by the closed cup tester. According to Section 102 of the Fire Prevention Code of the National Board of Fire Underwriters, flammable liquids are classified as follows: (31, page 10.)

> Class I. Liquids having a flash point below 25 degrees F. closed cup tester. Examples, acetone, ether, gasoline, naptha, and benzol.
>
> Class II. Liquids having flash point above that

of Class I and below 70 degrees F. closed cup tester. Examples, alcohol, amy acetate, and toluol.

Class III. Liquids having a flash point above that for Class II and below 200 degrees F. closed cup tester. Examples, kerosene, stoddard solvent, fuel oil, and turpentine.

These liquids are dangerous because of their volatile nature, by means of which they give off vapors that are easily ignited. The Underwriters' Code recommends that no Class I or Class II liquids be kept or stored in places of assembly,

TABLE V

CHARACTERISTICS OF FLAMMABLE LIQUIDS USED IN THE SCHOOL SHOP

| Flammable Liquids | Vapor Density Air= 1 | Flash Point Deg. F. | Explosive Limits % in Air by Volume | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Acetone | 2.0 | 0 | 2.0 | 9.0 |
| Alcohol | | | | |
| (Amyl) | 3.0 | 100 | 1.1 | 4.0 |
| (Butyl) | 2.6 | 100 | 1.7 | 18.0 |
| (Ethyl) | 1.6 | 55 | 3.5 | 19.0 |
| Benzine | 3.0 | 75-84 | 1.4 | 5.9 |
| Benzol (Benzene) | 2.7 | 12 | 1.4 | 8.0 |
| Gasoline | 3.5 | -45 | 1.4 | 6.0 |
| Keresene | 4.5 | 100 | 1.1 | 6.0 |
| Lacquer | | 80 | | |
| Linseed Oil | | 432 | | |
| Naptha | | 100-110 | 1.1 | 6.0 |
| Turpentine | 4.7 | 95 | 0.8 | |

such as schools, churches, and other public buildings, with the exception of laboratories for experimental purposes.

The use of flammable liquids has become so common in and outside of the school shop that the potential hazards are often overlooked. One of the neglected facts is that flammable liquids vaporize continuously, and like water, the higher the temperature the faster the evaporation. Most of these vapors do have characteristic odors, but since the vapors are heavier than air, the odors may go undetected because the vapors may settle to the floor. Exhaust fans, if located too high, cannot carry off these heavy vapors. These vapor mixtures are easily ignited by heat sources that usually escape attention. The presence of hot metals, such as copper, electrical resistance elements, aluminum, and wrought iron may act as catalyses in the ignition of these vapors. Static electricity, which goes undetected, is even more dangerous and is often the cause of explosions or fires. Static electricity is generated by the separation of two non-conductors, a conductor and non-conductor of electricity, or by the flow of the liquids themselves, if they are non-conductors or poor conductors of electricity.

Storage of flammable liquids in the school shop should be limited to one or two gallons stored in safety cans. These safety cans are made of 24 and 26 gauge steel, which is double seamed and soldered, and are finished in red enamel. They are available in one pint, one quart, one half gallon, one gallon, two gallon, two and one half gallon, three, and five gallon sizes. The safety features of these cans prevent spillage when over turned or when dropped. If pressure is built up in the can, the lid will open until pressure is relieved. Safety screens may be installed in cans to prevent flash-back. Safety cans containing small amounts of flammable liquids may be stored in metal lockers or ventilated concrete vaults in the school shop. Larger amounts may be stored in an outside building. Flammable liquids should not be stored within ten feet of a stairway or exit unless separated by a fire resistive partition, or close to stoves, hot pipes, rays of the sun, or other sources of heat.

Dangers from Use of Flammable Gases: All gases used for heating will, with proper mixtures of air, burn rapidly and produce enormous destructive forces of the same nature as those of an explosion. All gas services and appliances should be installed according to accepted codes and regulations. Gas using appliances have the need for automatic features to prevent the free discharges of unburned gas, and vent piping, extending to the outside, to replace air consumed by the gas burner. The use of rubber hoses for gas connections should be avoided because the hose may ignite, pull out, or deteriorate, allowing gas to escape, which may become a hazard. Flexible tubing and rigid piping are preferable.

Natural gas does not have a distinctive odor, and, for this reason, it presents definite fire hazards. Gas may escape in large amounts and accumulate unnoticed. The New London, Texas, schoolhouse disaster, in which 294 deaths occurred, is a vivid example of the results of an explosion that escaping odorless gas may cause. This disaster influenced the passing of a law in Texas that all natural gas for domestic and industrial use be odorized.

Students should be instructed to report any detection of gas odor or suspected gas leakage to the shop teacher and not try to locate the escapage with a match or cigarette lighter. The instructor should:

1. Open windows for ventilation.
2. Turn off all gas safety valves.

after proper precautions, the student and instructor may then look for the gas leak by using soap suds.

Physical Arrangements for Fire Protection in the School Shop: Safety and fire protection must be an integral part of every phase of planning in the industrial arts shop. Physical arrangement will be treated here in the sense of arranging the school shop as to the most adequate protection against fire hazards, such as:

1. Adequate and proper provisions for exits for prompt emergency use is the major factor in life safety from building fires.
2. It is desirable to have two exits from every area within the shop.
3. Exits should never be obstructed by equipment or stored materials.
4. The floor plan of the shop areas should allow for unobstructed aisles leading to the exits.
5. The electrical circuits should be divided into two divisions, a light circuit and a power circuit. The loads on these circuits should be calculated and properly fused.
6. The master switch box should be readily accessible from all shop areas in case of an emergency.
7. Local heating units and open fires should be inspected frequently and located away from flammable

materials or mixtures.

8. Furnaces or heating elements should be placed on fireproof metal or asbestos bases.

9. Two valves should be installed for a gas furnace, one at the furnace itself and one at the main gas line.

10. Oil transformers and acetylene generators should be placed in separate fire resistive buildings.

11. The location of the finishing room is of importance because of the storage and use of flammable liquids in that area. The room should be located as far as possible from the main part of the building, preferably at the end of a wing.

12. Vent fans installed in the finishing room or area should exhaust to the outside.

13. Vapor-proof electrical circuits and lights must be provided in the finishing room.

For further fire protective measures, adequate fire extinguishment equipment must be available for immediate use in all shop units. The maximum distance to secure an extinguisher should not exceed fifty feet.

