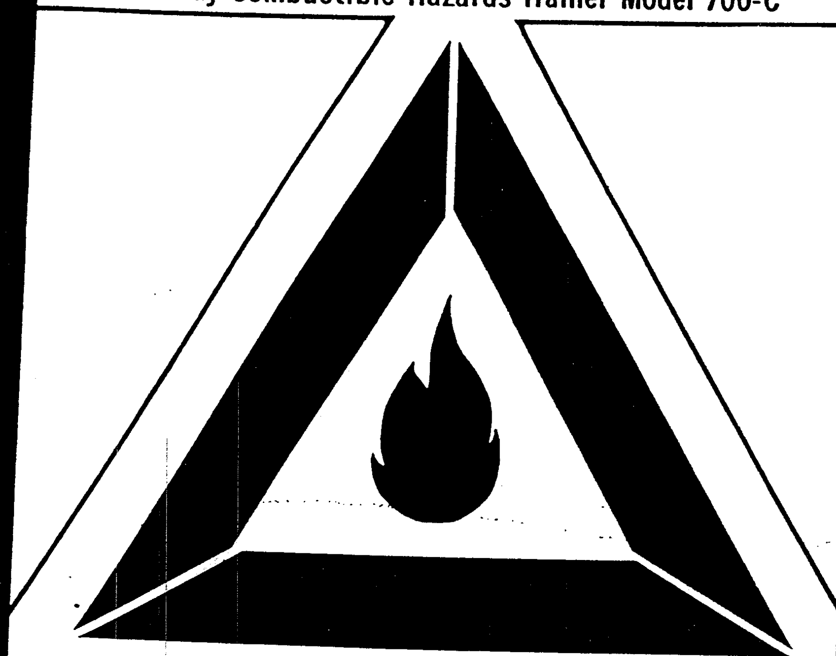
Carmody Combustible Hazards Trainer Model 700-C



Carmody
Combustible Hazards Trainer
Model CHT-700-C

INSTRUCTOR'S GUIDE

INCLUDING A CURRICULUM AND LESSON PLAN

TRINITY CORPORATION

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T A B L E   O F   C O N T E N T S

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SECTION I

INTRODUCTION

ABOUT THIS GUIDE

This guide is supplied to help you obtain maximum training results from your Carmody Combustible Hazards Trainer (CHT).

ABOUT THE TRAINER

The CHT is designed to satisfy the need for simple demonstration equipment for indoctrinating all concerned personnel in the fundamentals of fire and explosion.

One of the special features of this trainer is the high retention of instructional material, resulting from audience participation in the demonstrations. Students and trainees can either assist the instructor in making the demonstrations, or, as part of a planned program, they can work through the demonstrations individually, under the guidance of the instructor. As a result of this active participation in the dynamic demonstrations, students and trainees retain more useful knowledge than they do by just reading pamphlets or attending lectures or movies, and they are thus better prepared to meet an emergency.

With the trainer you stop telling how fires start, and instead show how they start. In addition, you can give many practical demonstrations of the potential causes of fires and explosions. Demonstrations also cover the means and methods of extinguishing fires.

Although the Carmody Combustible Hazards Trainer is a highly effective weapon against explosion and fire, your function as a skillful instructor is vital to the completion of an effective training program. If you do not possess a teaching background, you may find it helpful to obtain a good handbook on training. Your local public library can furnish a bibliography and help you make an appropriate selection. This instructor's guide includes a curriculum-lesson plan to assist you.

Properly used, the CHT can be an indispensable aid for use in all fire training programs, including those connected with civic organizations and public relations activities, as well as industrial training programs, fire departments and schools.

SECTION II

SCOPE OF THE DEMONSTRATIONS AND DESCRIPTION OF THE APPARATUS

DEMONSTRATIONS

The Carmody CHT enables you to make many demonstrations relative to training in these major areas of fire protection:

1. Fuels: Their Characteristics and How They Burn (Demos 1 through 6)
2. Sources of Fire Ignition (Demos 7 through 11)
3. Oxygen: Its Role in the Combustion Process (Demo 12)
4. Explosions (Demos 13 and 14)
5. Extinguishment of Fire (Demos 15 through 19)

The information to be acquired through witnessing, and participating in, these demonstrations will provide a sound basis for a comprehensive training program in fire prevention and control. The demonstrations can be presented in a self-contained basic course, or they can be utilized in conjunction with a previously established program.

APPARATUS

The trainer provides all the apparatus necessary to perform demonstrations 1 through 19. Also included is an initial supply of the various materials used in the demonstrations with the exception of the gasoline, kerosene and fire extinguisher. For a detailed listing of the trainer components, refer to the illustrated parts breakdown on pages 2-3 and 2-4. See also Note 1, below.

The following additional useful items are not part of the kit:

Wooden matches	Disposal container (coffee can or equal)	Extension cord
Lighter fluid	Spare fuses (AGC-1 & AGC-3 Slo-Blow)	Utility tweezers
Water	Scraps: cotton cloth (6 in.^{2}, 39 cm^2)	Stirring tool
Heavy-duty gloves	Measuring spoon--1/4 tsp. (1 ml)	Paper towels

Three supplementary demonstrations are described in the lesson plan. Details of the simple equipment required are described in Lesson 2, Par. 8; Lesson 4, Par. 6 and Lesson 6, Par. 13. (See pages 3-10, 3-52 and 3-76.)

Note 1

Because of strict regulations governing transportation of hazardous materials, even in the small quantities involved it is necessary for kit users in some areas, particularly overseas, to purchase their own supply of the following items:

Part No.	**15-00 Denatured Alcohol - 4 oz. (118.3 ml)**
	16-00 Potassium Permanganate Crystals - 1 oz. avd. (28.3g.)

For shipments into these areas, empty containers are included in the Kit.

Note 2

The Power Supply provided with this trainer is rated at one of the following inputs to the line voltage or "power" section:

U.S.A.	Model No. 07-00:	110 Volt/60 Cycle
Overseas	Model No. 07-00-OS	220 Volt/50 Cycle
Australian	Model No. 201B-AUS	220 Volt/50 Cycle

The OVERSEAS model is equipped with a special 110 volt receptacle on the rear of the case for plugging in the Fire Factor Display.

The AUSTRALIAN model is similarly equipped for powering the Fire Factor Display. There are also other modifications to meet the Australian Electrical Code, requiring a special procedure for Demonstration No. 7 (Electric spark as a source of fire ignition). See page 3-36-A for details.

TROUBLESHOOTING

Here are some tips on solving operational problems that may arise.

Power Supply, p/n 07-00

If any of the circuits (high, low or line) are not working, check first to insure that the fuse is intact. If blown replace with properly rated SLO-BLOW fuse (see page 3-95-B-1, B-2 or B-3).

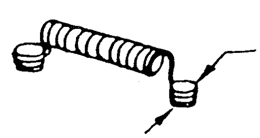
If the problem persists and cannot be traced to a defective piece of equipment plugged into the circuit, we recommend you return the Power Supply to us for repair.

Fire Factory Display, p/n 09-02

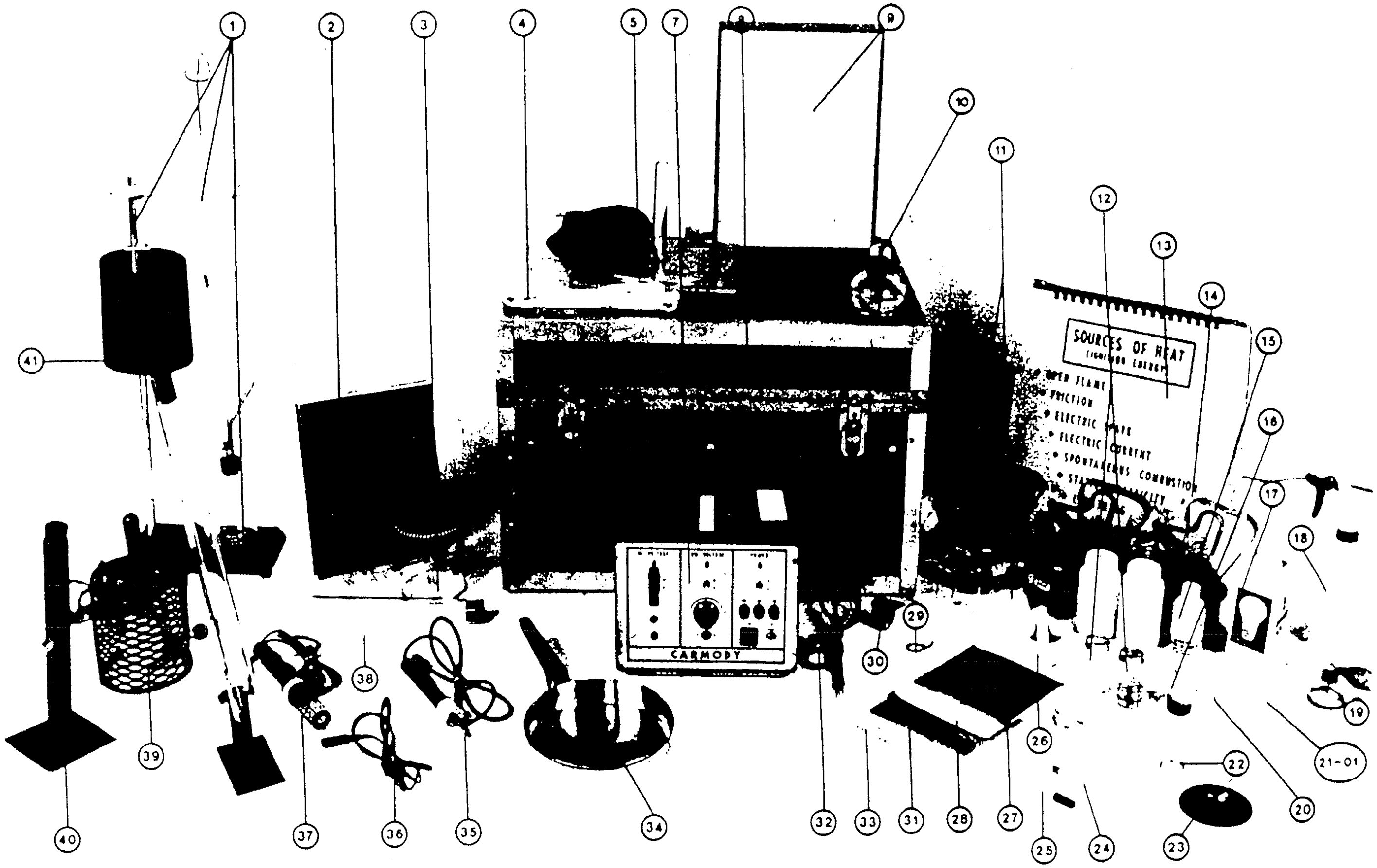
To replace burned-out bulbs, remove screws from base and slide out front cover/diffuser. See parts list on Page 2-4 for replacement bulbs.

Low Voltage Heating Element and Probe, p/n 35-00

If the element coil does not heat up, it could be due to a broken heater element or a bad connection between the element and the probe tips. The element can be squeezed slightly to make a better contact with the probe tip.



Squeeze diagonally so as to make opening slightly oblong and thus smaller, to fit more snugly.



SOURCES OF HEAT
CARMODY

PARTS LIST — COMBUSTIBLE HAZARDS TRAINER — MODEL CHT-700C

Part No.	Description
01-00	Storage Tank Assembly
01-01	Funnel - 500 ml
01-02	Flask - 250 ml
01-03	Ring Support
01-04	Stopper Ass'y (Hose, Stopper, Vent Tube)
02-00	Instructor's Guide
03-00	Discharge Chamber w/Elastic Retainer
03-01	Elastic Retainer Only
04-00	Fire Resistant Table Cover
05-00	Static Electricity Generator Assembly
05-01	Acrylic/Brass Plate Assy.
05-02	Aluminum Disc w/Handle
05-03	Piece of Cloth
07-00	Power Supply (Complete)
08-00	Lockable Storage Container
09-02	Animated Fire Factor Display
09-03	Spare Bulbs (specify color)
10-00	Alcohol Lamp
11-00	Beaker - 250 ml (2)
12-00	Shaker (2)
12-01	Plastic Bottle - 8 oz. (236.6ml) (2)
12-02	Sand (including 8 oz. container)
12-03	ABC Dry Chemical (including 8 oz. container)
13-00	Instructional Charts
14-01	Quart Safety Can-Gasoline (Red Label)
14-02	Quart Safety Can-Kerosene (Green Label)
14-03	Quart Safety Can-Waste (Yellow Label)
15-00	*Alcohol - 4 oz. (118.3ml) (incl. container)
15-01	Plastic Squeeze Bottle - 4 oz.
16-00	*Potassium Permanganate Crystals-1 oz. avd (28.3 g.) (incl. container)
16-01	Plastic Bottle - 1 oz.
	*S[illegible]

Part No.	Description
17-00	100 Watt, 110 Volt Bulb (package of 2)
18-00	Water Fogging Gun
19-00	Atomizer
20-00	Glycerine-1oz. (29.6 ml) (incl. container)
20-01	Plastic Squeeze Bottle - 1 oz.
21-01	Beaker-Spoutless (200 ml)
22-00	Friction Sparker
23-00	Beaker Cover
24-00	Hypodermic Syringe
25-00	Eye Dropper
26-00	Mortar and Pestle
27-00	Cooling Screen - 6 sq. in. (38.7 cm^2)
28-00	Cardboard
29-00	Chain - 4 in. (10.2 cm)
30-00	Crucible and Cover
31-00	Square of Hardwood
32-00	Line Voltage Sparking Assembly
33-00	Pad of Paper
34-00	Pan - 8 in. (20.3 cm)
35-00	Low Voltage Heating Element and Probe
35-01	Spare Element
36-00	High Voltage Leads - Spark Plug Chamber
37-00	High Voltage Sparker (including leads)
38-00	Glass Tube - 20 in. (50.8 cm)
38-01	Rubber Stoppers (2)
39-00	Bulb Smasher
40-00	High Voltage Explosion Cylinder
40-01	Spark Plug
40-02	Rubber Stopper
41-00	Apparatus for Gasoline Vapors
41-01	Chamber
41-02	Rod and Base

SECTION III

LESSON PLAN

INTRODUCTION

Since there are may common aspects of the instruction of personnel in fire prevention, fire protection and fire suppression, we have designed this set of lesson plans to serve as a basis for virtually any type of fire course the instructor wishes to teach. The Carmody Combustible Hazards Trainer is the basic instructional tool, and supplementary films, slide tape programs and technical publications are also cited.

The lesson plans are prefaced by a statement of student behavioral objective followed by a methodology, a list of the Carmody demonstrations in the lesson, and a list of instructional supports to assist the instructor in preparing and teaching.

The lesson plan itself breaks down into three subdivisions: instructional notes, a time sequence, and instructional content/activities. Instructional notes contain specific information to assist the instructor with the lesson. The instructor is also encouraged to add notes to this column for his own use.

Supplementary films, slide tape programs and visuals are listed in the Instructional Notes column. The visuals may be overhead transparencies, for which hard copy can be found following each lesson in which they appear. The instructor need only transpose the hard copy onto transparency film. Also included in the kit are the same visuals in the form of Instructional Charts, which may be used according to instructor preference and equipment availability

The slide tape presentation referenced in the lesson plan is the Justrite audio-visual covering the safe handling of flammable liquids (available from Justrite Manufacturing Company, 2954 Dempster Street, Des Plaines, Illinois 60016, telephone 312-298-9250). However, the instructor is encouraged to seek out a presentation that best suits objectives and availability.

We also chose three films from the National Fire Protection Association to use in the curriculum. Alternatively the instructor may wish to use films that are available and with which he is comfortable, providing the lesson's objectives can be adequately met.

In the instructional notes we have also recommended two publications that may be referred to for additional information. These are noted by abbreviation in the outline, as follows:

FPH = The Fire Protection Handbook (N.F.P.A.)

FBTM = The Fire Brigade Training Manual, by David T. Gold (N.F.P.A

These N.F.P.A. films and books are available through the National Fire Protection Association, Customer Service Department, Batterymarch Park, Quincy, Massachusetts 02269, telephone 617-770-3500, telex 200250.

The middle column is Time Sequence. Each lesson except the last takes about two hours to complete. The actual times listed have been determined by educatior specialists, physically utilizing the equipment. However, variations in instructional techniques may cause some deviations in these times.

The third column in the lesson plan is Content/Activity. This is the actual instructional outline that should serve the instructor as a guide for the program. The instructor is encouraged to enhance the outline with information needed by the specific group.

Listed in the program are three supplemental demonstrations. The apparatus for these is not included in the Carmody Trainer, but can easily be gathered to reinforce the material in the applicable lesson. The instructor should familiarize himself with the equipment and methodology of the supplemental demonstrations so that he may be prepared in advance of the class.

The sequence of the demonstrations as presented in this lesson plan has been found effective in general orientation, safety and new employee training classes as well as in public relations presentations. However, all of the demonstration covering the major areas described on page 2-1 may not be required for each training session.

Each demonstration may be presented separately, if desired. When more specific training requirements exist, it may be preferable to omit any demonstrations that are not applicable, and expand or modify others to suit the situation.

If time is a limiting factor in any session, that lesson may be shortened by conducting only one or two demonstrations. However, meaningful discussion of the material covered, or audience participation, should never be sacrificed to gain time. Inadequate discussion and lack of audience participation result in an ineffective training session and reduced retention.