Improper Housekeeping as a Cause of Fires: Poor housekeeping accounts for many fires. Clean premises seldom burn. The expression "good housekeeping" is used to denote the care and cleanliness about the industrial arts shop. To establish good housekeeping procedure, it is suggested that the following check list be applied frequently to each shop.

1. Are there any accumulations of dirt or rubbish in the shop?

2. Is there any oily waste or other greasy material outside of approved waste cans?

3. Are there any waste cans not emptied daily after closing hours?

4. Are there any broken windows, plastering, partitions, flooring, or other similar defects?

5. Are any aisles obstructed?

6. Are any entrances obstructed?

7. Are any fire escapes obstructed, broken or out of order?

8. Are all water pails, hoses, nozzles, and chemical extinguishers in place and in good condition?

9. Are any sprinklers obstructed by partitions, piles of materials, etc.?

10. Are any sprinklers or sprinkler pipes exposed to freezing?

11. Are windows free from heavy screens, bars or obstructions?

12. If oil or gas fuel is used, is a remote-control valve provided?

13. Are approved metal containers used for all oily waste, polishing or cleaning materials?

14. Are restricted places maintained for smoking--no matter who is smoking?

15. Is there more than one exit from all rooms in the main building?

16. Are the storerooms kept free of rubbish, old rags, and waste paper?

17. Are oil mops or paint rags kept in closed metal containers to guard against spontaneous ignition?

18. Are safety matches used in the shop?

19. Are fires started with paper or kindling, never with flammable liquids?

20. Are all stovepipes, chimneys, and hoods cleaned and repaired annually?

21. Are all lockers clean and in good repair?

22. Can heating irons be set upon combustible material?

23. Do any motors need to be cleaned inside or outside?

24. Was the inspection complete, covering all parts of the premises, including looking under benches, into closets, behind radiators, etc.?

<u>Special Hazards Involved in the Use of Gasoline</u>: When gasoline is properly mixed with air, its explosive power can be compared with that of dynamite. G. M. Kintz of the Bureau of Mines explains in the information circular number 7150 that: (28, page 9-10.)

> . . . When a gallon of gasoline is used in a certain manner as in a combustion engine it is said to contain the energy equivalent of 15 to 50 or 85 to 95 pounds (depending on which authority is accepted) of 40 per cent straight nitroglycerin dynamite, that is, 30 to 200 sticks of dynamite.
>
> In many homes, garages, shops, and other places gasoline is stored in glass or other unapproved containers, yet the person responsible for keeping the gasoline in such a container or location would not think of leaving even one stick of dynamite in the same place, even though a gallon of gasoline contains one to two hundred times as much energy which, when vaporized, can be released nearly as easily as the energy in the dynamite.

Gasoline is treacherous in that it may be used many times without accident where conditions are not right for an explosion. Gasoline vapors are three and one half times heavier than air and may travel along the floor to another area for a considerable distance to a source of ignition and the flame flash back to the source of the gasoline. The explosive limits of gasoline in air are from 1.4 per cent to 6 per cent by volume. The flash point of gasoline is negative 45 degrees F., and, for this reason, the gasoline vapors may be ignited at any temperature found in the school shop. Gasoline is a non-conductor of electricity, and when it passes through a rubber hose, static electricity is produced. Therefore, gasoline hoses and cans should be grounded when pouring. It should never be stored in buildings except in small amounts in safety cans. Gasoline should never, without exception, be used as a cleaning agent.

It is the duty of the instructor to enlighten the students as to the dangers in the use and storage of gasoline and the proper technique in the fire extinguishment of Class B fires.

## PART B

## Special Hazards Related to Particular Shops

This section is devoted to the special hazards related to particular industrial arts shops, which include automobile mechanics, finishing rooms, foundries, general shops, machine shops, woodworking, printing, and welding. Special fire hazards may be due to the physical arrangements of the shop, the equipment being used, or to the nature of the work being done.

Automobile Mechanics: The major fire hazard in the automobile mechanics shop is the use of gasoline. Gasoline is manufactured for use in internal combustion engines and should not be used to clean automobile parts, tools, dirty clothing, or hands and arms. Safety solvents should be used for cleaning oil and grease from parts and tools. When pouring gasoline, see that containers are kept in contact to help prevent formation of static electricity. If gasoline is spilled, it should be wiped up and the soaked rags placed in safety waste cans. No excess gasoline should be stored in the automobile shop. All flammable liquids should be stored in safety cans and labeled properly.

Care should be taken not to spill gasoline on hot motors. Motors with leaking fuel pumps, lines, or carburetors should never be run. If an engine "backfires" and causes a carburetor fire, open the throttle and allow engine to run fast until the fire is extinguished. No motor should be primed without an instructor or student standing by with a foam or carbon dioxide fire extinguisher. Extinguishers should always be placed where handy.

Other causes of fire in the automobile mechanics shop are:

1. Oil.
2. Oily rags or waste.
3. Unclean floors.
4. Dirty rags or clothing stored in lockers.
5. Smoking and careless use of matches.

Additional safety measures include:

1. Disconnect batteries while motor is being repaired.
2. Never spark-test a battery.
3. Keep live wires away from carburetors and gas lines.
4. Never use improper tools where they may slip and cause sparks.
5. Should clothing become wet with gasoline, the clothing should be removed immediately and dry clothing put on.

Finishing Rooms: Sources of ignition which cause fires in finishing rooms include: smoking, static electricity, sparks from metal contacts with the floor or other materials, unprotected lamps, non-rigid conduit, and the absence of explosion-proof equipment. Charles C. Dominge in the book, Fire Insurance Inspection and Underwriting, relates that: (16, page 1006.)

> . . . Fires in spray booths, regardless of the finishing material employed, as a general rule, result from four principle causes: first, fans and motors used for venting the booths; second, broken electric lamps and other electrical defects; third, cleaning interior of booths, fans and motors with highly flammable solvents; fourth, accumulations of deposits or residues in the tubes and vent pipes, resulting from neglecting to clean them frequently, and from poor design.
>
> Spontaneous ignition of residue in the booth or ventilating duct, especially where quick-drying oils are used, is a frequent cause of fire. The quick-drying oil or thinner causes oxidation and the resultant heat ignites the lacquer. Scraping the metal sides of booths with a metal scraper may cause sparks which will ignite the residue.

Spraying should be done in closed, fireproof construction booths with good ventilation to the outer air because the vapors may hang in the air like dust particles and will explode when mixed with air in the proper proportions. No open lights should be within twenty-five feet of the spraying operation. There should not be over a few hours supply of volatiles kept in the finishing area. Storage of paints, lacquers, and other materials should be in other areas outside of the finishing room. All finishing materials should be removed from the finishing room at the end of each day of work. These materials should be stored in a room outside the main building.

<u>Foundries</u>: One cause of fire in the foundry may be traceable to the core ovens. In heating the cores, heavy smoke is driven off which causes a heavy black sticky deposit to form in the vent pipe or stack. This may lead to the clogging of the vent or stack which, in turn, will cause overheating that may ignite woodwork nearby. Wooden flasks frequently become charred from molten metal, and fires may occur in storing these flasks against wooden partitions where a hidden spark may break out in a fire. Floors made of combustible material often cause fires in foundries. Extreme care must be exercised to avoid spillage of molten metal. Wood, rag waste, or flammable liquids, when in proximity of furnaces, are fire hazards. Wood surfaces should not be subject to continued temperatures greater than ninety degrees F. because the drying and charring of the wood may eventually lead to ignition.

Fire safety measures to be observed in the foundry area are:

1. Never leave gas flames burning or unlit gas turned on.
2. Clean out all stacks and vents periodically.
3. Always stand clear when plunging hot iron into tempering oil in case of a possible flare-up of oil.
4. Never light a gas furnace or torch when anyone is standing near the source of the flame.
5. Never lay down a burning gas torch. Turn it off immediately.
6. Avoid pouring molten metal in moist containers as an explosion may result.

<u>General Shops</u>: The fire hazards in the general shop are the composite hazards of all the areas represented. The general hazards treated in Part A are especially appliable to the general shop. Hazards may also be caused by the arrangement of the general shop. Other hazards in the general shop include:

1. All areas where heating equipment is used should be segregated from other areas. This area should have a concrete floor.

2. Welding areas present specific hazards.

3. Blow torches in which gasoline is used as a fuel should be dispensed with since other equipment can be adapted.

4. Care should be taken in the use of soldering coppers in the general shop. Never place the coppers on flammable materials when hot.

5. The soldering area should be covered with asbestos sheeting.

6. Only safety matches should be used in any shop and these should be stored in metal containers.

7. Always pour acids into water, not water water into acids, as there may be a possible explosion.

8. High heat gas-fired units should be attended at all times when in use.

9. Equipment should be well maintained. Hot bearings, overloaded motors, or arcing switches should be prevented or repaired.

<u>Machine Shop</u>: Metal chips and turnings are readily ignited and any large accumulation would present special fire hazards. These metal chips and turnings should always be kept at a minimum and the accumulations placed in covered metal containers or removed immediately to a remote outside storage place. All general fire safety measures are

appliable in the machine shop.

Printing: Hazards in the print shop are ink mixing, benezine used for cleaning presses, oily rags, oily waste, waste paper, oily floors, and overheated lead pots. The ink should be stored in covered metal cans and kept in lockers. Any spillage should be immediately wiped up and the rags placed in standard safety cans. All printed waste paper, sweepings, and rubbish should be disposed of in metal covered cans. Standard precautions for the use of flammable liquids should be followed in using benezine or other cleaning solvents.

Woodworking: The woodworking shop is subject to dust explosions, overheated glue pots, ignition of wood shavings or waste, and fires caused by storing lumber too close to heating elements or pipes. The waste of large woodworking machines should be exhaused from the shop to an outside hopper. The glue pot should be connected with a safety light to indicate when it is turned on. Wood waste should be stored in closed metal containers. Lumber should never be stored near any source of heat.

Welding: Student operators of cutting and welding torches do not always appreciate the serious fire hazard of the globules of molten metal which result from their use. These bits of hot metal may travel twenty-five feet or more, and some of them hold heat for a considerable time. The globules of molten metal will readily ignite any light combustible materials with which they come in contact. Of fires reported to the Factory Mutual Insurance Companies involving cutting and welding operations, ninety per cent were caused by sparks and only ten per cent from the heat of the torches or from failure or abuse of the equipment. Fires may start from molten metal droplets that cannot be seen through the welders goggles. These sparks often drop unnoticed through cracks, pipe holes, or other small openings in the floors or partitions, starting fires out of sight of the operators or students stationed to watch for them. The sparks can set fire to all kinds of combustible materials, such as: oily waste, burlap wrappings on stored goods, tarpaulins, paint residue, rags, waste paper, excelsior, and wood refuse. In some instances, sparks have fallen into containers of flammable liquids, and this results in quick and dangerous fires or explosions.

In shop areas equipped with permanent welding apparatus, steps can be taken to prevent the danger of sparks by locating the work in a fire resistive building or in areas properly separated from other operations. No combustible material should be within thirty to forty feet of the welding equipment unless properly shielded. The greatest danger of welding fires exist when portable equipment is used. Before the equipment can be moved, written consent of the instructor should be obtained by the student. The area the equipment is moved into must be inspected and approved by the instructor. The National Fire Prevention Association

Handbook gives rules for the prevention of fires due to welding and cutting operations. (38, page 346.)

1. Do not perform cutting or welding work where an open flame would be dangerous, as in or near rooms containing flammable vapors or liquids, or exposed loose combustible material.

2. Be sure that cutting and welding equipment is not used where there is any possibility of flammable vapors, sparks or molten metal passing through broken or open windows, open doorways, cracks or holes in walls or floors.

3. If the work can be moved, it is perferable to take it to a safe place for cutting and welding rather than to perform the work in a hazardous location.

4. Where welding or cutting must be done in the vicinity of combustible material, special precautions should be taken to make certain that sparks or hot slag do not reach combustible material and thus start a fire. If the work cannot be moved, exposed combustible material should, if possible, be moved a safe distance away. Sweep floors clean and, if they are not of fire-resisting material, wet them down before starting work. Wooden floors should perferably be covered with metal or other suitable non-combustible material where sparks or hot metal are likely to fall. Station a guard near any opening to warn passerby who might otherwise be burned by sparks or slag. Use sheet metal guards or asbestos curtains where needed. Make sure that the guards and curtains are adequate. Because hot slag may roll along the floor for considerable distances, it is important when using asbestos blankets as a curtain that no opening exists where the curtain meets the floor.