As previously stated, the most effective program is arranged to provide time for some, if not all, of the trainees to work through the demonstrations individually, under the guidance of the instructor. Of course, discretion must be used when having a student or trainee participate in the demonstrations so that no element of danger is introduced. "Training by Guided Practice" means that the instructor must always have full control of the situation. Any loss of control by the instructor resulting in a minor accident would be a negative learning experience and must be avoided. "Learning the hard way" is a dangerous way to learn about combustible hazards.

If you require assistance in setting up your training, Trinity Corporation's TRAIN THE TRAINER program is available. Consult us for details.

SAFETY PRECAUTIONS

This trainer should be used only by responsible persons who are thoroughly acquainted with the hazards of combustible products. Trainee participation in the demonstrations, although encouraged, should take place only under the close guidance of the instructor.

ADHERENCE TO NORMAL SAFETY RULES THROUGHOUT THE DEMONSTRATIONS IS PARAMOUNT. HAVING A FIRE EXTINGUISHER (FOR PETROLEUM TYPE FIRES) AVAILABLE AND BEING PREPARED FOR AN EMERGENCY ARE COMMON SENSE PRECAUTIONS. MOST IMPORTANT, PRACTICE GOOD HOUSEKEEPING DURING THE ENTIRE PRESENTATION.

Listed throughout this manual are the most critical safety practices to be followed in conjunction with each demonstration. THE PRECAUTIONS LISTED ARE NOT NECESSARILY ALL-INCLUSIVE AND SHOULD NOT BE CONSTRUED AS ALL OF THE SAFETY MEASURES NECESSARY IN EACH INSTANCE. The location of the demonstration, the makeup of the class or audience, and the nature of the fuels or materials used in the demonstration (if different from those suggested in this manual, as may be the case when specific products of your own manufacture are utilized for training value) may dictate additional safety precautions.

If a presentation is to be made away from your normal demonstration area, you should investigate local ordinances pertaining to the combustible materials utilized in the demonstration and make sure that any such ordinances are not being violated.

PREPARATION FOR THE DEMONSTRATIONS

Before conducting the demonstrations, be sure your preparations are complete by checking the following:

1. **Lesson Plan.** You should always have an outline of your plan for the complete training session. In addition, you should:

   a. Be prepared to state the objectives of the entire session, as well as those of the individual demonstrations.

   b. Be prepared to relate the demonstrations to the needs of the attendees.

   c. Be sure you can relate each demonstration to something the attendees already know.

   d. Know how you are going to explain the principles you demonstrate — practice your presentation before it is time for the session

   e. Make a list of questions you should ask the attendees should you need to stimulate further discussion and promote understanding.

   f. Know how you are going to provide for attendee participation. Remember, "Learning by Guided Practice" is more than just a nice sounding phrase, it is a proven teaching technique.

2. **Check the Equipment.** Before the session, be sure you have all the items of equipment you will need, and have them arranged properly. A fresh supply of gasoline or equivalent fuel should be used in each "performance" to eliminate the possibility of contamination or change in characteristics due to partial evaporation. Some of these factors could affect the validity of the demonstrations and perhaps the safety with which they are performed.

3. **Practice Good Housekeeping and Handling Procedures.** Before each presentation, remove all unnecessary items from the immediate demonstration area. Pour residual gasoline and kerosene into waste can following each demonstration, unless it is required for demonstration(s) immediately following. A glove should be used to handle hot beakers. Tweezers may be utilized to remove matches floating in gasoline or kerosene to disposal container. When pouring gasoline or kerosene into beakers, place beakers in 8-inch pan to prevent spillage onto table cover.

4. **Be Sure You Can Perform.** Read the Instructor's Guide thoroughly and practice all demonstrations before the session occurs. Your ability to perform and communicate should lead to the satisfaction of the objectives you set forth.

5. **Prepare the Classroom.** Arrange the demonstrations and the seating so that all attendees will be able to see you perform. Insure that lighting and ventilation are adequate.

6. **Wear Short Sleeves and Remove Necktie.** Common sense dictates that safety is more important than formality.

7. **Check for Heat or Smoke Detectors** in the demonstration area, and take appropriate steps to handle the possibility of their being activated.

8. If necessary, inform the plant fire brigade and obtain a hot work permit.

PREFACE TO LESSON 1

We have traditionally looked at fire from the perspective of a triangle. A triangle is a geometric figure in which each of three sides has a unique and direct relationship with the other two sides. Fire is a process in which each of three factors, temperature, oxygen and fuel vapors, has a unique and direct relationship with the other two factors. The result of the appropriate combination is the ignition of fire.

We now recognize that there is a fourth factor which comes into play. As the three legs of the fire triangle interact, ignition will occur if the right combination is present. However if the fire is to sustain itself, it is necessary for a chemical reaction to take place.

During fire, complex molecules are broken down into simpler compounds and other substances. As the temperature increases and additional oxygen is drawn into the flame, these new compounds and substances recombine and further break down. As these recombined molecules and substances reach their ignition point, they begin to burn, causing an increase in the temperature, drawing in additional oxygen, and forming new compounds and substances. This process continues until these substances reach a lower temperature. Therefore, as long as there is adequate fuel and oxygen, and the temperature is sustained, the chain reaction continues the combustion process.

LESSON 1: INTRODUCTION AND OVERVIEW

TIME: 2

OBJECTIVES

By the end of this lesson the participant will be able to:

1. Describe the program and its contents.
2. Relate this program to how fires can be prevented.
3. Explain the tetrahedron of fire.

METHODOLOGY

Welcome participants, present administrative information, and identify purpose and objectives of the course. Group discussion will explore the importance of the understanding of the nature of fire to fire prevention concepts. A lecture presentation with audio visual support will explain the tetrahedron of fire.

INSTRUCTIONAL NEEDS

- One 16mm Movie/Sound Projector
- One Screen
- Flip Chart or Black Board
- Carmody Combustible Hazards Trainer

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	10 min	1. ADMINISTRATIVE MATTERS AND OVERVIEW A. Welcome Participants B. Administrative Matters C. Student Introductions D. Instructor Introductions E. Overview Course F. Explain Requirements 2. PRESENT COURSE OBJECTIVES

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
Introduce and show film Fire in America (NFPA). Instruct the participants to note the causes of fires in this film and how these fires could have been prevented with a better understanding of the chemistry of fire.	1hr20m	3. FILM: FIRE IN AMERICA 4. GROUP DISCUSSION ON FIRE PREVENTION ISSUES A. Understanding Ignition B. Understanding Fuels C. Understanding Oxygen D. Human Behaviors
Use Carmody Fire Factor Display Note that OVERSEAS and AUSTRALIAN versions of the Power Supply are equipped with a 110V receptacle on the rear of the case for plugging in the Fire Factor Display.	25 min	5. THE TETRAHEDRON OF FIRE A. Discuss Each Element -Temperature -Fuel -Oxygen -Chain Reaction B. Define Each Element's Interdependence on the Other Elements 6. SUMMARIZE KEY POINTS OF LESSON 1.

LESSON 2: FUELS, THEIR CHARACTERISTICS AND HOW THEY BURN

TIME: 2 HOU

OBJECTIVES

By the end of this lesson the participant will be able to:

1. Describe the three different states of fuel and how each burns.
2. Differentiate between flammable and combustible materials.

METHODOLOGY

An explanation of the fuel element of the fire tetrahedron will be given reinforcing the importance of a fuel being in a state in which it can burn. A slide tape presentation will explain key points of flammable liquid safety. The differentiation between flammable and combustible fuels will be explained. Live demonstrations using the Carmody Combustible Hazards Trainer will emphasize key points.

DEMONSTRATIONS 1,2,3,4,5,6

INSTRUCTIONAL NEEDS

- One Overhead Projector
- One 35 mm Slide Projector And Tape Player
- One Screen
- Flip Chart or Black Board
- Carmody Combustible Hazards Trainer
- Materials Listed In #8 Below

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	10 min	1. ADMINISTRATIVE MATTERS. 2. PRESENT LESSON OBJECTIVES.
Use the Carmody Fire Factor Display * Visual #1 - DEFINITIONS These properties will be be discussed during the slide tape presentation later in this lesson. Visual #1 - DEFINITIONS	1 hour	3. EXPLAIN THE FUEL ELEMENT OF THE FIRE TETRAHEDRON. A. The fuel must be in a state in which it will burn. B. This state may be partially determined by the fuel's physical properties. C. One important property is the fuel's flash point. -Define FLASH POINT: The temperature at which a fuel gives off sufficien vapors to flash momentar when ignited by a flame or a spark. D. Other physical propertie include: -Boiling Point -Vapor Pressure -Solubility in water -Specific gravity -Flammable limits 4. DESCRIBE THE THREE STATES OF MATTER FUELS CAN BE FOUND IN AND THE INHERENT DANGERS ASSOCIATED WITH EACH STATE. A. Solids B. Liquids C. Gases 5. DEMONSTRATE THAT ONLY VAPORS BURN. A. Demonstration #1 Only Vapors Burn 6. DEMONSTRATE FLASH POINT AND OTHER PHYSICAL PROPERTIES. A. Demonstration #2 Flash point

* If you are using the Instructional Charts supplied with the kit as visuals, note that the Fire Factor Display with its grooved base may be used as a stand.

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
Visual #1 - DEFINITIONS Visual #2 - CHARACTERISTICS Visual #2 " Visual #2 "		B. Demonstration #3 Mechanical Vaporization C. Demonstration #4 Vapor Weight D. Demonstration #5 Specific Gravity E. Demonstration #6 Miscibility
SLIDE/TAPE PRESENTATION, "How to Handle Flammable Liquids Safely," from the Justrite Company NOTE:Please read and follow safety precautions in the Instructors Guide page 3-1	20 min	7. SHOW SLIDE TAPE PRESENTATI 8. SUPPLEMENTAL DEMONSTRATION HEATED GAS EXPANSION. THE FOLLOWING DEMONSTRATIO WILL SHOW THAT FUEL, IN A GAS STATE WILL EXPAND WHEN HEATED A. Needs -One candle -Two balloons -Wire screen -Fire extinguisher -Protective cover B. Method -Inflate balloons equall -Heat one using screen -Indicate balloon expand and floats -Remove flame, balloon deflates and settles -Explain that it is the nature of a gas to expa when heated. Balloon ri because same weight of increases in volume. Heated gas fuels expand in their containers.
Instruct the participants to work in small groups listing hazards by fuel. After 15 minutes call time and ask the groups to	30 min	9. GROUP DISCUSSION ON FUEL HAZARDS A. Solid Fuel Hazards B. Liquid Fuel Hazards C. Gas Hazards

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
report out while you list key points on board or flip chart.		
		10. SUMMARIZE KEY POINTS OF LESSON 2.

FLASH POINT

THE TEMPERATURE AT WHICH A LIQUID GIVES OFF SUFFICIENT VAPOR TO FLASH MOMENTARIL WHEN IGNITED BY A FLAME OR SPARK

FIRE POINT

WHEN A LIQUID IS HEATED PAST ITS FLASH POINT IT WILL REACH A TEMPERATURE WHERE SUFFICIENT VAPOR IS GIVEN OFF TO MAINTAIN COMBUSTION

IGNITION TEMPERATURE

THE MINIMUM TEMPERATURE AT WHICH A SUBSTANCE WILL BURN OR IGNITE INDEPENDENT OF AN EXTERNAL HEAT SOURCE

Visual #1- DEFINITIONS

...ADDITIONAL CHARACTERISTICS IMPORTANT TO THE SAFE HANDLING OF FUELS AND CONTROL OF FIRES OR EXPLOSIONS...

- VAPOR WEIGHT (GASOLINE VAPORS ARE 3.5 TIMES HEAVIER THAN AIR)

- COLOR OR ODOR (PURE GASOLINE IS COLORLESS AND NEARLY ODORLESS)

- SPECIFIC GRAVITY

- MISCIBILITY OR IMMISCIBILITY OF LIQUID FUELS

DEMONSTRATION No.1

TITLE: The Chemistry of Fire (A).

OBJECTIVES: To demonstrate that only vapors burn.

EQUIPMENT:

1. Fire Factor Display
2. Square of hardwood
3. Square of cardboard
4. Beaker (2)
5. Kerosene
6. Gasoline
7. Alcohol lamp
8. Matches
9. Beaker cover

INTRODUCTION: What causes a fire? — or an explosion, which is defined as a combustion occurring in a confined space? Most persons think of fire in terms of fuel or material that is burning.

Through the use of the Fire Factor Display, this demonstration will show that normally three elements, fuel, oxygen, and a source of ignition must be present before a fire or explosion will occur. A fourth factor, chemical reactio may also, as seen in demonstration No 1 1 cause the ignition of fire, or an explosion. This fourth factor is also responsible for the propagation of fire. Although combustion is more complex than the Fire Factor Display indicates it will suffice to convey a basic concept of fire and explosion.

Actually, all fuel, whether liquid or solid, must be vaporized and mixed with a or oxygen before it will burn. In addition, the ignition source must produce enough heat to bring some portion of the combustible mixture up to the ignition temperature of the particular fuel involved.

Throughout the demonstration, be sure to relate the various points illustrated to conditions or hazards that may be present in your particular plant.

Whenever it is practical and safe to do so, have one or more persons from your audience or class assist you in making the demonstration.

PROCEDURE:

1. Push all four switches on the Fire Factor Display and explain that all four elements are necessary to complete the fire factors and cause a fire.

2. Light the alcohol lamp, hold the square of hardwood in a horizontal position and pass the flame back and forth beneath the edge of the wood. Note that it does not burn.

3. Repeat Step 2, but use the square of cardboard instead of the square of wood. Note that it also does not burn, but merely accumulates soot from the open flame.

4. Explain that you have demonstrated that the hardwood and cardboard, in themselves, do not burn.

5. Next, pour 40 ml of kerosene into one of the beakers. Then drop a lighted match into the kerosene. Explain that, although the kerosene is a combustible material, the match is extinguished in the same manner as it would be if it were dropped into water. To demonstrate that it is not the sudden transfer of the match into the liquid that extinguishes it, hold a lighted match just over the surface of the kerosene. Note that it still does not burn.

6. Continue by placing an equivalent amount of gasoline in the second beaker and drop a match into the gasoline. The gasoline vapors will immediately ignite. Extinguish the flame promptly by covering the beaker with the flat beaker cover.

7. Ask the audience if anyone knows why the wood, cardboard, and kerosene (all acknowledged as common fuels) did not burn, while the gasoline did.

8. Explain that the gasoline was not actually burning, but that vapors coming from the gasoline were burning.

9. Point out that "fuel vapors" form one element of the fire factors and that fuel vapors are necessary to produce a fire.

10. Note the color of the burning gasoline in this demonstration so it may be compared with the color of burning kerosene in the following demonstration.

PROCEDURE (cont.):

11. Ask for questions and encourage discussion on the demonstration.

12. When feasible, have at least one or two attendees perform some of t demonstrations. Persons who are skeptical can often be convinced by this technique.

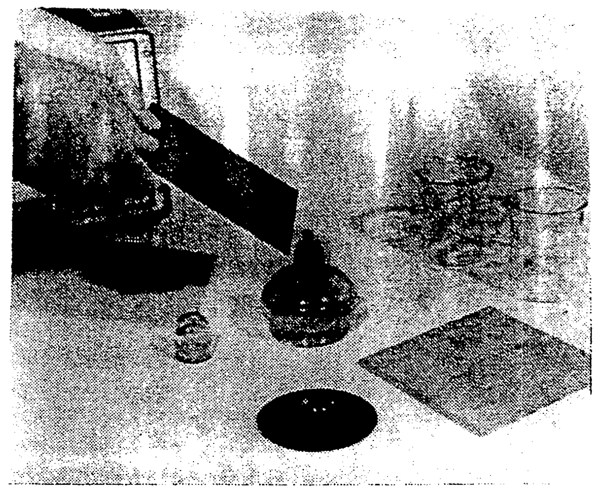


Figure 2. Only Vapors Burn - Solid Fuels.

DEMONSTRATION NO. 2

TITLE: The Chemistry of Fire (B)

OBJECTIVES: To further demonstrate that only vapors burn.

EQUIPMENT:

1. Fire Factor Display.
2. Beaker with 20 ml of kerosene in bottom. (Beaker and kerosene used in Demonstration No. 1 can be used, but part of the kerosene can be poured into the waste can as only a small amount is needed for this demonstration.)
3. Ring stand and ring
4. Cooling screen
5. Alcohol lamp
6. Matches
7. Beaker Cover

FIRE CHART DISPLAY: "Definitions"

INTRODUCTION: Keeping in mind that "fuel vapors" are one of the four factors which combine to cause and propagate a fire, note that one of the common hazards encountered in the handling of combustible materials is the vapor emitted from liquid fuels when they are heated. During this demonstration, a small amount of kerosene will be heated to more thoroughly demonstrate that only vapors from a fuel burn, and that these vapors constitute a serious hazard. Note that a barrel or tank exposed to the sun is a potential hazard. Ask members of your audience to cite similar hazards at their own plant or facility.

Figure 3 Only vapors burn - Liquid Fuels

PROCEDURE:

1. Place the "cooling screen" on the ring stand, set the beaker containing the kerosene on the "cooling screen" and place the alcohol lamp beneath the "cooling screen."