5. When it is necessary to do welding or cutting close to wooden construction or in locations where combustible materials cannot be removed or protected, small water hose, chemical extinguishers, or pails of water should be readily available. A helper should be stationed to guard against sparks.

6. Whenever combustible material has been exposed to molten metal or hot slag from cutting operations, a man should be kept at the place of the work for at least a half hour after completion to make sure that smoldering fires have not been started.

Welding and cutting operations are inherent fire hazards, and extra precautions justify additional time and work involved to help prevent these hazards.

It is of great importance to keep oxygen away from oil and grease. The impinging of high pressure oxygen, even on a thin film of oil or grease, may cause rapid and violent combustion. There is no need to oil any part of oxy-acetylene welding or cutting apparatus, and if equipment does not work properly, it should be sent back to the manufacturer or the representative.

Cylinders must bear stamped markings of inspection and approval by the Interstate Commerce Commission. The cylinders must be retested at least every five years. Retests are not required for acetylene cylinders. Oxygen and acetylene cylinders should be stored separately, and the protective cap covering the valve should be in place except when the cylinders are being used. No cylinder should be dropped, knocked over, or exposed to heat or flame. If a cylinder is leaking, it should be moved to the outdoors where the gas can escape in safety. Hose and line pressure should always be kept at not more than fifteen pounds per square inch in acetylene lines. All cylinders should be fastened to a stationary object to prevent falling.

In electric welding the same precautions may be followed as those in gas welding. In addition to these, care should be taken to shield the arc from other persons who may be near, and the insulation should be checked to see that it is in good condition to avoid short circuiting.

Welding operations should be restricted to well ventilated areas and as far as possible from combustible materials and paint spraying operations. Safety precautions should be observed at all times in welding shops because of the constant danger of flammable liquids or gases in the presence of the welding flame. No welding or cutting operations should be permitted on tanks containing flammable liquids or gases.

Protective clothing plays an important part in all welding operations. Students in welding should wear leather or asbestos gloves and should be furnished with a standard welding face shield or helmet. Goggles must be worn while welding, not only to protect the eyes from intense light, but also to protect them from flying sparks and drops of molten metal which may be discharged from the pieces that are being welded. In arc welding it is also necessary to protect the skin from harmful rays as well as the eyes. Students observing welding operations should also wear protective goggles. Aprons made of asbestos or chrome tanned leather may be worn for protection against heat and molten metal. Leggings may be used to prevent hot sparks from falling into the shoe tops or on the pants legs. The collar should be worn closed at the neck. All clothing should be worn so that no sparks will be trapped in folds of the clothing.

Numerous fire hazards can be eliminated by using equipment and materials approved by Underwriters' Laboratories, Inc. and Factory Mutual Fire Insurance Companies and by following the National Fire Protection Association's Codes. However, there are still shop activities that are inherent fire hazards and need the instructor's constant vigilance. In addition to these inherent fire hazards, the human element takes its toll each year in loss of life and property. Along with the study of fire prevention, there should be integrated the instruction of fire extinguishment measures.

# CHAPTER VII

## FIRE SAFETY AND EXTINGUISHMENT IN THE SCHOOL SHOP

Fires can be extinguished successfully by controlling or taking away any one of the three elements, fuel, heat, or oxygen from the fire triangle. Occasionally the fuel supply can be removed or the heat of the fire can be removed by quenching, and the oxygen excluded from the atmosphere by blanketing with certain substances. The following paragraphs will deal with the three classifications of fires and the equipment and substances that make it possible to extinguish the fires. Fire drills and first aid for burns will also be discussed in this chapter.

Classification of Fires: For practical purposes fires have been divided into three general classifications. The Manual of Fire-Loss Prevention of the Federal Fire Council lists these classes as: (18, page 59.)

1. Class A fires--Fires in ligneous or cellulosic materials like wood, paper, textiles, and animal and vegetable fibers generally, some in this class, as well as those in solid carbonaceous materials such as coal, coke, starch, sugar, cereals, and in bitumen, asphalts, and waxes that do not melt readily under heat. Fires in materials containing nitrocellulose, such as photographic, X-ray, and motion-picture film and pyroxylin products generally, can be placed in this class.

2. Class B fires--Class B fires are those occurring in mineral, vegetable, and animal oils. Petroleum oils in the form of crude oil, gasoline, kerosene, fuel oil, transformer oil, lubricating oil and grease

and coal-tar oils such as benzol constitute the bulk of mineral-oil products. Among vegetable oils are the alcohols, acetone, turpentine, linseed oil, coconut oil, palm oil, olive oil, cottonseed oil, tung oil, and soybean oil. Some of them are contained in paints, varnishes, and lacquers. Animal oils include lard oil, oleo oil, red oil, menhaden oil, and whale oil.

3. Class C fires--Class C fires are fires in electrical equipment for which the extinguishing medium should be a non-conductor of electricity if applied before the equipment is disconnected from the source of energy supply. Fires in insulation of motors, generators, transformers, switchboards, and electrical wiring generally, are included in this class. Fires in the oil of oil-cooled electrical equipment should be regarded as class C fires while the equipment is energized, but after it is disconnected they can be regarded as class B fires.

Class "A" fires require the "quenching and cooling" effects of quantities of water or solutions containing a large percentage of water. Class "B" fires require a "smothering or blanketing" effect, and Class "C" fires require the use of "non-conducting" agents.

First-Aid Fire Extinguishing Equipment: First-aid fire extinguishers are appliances which contain only a limited supply of fire extinguishing medium and are readily portable. These are called "first-aid" equipment because of their limited capacity and are effective on fires only in the incipient state. The effective use of the equipment depends upon the early discovery of the fire before it has spread to a size beyond the capacity of the extinguishing limits immediately available. Most schools and school shops will have only first-aid fire fighting equipment available. An understanding of the characteristics and uses of this equipment are of vital necessity to both the instructor and students.

The first-aid fire equipment should bear the Underwriters' Laboratories label. On the approval notice can be read classification A-1, B-1, or classification B-2, C-2, or something similar. The letters A, B, or C on the extinguishers indicate the type of fire for which they may be used. The number following A, B, or C indicates the number of this type of extinguisher necessary to extinguish a standard type fire in each class, as specified by the National Board of Fire Underwriters under test conditions.

Fire Extinguisher Information: Heisler, in Forcible Entry and Minor Extinguishment Practices Unit I, supplies a table to aid in comparing the efficiency of first-aid extinguishers and to further assure their proper use. This table is reproduced as Table VI in this problem. (25, page 29.)

1. Carbon Tetrachloride Extinguisher: Carbon tetrachloride is a liquid that vaporizes into a gas by the heat of a fire. This vapor is heavier than air and smothers the fire by cutting off the oxygen supply. It is generally less damaging to equipment and materials than foam or water. Rooms should be well ventilated after its use since the gas is irritating and toxic. Caution should be taken when it is used in closed areas. Aim the stream at the base of the blaze. On a spill-fire work from the windward side and progress slowly down the fire. On a small tub fire have the

TABLE VI

INFORMATION ON FIRE EXTINGUISHERS

| | CARBON TET. | SODA-ACID | FOAM | $CO_2$ | PUMP CAN | DRY POWDER | LOADED STREAM |
|---|---|---|---|---|---|---|---|
| MOST COMMON USE (Size) | 1 qt. | 2½ gal. | 2½ gal. | 15 lbs. | 5 gal. | 20 lbs. powder | 2½ gal. |
| OPERATION | pump air pressure | invert break bottle turn over | invert | open valve | pump air pressure | opening trigger valve | invert break bottle |
| MAINTENANCE | inspect for leakage | recharge annually | recharge annually | inspect for leakage by weighing | keep full | recharge after use | recharge annually |
| CONDUCTOR OF ELECTRICITY | No | Yes | Yes | No | Yes | No | Yes |
| RANGE | 20 ft. | 30 ft. | 30 ft. | 8 ft. | 30 ft. | 8-14 ft. | 30 ft. |
| TIME TO EMPTY | rate of pumping | 1 to 1½ min. | 1 to 1½ min. | 1 to 2 min. | rate of pumping | ½ min. | 1 min. |

TABLE VI (Cont.)

INFORMATION ON FIRE EXTINGUISHERS

| | CARBON TET. | SODA-ACID | FOAM | $CO_2$ | PUMP CAN | DRY POWDER | LOADED STREAM |
|---|---|---|---|---|---|---|---|
| CHEMICALS USED | Carbon tet. and anti-freeze lubricants | Sodium bi-carbonate, 1½ lbs., Sulphuric acid, 4 oz. | Aluminum sulphate, sodium bi-carbonate stabilizer | Liquid $CO_2$ | Water | Treated bicarbo-nate of soda | Alkali-metal salt |
| NEED OF FREEZING PROTECTION | No | Yes | Yes | No | Yes | No | No |
| EXTINGUISH-ING EFFECT | Smothering by gas | Cooling by quenching | Blanketing | Smother-ing by gas, cool-ing | Cooling by quench-ing | Smother-ing and excluding air by $CO_2$ | Cooling by quench-ing |
| EFFECT ON CLASS A FIRES | Poor | Excellent | Fair | Poor | Excel-lent | Poor | Excel-lent |
| EFFECT ON CLASS B FIRES | Fair | Poor | Excellent | Good | Poor | Good | Fair |
| EFFECT ON CLASS C FIRES | Good | Poor | Poor | Excel-lent | Poor | Excellent | Poor |

stream hitting the wall of the container slightly above the surface of the liquid. The "banking off" aids in breaking up the stream and accelerates the vaporization. Walk around the tub while applying the stream to insure maximum coverage.

2. Soda Acid Extinguisher: In the use of the soda acid extinguishers a solution of sodium bicarbonate is employed and is mixed with sulphuric acid. This mixture results in the formation of sodium sulphate, water, and carbon dioxide gas, in such proportions that presumably an acid-free discharge is given off. The gas formed by the chemical reaction in the closed container serves to expel the liquid solution under pressure. Damage from staining materials is somewhat greater than that for water. Do not invert extinguisher until ready to fight the fire. Play the stream at the base of the blaze and keep the wind at your back. Scatter embers when fire is out to prevent rekindling.

3. Foam Extinguisher: Foam for fire extinguishing consists of a mixture of solutions of aluminum sulphate and sodium bicarbonate to which a foam stabilizing agent has been added. The foam consists mainly of tough bubbles containing carbon dioxide. Foam should be applied gently at a point slightly over the surface of the oil and in a large enough quanity to form a blanket over the whole surface. Foam extinguishes oil fires partly by cooling from the water contained, but more important is the cutting off of the oil surface from the air, flames, and radiant heat. This will inhibit or retard oil vapor formation that is necessary for

fire continuance.

4. Carbon Dioxide Extinguisher: At normal temperatures and pressures carbon dioxide is a colorless, odorless, inert gas, and it extinguishes fires by smothering. It is non-damaging to most materials, leaves no residue, and is non-corrosive. When used in fire extinguishers, it is stored in steel cylinders in the liquid form at room temperatures at pressures up to 1,050 pounds per square inch. When it emerges from the special valve, it expands to about 425 times its stored volume. The discharge is carbon dioxide gas and snow at -110 degrees F. The gas smothers the fire while the snow aids in cooling. In operating, care should be taken to hold the nozzle by the insulated handle to prevent hand injuries. Remove lock pin, aim spray at the base of the fire, and pull the trigger.

5. Pump Can Extinguisher: The pump can is a portable water gun extinguisher. It can be refilled, while in operation, by a bucket brigade. It is equipped with a double action hand pump and is capable of discharging a continuous stream of water from the nozzle for thirty to forty feet.

6. Dry-Powder Extinguisher: Dry-powder extinguishers contain a mixture of baking soda and other ingredients that prevent its absorbing moisture. The powder is sprayed as a dust from the container by a jet or non-flammable gas. Two effects are produced, first, the dust excludes air from the fire, and second, soda coming in contact with heat separates to form carbon dioxide and other elements. The carbon

dioxide helps to smother the fire. The extinguisher is available in several sizes and is recommended for oil and gasoline fires, as well as for general purposes. It must be sprayed over the entire surface as it does not spread like foam.