2. Light the alcohol lamp and adjust height of ring so that the screen is at the tip of visible flame. Point out that, as the temperature rises, vapors are emitted from the kerosene (this occurs at approximately + 120° F. (- 48.9° C.), depending on the grade of kerosene).

3. When the kerosene has become heated, extinguish the alcohol lamp with the lamp cap and drop a lighted match into the beaker. The kerosene vapors will ignite the same way the gasoline vapors ignited in Demonstration No. 1.

4. Discuss the subjects of "Flash Point" and "Fire Point," as defined below and on the Flip Chart. Compare the flash points and fire points of typica flammable liquids. Discuss them in connection with the kindling temperature of other combustible materials.

5. Note that the temperature required to vaporize liquids is not the same a the temperature which ignites the vapors, the latter being the temperature element of the Fire Factor Display.

6. Note the color of the burning kerosene, and compare this with the colo or the burning gasoline in the previous demonstration.

DEFINITIONS:

Flash Point: The temperature at which a liquid gives off sufficient vapor to flash momentarily when ignited by a flame or a spark.

Fire Point: When a liquid is heated past its flash point it will reach a temperature where sufficient vapor is given off to maintain combustion.

Ignition Temperature: The minimum temperature at which a substance will burn or ignite independent of an external heat source.

Typical examples of flash point and ignition temperatures are as follows:

Liquid	Flash Point	Ignition Temp.
Gasoline	- 45° F. (- 42.8° C.)	536° F. (280°C.)
Kerosene	110° F. (43.3° C.)	410° F. (210° C.)
Light Motor Oil	approx. 375° F. (190.6° C.)	approx. 600° F. (615° C.)

Note that a substantial temperature range exists between the flash point and the ignition temperature of the above examples. Personnel should know the flash point and ignition temperature as well as any other hazardous characteristics of the liquids they are handling.

DEMONSTRATION No. 4

TITLE: Vapor Weight

OBJECTIVES: To demonstrate additional hazards encountered in the handling of "heavy-vapor" fuels.

EQUIPMENT:

1. Fire Factor Display
2. Chamber
3. Plastic slotted tube and support
4. Support rod and base
5. Beaker
6. Alcohol Lamp
7. Gasoline
8. Piece of cotton cloth about 6 sq. in. (38.7 cm^2)

FLIP CHART DISPLAY: "Charactistics"

INTRODUCTION: In demonstration No.14 , gasoline vapors are "poured" from the explosion tube. This was possible because gasoline vapors are three-and-one-half times heavier than air. Recognition of this particular characteristic of gasoline, or any other fuel having a similar characteristic, is very important in the safe handling of the product.

Other flammable liquids having vapors heavier than air include alcohol, naphtha, gasoline, benzene, kerosene, amyl acetate, and carbon disulfide. Industrial gases such as acetylene, carbon monoxide, hydrogen, and natural gas, are lighter than air. Although these gases normally do not seek the lowest available level, they do constitute a fire and explosion hazard, particularly in a confined area.

Two important steps to take in preventing explosions are (1) prevent the formation of explosive mixtures of fuel vapor and air, and (2) eliminate all sources of ignition.

The equipment for handling and storing flammable gases and liquids should comply with existing codes and should be inspected regularly by qualified individuals.

Under most conditions, adequate ventilation will help prevent the excessive accumulation of dangerous gases and vapors. The method of ventilation should be determined by consideration of the weight of the vapor to be

continued —

PROCEDURE (cont.):

dispersed. For example, windows and doors should be located where the concentration of gases is most likely to occur. Explosion-proof ventilation equipment and motors should be installed if necessary.

The extent to which you may wish to expand this demonstration depends on the actual environment for which the trainees are being prepared. An appropriate comment is that the characteristics emphasized in this demonstration have caused, and continue to cause, numerous tragic fires. A classic example is when gasoline, or a similar product having heavy vapors, spilled in one area, and the heavy vapors flow through draining ditches, ventilator systems, or sewers, to an ignition source a considerable distance (even miles) from the spillage area, and cause fire or explosion at the latter location.

This demonstration not only shows the characteristics of heavy vapor fuels, is also a graphic display of flame propagation and partial explosion — both c which the trainees see. This visual presentation reinforces the trainees' learning and increases their retention of the material presented.

Other characteristics of combustibles are noted on the flip chart. These include color, odor, specific gravity, and miscibility (capability to mix) and immiscibility in the case of liquid fuels. Comments on these characteristics should be emphasized in accordance with the fuels and environment in whic the trainees will be involved. It may be appropriate to mention that highly combustible, or otherwise dangerous materials, which in their pure form are colorless and/or odorless, are often dyed or scented to warn handlers of the presence.

NOTE

To ensure safety while making the demonstration shown on the next page, it is important to perform steps in order given.

continued

PROCEDURE:

1. Set up the apparatus exactly as shown in Figure 5 with the slot in the tube facing up and the alcohol lamp positioned approximately 1 to 2 inches (2.5 to 5 cm) from the slotted tube.

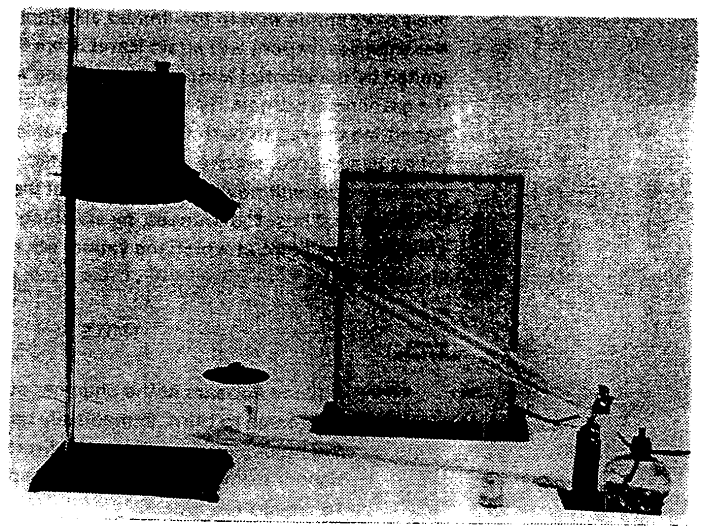


Figure 5. Gasoline Vapor Is Heavier Than Air.

2. Light the alcohol lamp.

3. Pour a small amount of gasoline, about 10 ml or less, in the beaker; then absorb this gasoline in a piece of cloth about 6 sq. in. (38.7 cm^2).

4. Place the saturated cloth in the chamber, positioning it to the rear of the chamber and away from the outlet to the slotted tube. **Immediately close the cover on the chamber.**

NOTE

Stand behind the equipment and face the class. DO NOT stand between the equipment and the class.

5. In a matter of a few seconds the gasoline vapors, which are ordinarily invisible, but which in this case may be visible as they pass down the trough, will travel down to the alcohol lamp flame and ignite. The flame will either "run" or "flash back" to the chamber, depending upon any drafts or air currents in the room.

continued --

PERFORMANCE (cont.): 6. It is very likely that a small explosion will occur within the chamber, which is a partially closed container even when the cover is closed. T explosion may cause the cover to pop up and a flash of flame to belct from the outlet of the chamber. Caution is advised, but the fire is not likely to continue due to the limited air supply in the cannister. **Nevertheless, vapors will again travel down the open trough and be ignited by the alcohol lamp.** This sequence will continue until most of the gasoline is burned. By lifting the cover on the chamber and permitting the rag to burn for a few moments, and then closing it to extinguish the fire, smoke will be generated, and smoke-ladened gasoline vapor will flow from the outlet of the chamber down the trou to the flame. Thus, the trainees, by watching the smoke, will be able t anticipate the point at which the vapors will ignite and travel back up slotted tube.

NOTE

1. If flame appears at the chamber outlet and continues to burn, immediately open and then close the chamber cover. This will divert burning vapors from the lower outlet and prevent damage to the slotted tube.

2. **Caution:** Exercise care in opening the chamber cover. Never look directly into the chamber when the demonstration is in process.

3. In assembling the plastic slotted tube to the neck extension on the chamber, the tube need only go on approximately ¼" (.635 cm). Forcing the tube the full length of the neck is unnecessary, and may damage the tube.

4. If you wish to terminate this demonstration before available fuel vapors are exhausted, use a pair of utility tweezers to remove the piece of cloth from the chamber. An empty coffee can with its plastic cover makes a handy air-tight receptacle for the piece of cloth. Be sure that removal is timed so that vapors are not about to re-ignite, and extinguish the alcohol lamp after the last accumulation of vapors has burned.

DEMONSTRATION No. 5

TITLE: Specific Gravity and Combustion

OBJECTIVE: To demonstrate that differences in specific gravity affect combustion.

EQUIPMENT:

1. Fire Factor Display
2. Beaker
3. Friction sparker
4. Beaker cover
5. Eyedropper
6. Gasoline

FLIP CHART DISPLAY: "Characteristics"

INTRODUCTION:

Specific gravity is defined by Webster as, "The ratio of the weight of any volume of a substance to the weight of an equal volume of some substance taken as a standard or unit, as, usually, water for solids and liquids, and air or hydrogen for gases."

Differences in specific gravity affect the miscibility (capability for mixing) of liquids. For example, the lower specific gravity of oil or gasoline causes these liquids to float on water, thus adding to the hazards that must be coped with when handling these liquids.

PROCEDURE:

1. Fill one of the beakers with water.

2. Place several drops of gasoline on the water and ignite the vapors emitted from the gasoline.

3. Observe that, because of its lower specific gravity, the gasoline remains on the surface of the water where it vaporizes and becomes a hazard.

DEMONSTRATION No. 6

TITLE: Miscibility and Combustion

OBJECTIVE: To demonstrate that miscibility affects the combustion characteristics of liquids.

EQUIPMENT:

1. Fire Factor Display
2. Two beakers
3. Friction sparker
4. Beaker cover
5. Eyedropper
6. Gasoline and kerosene

FLIP CHART DISPLAY: "Characteristics"

INTRODUCTION: Miscibility, like specific gravity, affects the combustion characteristics of the liquids involved. Consequently, an understanding of the potential miscibility different liquid fuels and the characteristics of the resultant mixtures is important to ensure their safe handling.

A good example, keeping in mind some of the characteristics already established, is that of a mixture, or blend, of gasoline and kerosene. It has been shown (Demonstration No. 1) that kerosene will not ignite at normal room temperatures, and that gasoline, because it is continuously emitting vapors, readily ignites when exposed to an energy source, and the air-vapor mixture is in the combustible range.

PROCEDURE:

1. Pour 40 ml of kerosene into one beaker and an equivalent amount of gasoline into the second beaker.

2. Using the friction sparker, strike sparks in several places about the mouth of the kerosene beaker to demonstrate that no vapors are presei above the kerosene, and therefore no combustion occurs when the sparks are struck.

3. Again using the friction sparker, strike a spark at the mouth of the gasoline beaker to show that combustible vapors are present. Extinguish the resultant flame with the beaker cover.

continued

PROCEDURE (cont.):

4. Pour a small amount of gasoline into the kerosene and stir thoroughly to establish the miscibility of the two liquids.

NOTE

A common assumption on the part of many trainees is that the new blend will have characteristics unlike either of the two original materials, but probably lying somewhere between the characteristics of the two. This is true insofar as specific gravity is concerned. However, more critical characteristics such as "flash point" are not necessarily combined. In fact, although a very small amount of gasoline has been added to the kerosene, there are combustible vapors being emitted from the new blend. These are gasoline vapors ("flash point" **minus** 45° F., or -42.8° C.) and will ignite in the same manner as that in which pure gasoline vapors ignited (Demonstration No. 1).

5. Strike the friction sparker over the beaker containing the blended mixture to demonstrate the presence of the combustible vapors described above.

   Depending on the configuration of the container and other conditions such as air movement, etc., the heat developed from the burning gasoline vapors may quickly cause the kerosene to vaporize (vapor temperature of approximately 120° F. or 48.9° C.) and the resulting flame will have a new characteristic insofar as color is concerned, because of the combustion of both gasoline and kerosene. Compare this with the colors of burning gasoline and kerosene observed in Demonstrations No. 1 and No. 2.

6. Point out that the same thing occurs in a fire. Materials with lower flash points are the ones that vaporize first and start to burn, generating reactions that raise the temperatures and start the vaporization and combustion of other materials that have a higher flash point.

OBJECTIVES

By the end of this lesson the participant will be able to:

1. List six sources of heat and explain how they contribute to the temperature arm of the fire tetrahedron.
2. Describe heat transfer.
3. Describe fire hazards by sources of ignition.

METHODOLOGY

An explanation zeroing in on the tetrahedron of fire's temperature element will emphasize that most industrial fires are ignited by an electric heat source. Heat transfer will be explained. Heat sources will be listed and categorized. Live demonstrations utilizing the Carmody Combustible Hazard Trainer will emphasize and reinforce key points.

DEMONSTRATIONS 7,8,9,10,11

INSTRUCTIONAL NEEDS

- Flip Chart or Black Board
- Carmody Combustible Hazards Trainer

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	10 min	1. ADMINISTRATIVE MATTERS. 2. PRESENT LESSON OBJECTIVES.

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	1 hour	3. REVIEW THE FIRE TETRAHEDRON.
Relate this discussion to the temperature element of the tetrahedron using the Fire Factor Display.		4. EXPLAIN TEN SOURCES OF HEAT THAT CONTRIBUTE TO THE IGNITION OF FIRE. GIVE EXAMPLES OF FIRES CAUSED BY THESE SOURCES. A. Electrical -Resistance -Arcing -Sparking
Stress that static ignition only occurs with fuels that have reached their flash point.		B. Static C. Chemical Reaction D. Friction E. Compression of a Gas F. Lightning G. Spontaneous Combustion H. Hot Surfaces I. Open Flames J. The Sun
		5. EXPLAIN THAT THE MOST COMMON CAUSE OF WORKPLACE FIRES IS ELECTRICITY AND THE FOLLOWIN DEMONSTRATIONS WILL SHOW HOW THIS IGNITION OCCURS.
Visual #3 - SOURCES OF HEAT		A. Demonstration #7 Electric Spark
Visual #3 "		B. Demonstration #8 Resistance Heat
Visual #3 "		C. Demonstration #9 Resistance Heat
		6. EXPLAIN HOW STATIC ELECTRICI ALTHOUGH HARMLESS TO HUMANS, CAN IGNITE A FIRE OR EXPLOSION.
Visual #3 "		A. Demonstration #10 Static Ignition
		7. DESCRIBE HOW TWO CHEMICALS, WHEN MIXED, CAN CAUSE IGNITI
Visual #3 "		A. Demonstration #11 Chemical Reaction
	20 min	8. EXPLAIN HOW HEAT MAY BE MAY BE TRANSFERRED FROM ONE

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
		SURFACE TO ANOTHER A. Conduction B. Convection C. Radiation
Instruct the participants to work in small groups listing sources of ignition under the ten different categories listed in 4 above. Call time after fifteen minutes. Ask groups to report out while you list key points on board or flip chart.	30 min	9. GROUP DISCUSSION ON SOURC OF IGNITION 10. SUMMARIZE KEY POINTS OF OF LESSON 3

THE SOURCES OF HEAT

Supplement to Lesson 3

1. **Electrical ignition of fires** occurs through sparking, arcing, resistance and static electricity.
   Sparking is a sudden, one-time discharge of electricity. Sparking will normally not ignite combustible materials but can ignite fuel vapors.
   Arcing is electrical energy jumping between two points, producing heat which may be enough to ignite combustibles or ignite flammable liquid vapors.
   Resistance is the obstructive quality of a conductor which inhibits the flow of electricity. Light bulbs, electric heaters, and electric ranges all utilize electric resistance to function. Heat from these or from overloaded electric circuits can ignite combustible materials or flammable liquid vapors.
   Static sparking occurs when two substances that were joined together are separated. Unless the materials are grounded or bonded together to prevent the static spark, ignition of flammable liquid vapors may result.

2. **Spontaneous combustion** occurs when chemical reactions between fuel vapors and oxygen cause a temperature increase that will lead to spontaneous ignition of the materials.

3. **Friction, lightning, compression** and the **sun** are other common sources of heat ignition.

SOURCES OF HEAT

THAT CONTRIBUTE TO THE IGNITION OF FIRE

ELECTRICAL
-RESISTANCE
-ARCING
-SPARKING

STATIC

CHEMICAL REACTION

FRICTION

COMPRESSION OF A GAS

LIGHTNING

SPONTANEOUS COMBUSTION

HOT SURFACES

OPEN FLAME

THE SUN

DEMONSTRATION No. 7

TITLE: Sources of Heat (A)

OBJECTIVE: To demonstrate that an electric spark is a source of heat sufficient to cause a fire.

EQUIPMENT:

1. Fire Factor Display
2. Power supply
3. Pan - 8 in. (20.3 cm)
4. Line voltage sparking assembly
5. Large Cover (Use aluminum disc w/handle)
6. Electric bulb smasher (with bulb)
7. Gasoline

FLIP CHART DISPLAY: "Sources of Heat"

INTRODUCTION: The flip chart provides a listing of common sources of heat.
The equipment necessary to perform several electrical energy demonstrations is included in this trainer. These provide for the use of normal household line voltage (110 volts), low voltage (6 volts ac and below), 5,000 volts and static electricity.