7. Loaded Stream Extinguisher: This loaded stream extinguisher is similar in principle to the plain water extinguisher. The anti-freeze solution used is a special solution of alkali metal salts. Pressure to expel the contents is produced either by a carbon dioxide cartridge or by a chemical reaction. The extinguishing agent has an effect on fires unlike any other agent. There is no smothering vapor produced, but there is a chemical action tending to inhibit oxidation. Carry the unit to the blaze before inverting, and aim the stream at the base of the blaze.

8. Sprinkler Systems: Automatic sprinkler systems rate high in their effectiveness to prevent fire loss if properly installed and maintained. Types of automatic-sprinkler equipment using water include: wet pipe, dry-pipe, thermostatically operated systems with either closed or open heads, and open systems for protection against exterior exposure. There are also foam and fixed carbon dioxide fire extinguishing systems used in building and storage areas. If there is a system of sprinklers in the school shop, the instructor should inspect it occasionally to see that there are no leaks or corrosion. If any sprinklers are found out of order, it should be reported to maintenance. In planning a school shop it would be wise to include a fire sprinkler system. The

dividends are likely to be well worth the investment.

9. Fire Extinguisher Demonstrations: Demonstrations of various fire extinguishers may be planned and performed by the instructor, allowing for practices by the students. These demonstrations could be planned so that the extinguishers are used before the annual inspection and recharging process occurs. In the organization of these demonstrations the assistance of the local fire department may be obtained. There are films and posters obtainable that can be correlated with these demonstrations.

Appropriate extinguishers should be placed within each school shop for use of fires that may occur in that particular shop area. The extinguishers should be mounted on heavy boards labeled with the proper classification and instructions for using each extinguisher.

First Aid for Burns and Scalds: Every shop instructor should have a knowledge of first aid in order to treat accident patients until the services of a doctor are obtained. The instructor has the responsibility of ordering and maintaining first-aid supplies for the school shops; therefore, it is essential that the teacher keep abreast of the new developments in first-aid treatments. From the fire protection standpoint, treatment for burns and scalds will be discussed. The *Manual of First-Aid Instruction* distributed by the Bureau of Mines contains the following information: (9, page 135.)

The emergency or first-aid care of burns or scalds has for its objects the exclusion of air from the burned or scalded area, the relief of pain, and the prevention of infection.

Remove all clothing from the injured area, but any that adheres to the skin should be cut around and left in place. Keep the patient covered, except the injured part, as there is a tendency to chilling. As soon as the burned or scalded area has been explosed, it should be covered by a protective dressing and a loosely applied cover bandage. Modern medical treatment for burns and scalds employs water-soluble drugs, and the use of grease or oils in their first-aid care makes necessary the cleansing of the burned or scalded surfaces with a solvent before medical treatment can be started. This delays the medical treatment and is very painful. Therefore, first-aid dressings for burns or scalds should be free from grease or oil.

Picric-acid gauze is a popular burn dressing. It does not deteriorate and is easily applied. Adhesive compresses for small burns are now available employing picric-acid gauze. Tannic acid is also often used, but it rapidly looses its effectiveness by oxidizing in air. Gauze may be soaked in the solution or it may be sprayed over the area.

Burns and scalds are subject to infection, the same as open wounds, and precautions should be exercised in dressing. Never allow burned surfaces to come in contact with each other. Burn patients can be transported short distances without bandages. If bandages are applied, cover loosely as swelling often occurs. Permit patient to have all the water possible but given in moderate amounts frequently.

Chemical burns should be washed thoroughly with clean water to dilute the chemical and then dressed as for a burn. If chemical substances get into the eyes, wash the eyes freely with cold water while the patient is lying down. Hold up the eyelid and pour the water from a container into the inner corner of the eye and make sure it flows across the eye. After it is washed thoroughly, apply dressing and send patient to the hospital or to his doctor.

Fire Blanket: In all shops which have open flame, soldering equipment, furnaces, or welding equipment, there is the danger of clothing catching on fire. The recommended procedure for extinguishing a clothing fire is to use a wool blanket to smother the flames. This is done by quickly spreading the blanket on the floor and rolling up in it, pulling it tightly about the shoulders to keep the flames away from the face. The blanket should be stored in a metal container and placed near open-flame exposures. The teacher should demonstrate the use of the fire blanket. In these demonstrations the following points should be emphasized.

1. Do not run. Running fans the blaze and causes it to burn more rapidly.
2. Keep flames away from the face and drop to the floor.
3. If possible, wrap up in the blanket starting at the neck.
4. Do not attempt to put the fire out with water.
5. Never use a fire extinguisher to put out a clothing fire.

Safety Measures In Case of Fire: During the orientation of the industrial arts class, fire dismissal procedures should be outlined and then practiced at frequent intervals during the school term. In planning for fire dismissal, jobs should be delegated to the students by the instructor or shop foreman, such as, closing all windows, cutting off all electrical and gas equipment, and closing doors not in use. The following procedures are recommended by Silvius and Baysinger in their book, Safe Work Practices in the Woodworking Shop. (51, page 13.)

1. Stop work immediately when you hear the signal for fire dismissal and walk to the nearest exit. Do not try to get your outer garments or personal belongings. Leave your tools where they are.

2. Form into lines as you walk out.

3. Follow directions for leaving the building.

4. Do not talk or crowd in line.

5. As you leave the building, continue in line until you have cleared the exit for other people who may be following.

6. Do not re-enter the building for any reason until the proper signal has been given.

Should the fire occur in the industrial arts shop, the instructor should immediately notify the main office of the fire and inform the students to prepare for fire dismissal. While the fire is in the incipient state, the instructor may, at his own discretion, undertake the extinguishment of the blaze. No attempt should be made by the students to extinguish any fire without the instructor being present.

All fires, with the exception of dust and flammable vapors, start in a small way. Prompt discovery and extinguishment with the proper first-aid fire extinguishment equipment is the most desirous control control to be strived for in fire fighting. In dealing with fire extinguishment, however, the primary consideration is the protection of life, and secondary is that of the protection of property.

# CHAPTER VIII

## CONCLUSIONS AND RECOMMENDATIONS

It has been proposed in this study that fire safety should be emphasized as an objective in industrial arts to better prepare the child of today for his future in the industrial world of tomorrow. The instructor should prepare to meet the need by becoming familiar with and taking advantage of the material made available by the national fire protection associations.