To minimize set up and handling time for the apparatus involved, it is recommended that Demonstrations No. 7, 8 and 9 be performed during one session and in the sequence in which they are presented in this manual.

continued—

INTRODUCTION (cont.): This demonstration No. 7 illustrates that an arc, or spark, derived from a normal 110-volt source, can set off a fire by igniting a gasoline-air-vapor mixture

PROCEDURE:

1. Connect the power supply to the household line voltage (110 volts).
2. Connect the bulb smasher to the line voltage receptacle in the power supply.
3. Connect the line voltage sparker to the "line probe" receptacle on the right side of the power supply.
4. Turn on the POWER switch on the power supply.
5. Call attention to the rather small spark that is obtained when the power switch is turned on and the tips of the probes are struck together in a glancing contact to create a minor arc. (Light bulb will simultaneously light up.)
6. Place a very small amount (not more than 2 ml) of gasoline in the pan and strike the arc over the pan. The gasoline vapors should readily ignite (Figure 6). To achieve the proper vapor-air mixture it may be necessary to blow across the surface of the pan. Be sure to remove the probes from pan area when blowing.

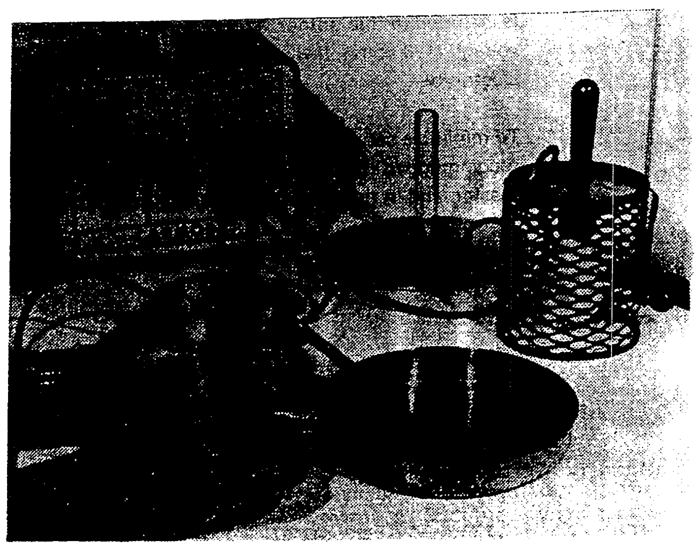


Figure 6. Heat from an Electric Spark Can Cause a Fire.

7. Extinguish the flames promptly by placing the large cover over the pan

DEMONSTRATION No. 8

TITLE: Sources of Heat (B)

OBJECTIVE: To demonstrate that a common electric light bulb makes a fine source of ignition.

EQUIPMENT:

1. Fire Factor Display
2. Power supply
3. Pan - 8 in. (20.3 cm)
4. Electric bulb smasher (with bulb)
5. Large Cover (Use aluminum disc w/handle)
6. Gasoline

FLIP CHART DISPLAY: "Sources of Heat"

INTRODUCTION: Electric current does not have to be in the form of an arc to cause a fire. As the objective of this demonstration states, a common electric light bulb, when broken, makes a potent source of ignition. Many disastrous fires are started as a result of the accidental breaking of lighted electric bulbs in the presence of fuel vapors.

Although an unbroken lighted bulb, even a 100-watt bulb, has a relatively hot surface, the temperature normally does not reach 495° F., (257.2° C.) and therefore cannot ignite the gasoline vapors from the gasoline that will be placed in the pan during the demonstration.

NOTE

> Under certain conditions, an unbroken lighted bulb, especially one of high wattage, can become a fire hazard. Lighted bulbs should never be allowed to come in contact with paper, fabrics, cobwebs, waste, or any other flammable material.

The bulb filament, through which electric current is passing develops a very high temperature, and, if the bulb is broken, will readily set off the gasoline vapors.

continued —

PROCEDURE:

1. Operate the POWER switch on the power supply to ON and allow the bulb to heat up for a few minutes so that normal operating temperatur[e] is reached.

NOTE

When performing the following demonstration strike the bulb away from the class, and from yourself, to avoid the remote possibility that a fragment of glass might pass through the bulb smasher and cause injury.

2. Place a few drops of gasoline (just enough to make a thin film) in the frying pan.

3. With one hand, hold the bulb smasher by the top handle and position firmly in the frying pan. Adjust the hammer, if necessary, so that it res[ts] firmly against the bulb.

4. With your free hand, pull and release the spring-loaded hammer on th[e] side of the cage (Figure 7). As the hammer is released, the bulb will break and the gasoline vapor will ignite immediately.

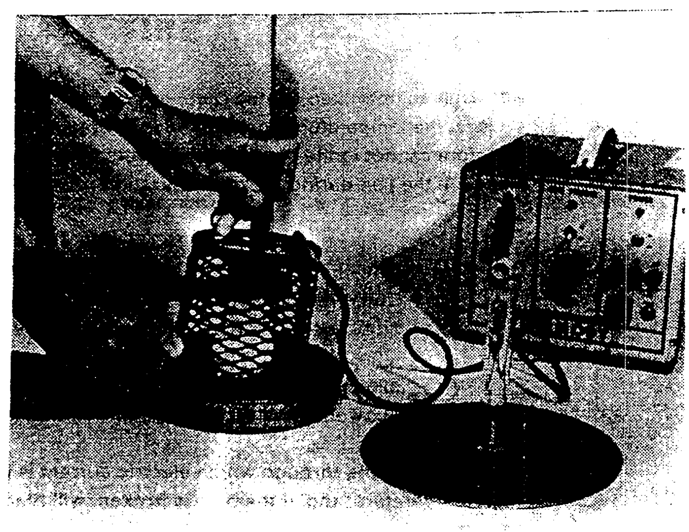


Figure 7. An Electric Light Bulb is a Potential Hazard.

continued

PROCEDURE (cont.):

5. Extinguish the fire immediately by placing the large cover over the pan.

WARNING

Be doubly sure that the power supply is turned OFF **before** touching the open end of bulb or attempting to remove its remains from the socket. The use of a heavy glove is recommended.

NOTE

1. When placing a new bulb in this unit, be sure to position the adjusting nut on the spring-loaded hammer to guarantee breakage of the bulb. Many high-quality bulbs and "rugged duty" bulbs are resistant to breakage. Consequently, the hammer must be properly positioned.

2. The cooling screen may be used to strain out glass particles from any residual gasoline in the pan during clean-up.

DEMONSTRATION No. 9

TITLE: Sources of Heat (C)

OBJECTIVE: To verify that even low-voltage, non-sparking, non-arcing electricity is a potential ignition source.

EQUIPMENT

1. Fire Factor Display
2. Power supply
3. Low voltage heating element and probe
4. Beaker
5. Beaker cover
6. Gasoline

FLIP CHART DISPLAY: "Sources of Heat"

INTRODUCTION: The type of heat source used in this demonstration, except when it is adjuste to a low voltage, is equivalent to a common hotplate, radiant heater, or simila equipment often used in industry, and particularly common to household appliances. Soldering irons and overloaded electrical curcuits are potential ignition sources of this type.

PROCEDURE:

1. With the power supply switch in the OFF position, connect the power supply to the household line voltage (110 volts).

2. Attach the low voltage heating element to the mating receptacle on the power supply.

3. Pour about 75 ml of gasoline in the beaker.

4. Place the power supply switch in the ON position and turn the control rheostat to the full counterclockwise position.

5. Hold the heating element over the mouth of the beaker and increase power until the heating element becomes hot enough to ignite the gasoline vapors (Figure 8).

6. Immediately upon ignition, withdraw the probe, and extinguish the fire with the beaker cover.

continued -

PROCEDURE (cont.):

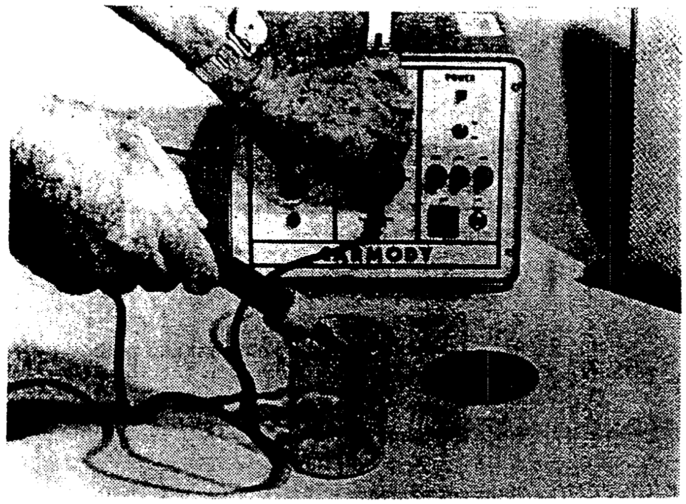


Figure 8. Low-Voltage, Non-Sparking Electricity Can Develop Sufficient Heat to Ignite Gasoline Vapors.