Conclusions of the Study: In this study fire has been treated both as a friend and an enemy of man. As a friend of man, fire has been instrumental in progress from the primitive to the modern civilization. As an enemy and uncontrolled, fire has caused a tremendous loss of lives and property, and associational organizations were established to make investigations and take steps towards fire prevention and extinguishment.

In order to instill proper attitudes and habits in the individual, it is necessary to begin with the education of the child; hence, the school program plays an important role. The causes and prevention of hazards in the school shop are related in conjunction with proper first-aid fire extinguishment, which is an indispensable part of the school program. It is the industrial arts instructor's responsibility to correlate fire extinguishment with the shop program in such a way that through these experiences students may obtain proper attitudes toward fire protection and fire safety. These attitudes which are formulated may then be applied and practiced in home and industry.

A Proposed Plan for a Fire Safety Program in the School Shop: The instructor should realize that there is no place in the school system that a definite safety program can be organized more effectively then in the school shop. An adequate safety program should always include fire prevention and extinguishment measures. The safety program should make the shop a safe place in which to work and attitudes should be developed which will reach beyond the shop into all activities of life. Fire protection should not be emphasized only during Fire Prevention Week but should be integrated into industrial arts curriculum planning throughout the school year. The following plan may be used in integrating fire safety into the shop program.

1. Physical equipment for fire safety.

    a. Fire extinguishers should be located on wall boards listing the type of extinguisher and the class of fire on which it is to be used.

    b. Location of appropriate extinguishers should not be over fifty feet from any work station in the shop.

    c. Approved safety cans should be used in the shop for the storage of flammable liquids.

    d. Approved safety containers should be used for disposal of oily waste and rubbish.

    e. Safety blankets should be stored in metal cans placed near open-flame exposures.

f. Numerous fire hazards can be eliminated by using equipment and materials approved by Underwriters' Laboratories and Factory Mutual Insurance Company, and by following the National Fire Protection's Codes.

2. Extinguisher Study and Demonstrations.

   a. Explain the scientific principles of the various types of fire extinguishers, such as pump can, soda acid, carbon tetrachloride, foam, carbon dioxide, dry-powder, and loaded stream extinguishers.

   b. Explain the classifications of fires and the extinguishers appropriate for each.

   c. Pupil-teacher planned actual demonstrations.

   d. Firemen may be invited to supervise fire extinguishment demonstrations.

   e. Plan for a "Parents' Night" for fire extinguisher exhibitions and demonstrations, and fire prevention activities.

3. Fire safety habits and attitudes should be integrated into shop activities.

   a. "Good housekeeping" practices.

   b. Use of safety clothing and equipment.

   c. Use of safety matches.

   d. "No smoking" regulations.

   e. Formulate fire safety check lists and routine inspections.

4. Make students aware of gasoline hazards.

   a. Review statistics on loss of life from improper use of gasoline.

   b. Stress that gasoline <u>should not</u> be used in the shop for any purpose <u>except for</u> use in internal combustion engines.

   c. If gasoline is needed, only store small amount in an approved safety container.

5. Fire safety may be incorporated in individual industrial arts projects.

a. Ash trays, designed to make cigarettes fall inside the tray.

b. Candle stick holders, balanced to prevent tipping.

c. Candle snuffer, designed to extinguish candles in a safe way.

d. Christmas tree stands, sturdily built with receptacle provided to hold water to prevent tree from drying out.

e. Lamps, wired properly to avoid fire hazards.

f. Metal match holder, to hold household matches with a compartment to receive burnt matches.

g. Smoking stands, balanced and weighted to prevent tipping.

h. Waste baskets, made of metal to confine a possible fire.

6. Fire safety may be incorporated in group or class projects.

   a. Plan for fire safety shop displays.

   b. Prepare mounting boards for fire extinguishers.

   c. Apply standard "color codes" in the shop.

7. Include a safety engineer and fire marshal in the student organization of the industrial arts class. Duties of the fire marshal will include:

   a. Assist instructor in selecting and acquiring available fire protection literature.

   b. In charge of routine shop fire inspections.

   c. Assistant to instructor in fire safety demonstrations.

   d. Act as coordinator between shop and school fire safety activities.

   e. In charge of program for "Parents' Night" demonstrations.

8. Plan field trips when possible.

   a. Visit local fire department.

b. Visit industrial plants with unique fire safety programs.

c. Visit manufacturing plants producing fire safety equipment.

9. Schedule a fire protection film for each semester. Fire prevention films that may be obtained free from the National Board of Fire Underwriters' Film Library, Bureau of Communication Research, Inc., 13 East 37th Street, New York 17, New York, by paying the return postage are:

   a. "Approved by the Underwriters"

   b. "Chemistry of Fire"

   c. "Crimes of Carelessness"

   d. "Fire Fighting for Householders"

   e. "Fire Prevention in the Home"

   f. "Men of Fire"

   g. "More Dangerous Than Dynamite"

   h. "Sixty Seconds to Safety"

   i. "Smoke Eaters"

   j. "Stop Fires--Save Jobs"

   k. "Tony Learns About Fire"

   l. "The Torch"

   m. "We Make a Fire"

   ( A short summary of each of these films may be found in Appendix B.)

   A catalog published by the National Fire Protection Association includes films that may be obtained from over twenty sources.

10. Display fire safety posters on separate poster boards.

   a. Fire posters may be obtained from the National Board of Fire Underwriters.

   b. Poster catalogs are available from the National Safety Council, and the cost of the posters is five cents each.

11. Devote a section of the shop library to available fire safety publications which may be obtained from the following sources.

    a. National Board of Fire Underwriters
       85 John Street, New York 7, New York

    b. National Fire Protection Association
       60 Batterymarch Street, Boston 10, Massachusetts

    c. Underwriters' Laboratories, Incorporated
       207 East Ohio Street, Chicago 11, Illinois

    d. National Safety Council
       425 North Michigan Avenue, Chicago 11, Illinois

    e. National Commission on Safety Education of the National Education Association,
       1201 Sixteenth Street, N. W., Washington 6, D. C.

    f. U. S. Forest Service, Department of Agriculture, Washington 25, D. C.

12. In teaching industrial arts activities in the various shops, safety and fire prevention procedures should be integrated into the regular class activities.

<u>Recommendations</u>: It is possible to make fire prevention as interesting and attractive as fire extinguishment through teaching aids that may be acquired from various sources. Organizations for fire protection have abundant literature available which may be obtained free or with a minimum charge. Material may be obtained by writing to the National Board of Fire Underwriters, National Fire Protective Association, and Underwriters' Laboratories, Inc. Material may be presented in the following ways:

1. Demonstrations.
2. Safety library.
3. Posters.
4. Representative from fire department.

5. Field trips.

6. Films.

The parents may become acquainted with the fire protection program in the school shop by demonstrations given by the students on a "Parents' Night". A section of the planning area may be devoted to a "safety corner" which contains a library of current safety and fire protection material. Attractive and practical posters, which are changed frequently, should be placed in the industrial arts shops. Vital interest may be stimulated by a visit from the local fire chief or one of his representatives. Field trips may be planned, with permission from the parents, to visit the local fire department and manufacturers or supply houses of fire safety equipment. Films should be used as a teaching aid and used only to emphasize specific material related to the program. A list of fire protection films are included in Appendix B.

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# APPENDIX A

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69. Factory Insurance Association, "Electrical Equipment for Hazardous Locations", Sentinel, 7:4-5, July, 1951.

70. Factory Insurance Association, "Formula for Fire Safety", Sentinel, 7:4-5, October, 1951.

71. Factory Insurance Association, "Misuse and Abuse of Electrical Equipment", Sentinel, 6:6-7, February, 1950.

72. Factory Insurance Association, "Survival Under Atomic Attact", Sentinel, 7:3, January, 1951.

73. Hunt, DeWitt, "Pre-College Safety Education", Safety Education, 29:3, September, 1949.

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81. Silverman, Milton, "So That's How to Treat Burns", The Saturday Evening Post, 224:34-35, September 22, 1951.

# APPENDIX B

## LIST OF FIRE PROTECTION FILMS

Approved by the Underwriters : Almost every person in the United States is protected in his daily life from hazards arising from heating, electrical and mechanical equipment by the safety standards of Underwriters' Laboratories, Inc. This film shows the rigorous testing methods used by the Laboratories to make sure that products "approved by the Underwriters" will not cause fire, injury or shock.
16mm sound 22 minutes

Chemistry of Fire: Demonstrates how the elements of fuel, oxygen, and ignition temperature must be present in order to have fire; differentiates between flash point and ignition point of fuels; and tells how a fire may be extinguished.
16mm 40 minutes

Crimes of Carelessness: This fire prevention film just released by the National Board of Fire Underwriters depicts the appalling loss of life and property which results from preventable fires. The film contains spectacular pictures of actual fires and will convey a moving message to young and old. It is appropriate for showing before any type of audience.
16mm and 35mm sound 11 minutes

Fire Fighting for Householders: This film relates ways in which to confine and extinguish fires in the home with the use of first-aid extinguishers. Excellent for adults and secondary school pupils.

Fire Prevention in the Home: This film is for the secondary school level. It may be used to acquaint students and parents with fire hazards in the home by following a fire inspection form.

Men of Fire: Fire fighting has made great progress since the early days of volunteer bucket brigades and hand-pumped engines. Today's fireman is a highly trained technician, carefully selected and schooled--capable of scientific fire suppression.
16mm sound 10 minutes

More Dangerous Than Dynamite: A forgotten electric iron, a lamp wire whose insulation has been worn off by age or zealous vacuum cleaning, a basin of cleaning fluid--like Mrs. O'Leary's cow, any of them can make a whole community homeless. More Dangerous Than Dynamite shows you how to be careful--and what happens if you're not.
16mm sound 10 minutes

*Sixty Seconds to Safety:* A minute may be saved by tossing old rags into an out-of-the-way corner of the school basement; or an hour by skipping a school fire drill. But all that is saved may be lost forever when disaster strikes. *Sixty Seconds to Safety* tells what may be forgotten, and it shows what can be done to prevent disaster.
16mm sound 10 minutes

*Smoke Eaters:* This excellent film, produced by a major motion picture company, depicts the role the fireman plays in the life of America. It shows the risks he takes to protect his fellow citizens and some of the methods he uses to extinguish fires and detect their origin. This film is recommended for both adult and younger audiences.
16mm 18 minutes

*Stop Fires--Save Jobs:* Many fires in industry can be stopped if employees know how they start and how to report them. This film was especially designed to be used to employee training programs; it encourages an alert attitude toward fires, it tells how to recognize common fire hazards and emphasizes the fact that fire is an enemy of jobs. This film should be a permanent part of every plant's employee education library.
16mm and 35mm black and white 18 minutes

*Tony Learns About Fire:* Tony, by being present when a fire started, became fire safety minded and served as a leader in school helping to promote Fire Prevention Week.

*The Torch:* Unusual new color cartoon just produced by the National Board of Fire Underwriters to show that there's just a bit of human carelessness in all of us. A new slide motion picture technique is used to make an intriguing and humorous film of fire safety.
16mm color and black and white 10 minutes

*We Make a Fire:* Good fire prevention film for younger audiences, (grades 4 to 7). Shows how campfires can be made safely, but emphasizes importance of care and caution in the use of fire, if forest lands are to be saved from destruction by fire.
16mm black and white 10 minutes

These films may be obtained from the following address and are free except for the return postage. Bookings should be made at least six weeks before the desired showing.

National Board of Fire Underwriters' Film Library
Bureau of Communication Research, Inc.
13 East 37th Street, New York 17, New York

# APPENDIX C

Dear Sirs;

I would greatly appreciate you sending me the following information and materials to aid in the preparation of a thesis on "Fire Safety and Protection as Related to the Industrial Arts Shop" which constitutes a major portion of my graduate work.

Please send me a list of your current publications including films and posters. Any information that you may have pertaining to fire prevention in the school shop will prove most helpful in this treatise.

Yours truly,

M. L. McQuigg
Graduate Student
Oklahoma A & M College

THESIS TITLE: FIRE SAFETY AND PROTECTION AS RELATED TO THE INDUSTRIAL ARTS SHOP

NAME OF AUTHOR: Marion Lee McQuigg

THESIS ADVISOR: DeWitt Hunt

The content and form have been checked and approved by the author and thesis advisor. "Instructions for Typing and Arranging the Thesis" are available in the Graduate School office. Changes or corrections in the thesis are not made by the Graduate School office or by any committee. The copies are sent to the bindery just as they are approved by the author and faculty advisor.

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