NOTE

1. When the power rheostat is turned to its full clockwise position, the heating element will glow a very bright red orange in a matter of a few seconds, even though only 6 volts are being applied to the heating element. By rotating the rheostat control counterclockwise, you can demonstrate that a reduced voltage (below 6 volts) will directly affect the surface temperature of the wire, and consequently, its color. With a red glow barely evident in the element, the surface temperature will exceed the 495° F. (257.2° C.) required to ignite gasoline vapors at the mouth of the beaker.

2. If only a small amount of gasoline is placed in the beaker, do not hold the element immediately above the surface of the liquid because the lack of oxygen at that point will prevent ignition, as will be shown in Demonstration No. 12.

DEMONSTRATION NO. 10

TITLE: Sources of Heat (D)

OBJECTIVE: To demonstrate that a spark caused by static electricity will cause a fire

EQUIPMENT:

1. Fire Factor Display
2. Discharge chamber
3. Static Electricity Generator (Plate and Disc)
4. Piece of cloth
5. Beaker containing about 75 ml of gasoline
6. Beaker cover
7. Paper to seal discharge chamber
8. Elastic retainer
9. Large cover (for discharge chamber) (Use aluminum disc w/handle)
10. Hypodermic syringe

FLIP CHART DISPLAY: "Sources of Heat"

INTRODUCTION: Each of the preceding demonstrations has utilized electricity in motion, or more specifically, dynamic electricity. Static electricity, or electricity at rest, is physically identical to its counterpart. Since static electricity is frequently produced at high voltage and small quantity, the two are often considered as being distinctly different types of electricity. In any event, it is accurate to anticipate that static electricity has the same fire-igniting qualities that have been displayed in the previous demonstrations.

The phenomenon of static electricity is manifested in innumerable ways. It will suffice in this demonstration to explain that static electricity is developed from the relative motion between, and/or the separation of various dissimilar materials.

You will want to practice this demonstration before presenting it to a training class or other audience, since the static electric charge developed, although high in voltage (at least 10 to 20 thousand volts), is extremely low in current and discharges so rapidly that the air-vapor mixture may not always be ignited on the first try.

continued —

INTRODUCTION (cont.): Several factors have been found to affect the reliability of this demonstration. The plate and disc must be dry, dust-free and otherwise clean. After using the aluminum disc as fire suppression cover for other demonstrations, it should be cleaned with a solvent before use in this demonstration. The electrodes within the chamber must be cleaned so that tars and/or soot from previous demonstrations do not hinder the static discharge. The demonstrator's hands must be dry or else he should wear a glove on the hand holding the disc.

In addition to the foregoing, the ambient relative humidity, if very high will have a deterring influence on the static discharge. A common misunderstanding is that static electricity is not readily generated in a humid atmosphere or, conversely, that very dry air is conducive to the development of static electricity. Experts advise that the electrostatic charge is developed equally well at both extremes. Humid air, however, has greater conductivity and "bleeds off" the static charge from the aluminum disc, thus reducing the potential available for discharge in the chamber. This condition is, of course, related to nature's most dramatic display of electricity — lightning.

PROCEDURE:

1. Rub the top of the plastic and brass plate vigorously with the cloth provided. (The top of the plastic/brass plate is the side with the electrodes protruding from diagonally opposite corners of the brass sheet).

2. Place the aluminum disc on the plastic/brass with a sliding-twisting motion. (Do not let your arm or shirt-cuff get near the disc or the static charge will bleed off.)

3. Moisten thumb and forefinger with your tongue and bridge between the top of the aluminum and one of the metal connections to the brass plate between the two pieces of plastic which are bolted together. (This conducts away the repelled negative charges from the disc, leaving it with a substantial positive charge.)

4. Touch the disc to your finger. A discharge should occur. (It may be necessary to repeat this operation until the disc builds up a suitable charge. Once this is achieved, consecutive charging and discharging of the disc will be possible.)

5. Adjust the spark gap to suit humidity conditions by changing the distance between the internal electrodes.

   The gap between the two electrodes (ball or acorn nut type) inside the combustion chamber has been factory-set to approximately 3/16". Before injecting fuel into chamber, charge the aluminum disc as described above and touch it to one of the external electrodes (ball or acorn nut type) while grasping the other electrode with

continued —

PROCEDURE (cont.):

your free hand. If high humidity has decreased the charge on the disc, it may be necessary to reduce the spark gap to achieve a spark capable of causing ignition.

Reduce the gap by adjusting the balls or acorn nuts until a "sharp" spark is seen and heard. (On later models the gap inside the chamber is equivalent to the gap between the external acorn nut and brass retaining nut on the adjustable electrode. The spark gap may therefore be varied by simple external adjustment.) If the atmosphere is low in humidity, the gap may be increased.

Figure 9. A Spark Caused by Static Electricity Can Start a Fire.

6. Draw ¼cc of gasoline from the beaker into the hypodermic syringe. (The reasonable accuracy of this amount of gasoline is necessary to obtain the required combustible range within the chamber.)

7. Carefully spray this small amount of gasoline around the upper inside wall of the chamber. Move the hypodermic syringe needle around the upper wall as the gasoline is forced through the needle.

8. Immediately place the sheet of paper and elastic retainer on the chamber to effect a seal. Do not shake the chamber

CAUTION

Keep face clear of chamber opening

continued —

9. Rapidly charge the disc as described above. Grasp one of the electrodes with your free hand and bring the charged disc into contact with the other electrode on the chamber. This action should cause a small explosion to occur. If there is no discharge from the disc, or if a discharge occurred but was not followed by an explosion, rapidly recharge the disc and once again bring it into contact with the free electrode. This may require several attempts as the vapors are settling slowly and may not have reached the internal electrodes during the first few attempts.

CONCLUDING REMARKS:

Under normal conditions the disc may discharge as much as ½-inch (12.7mm) from the electrode. The "snap" of this arc may be heard and frequently the arc will be visible. This discharge will carry through the electrodes causing ignition and dramatic explosion which will either tear the paper seal, or blow it of the chamber. If sufficient gasoline vapors remain after the ignition, extinguish the lingering fire with the large cover in order to minimize the accumulative effects of the fire on the acrylic plastic chamber.

If you are not successful in obtaining ignition on the first try, recharge the disc and repeat the procedure without "recharging" the chamber with gasoline vapors. In the event that several attempts prove unsuccessful, explain that several possibilities may exist. The most common "malfunction" of this demonstration is the lack of an air-fuel mixture in the combustible range in the immediate area of the electode gap within the chamber. This is not necessarily the result of an improper amount of gasoline being sprayed into the chamber, but rather the possibility that the gasoline has not vaporized sufficiently in the area of the arc, or that vapors due to their weight have fallen to the bottom of the chamber and the air-fuel mixture at the electrode gap is too rich.

Lastly, it may be that the relative humidity in the room is draining some of the electrostatic charge from the arc as previously explained. When this occurs, it may be helpful to add a small amount of lighter fluid to the gasoline in the beaker. This sometimes speeds vaporization and thus helps produce an explosion Another alternative is to improve grounding by attaching one of the electrodes to a convenient cold water pipe or other ground, using a clamp and wire.

A small amount of familiarization and practice will enable you to become proficient in this and all of the foregoing demonstrations. Practice will increase your confidence, ensure the full and proper use of the equipment, and maximize communication to the trainees. Even an unsuccessful effort in any of the demonstrations performed proves that one can never be sure that a fire will, or will not occur if the elements of ignition are present, and it may again be stressed that if they are present in the RIGHT COMBINATION, combustion will ALWAYS occur, and as chain reactions develop, fire will continue.

DEMONSTRATION No. 11

TITLE: Sources of Heat (E)

OBJECTIVE: To demonstrate that a chain reaction can generate spontaneous combustion as an ignition source.

EQUIPMENT:

1. Fire Factor Display
2. Mortar and pestle
3. Stainless steel crucible and cover
4. Potassium permanganate ($KMnO_4$). and glycerine
5. Piece of hardwood or 8 in. (20.3 cm) pan

FLIP CHART DISPLAY: "Sources of Heat"

INTRODUCTION: A frequently mentioned, but often not understood and neglected source of ignition is spontaneous combustion, or more correctly the ignition or explosion produced by successive chemical reactions between fuel vapor and oxygen that causes the gradual rising of temperatures until the self ignition point is reached.

Figure 10. Chemical Reaction Can Cause Heat and Combustion.

INTRODUCTION (cont.): The reaction rate, or the period of time required for different materials to produce sufficient heat to ignite whatever fuel is available, varies considerably. The demonstration provided by the Carmody Combustible Hazards Trainer requires only a few seconds.

Perhaps the most hazardous forms of spontaneous combustion are those which require days, or even weeks to ignite, depending upon ambient conditions. If chemicals which are a potential source of spontaneous combustion are produced or used in production at your facility, it is important that your employees know this hazard. Petroleum products and many others used in industry, will not ignite through spontaneous combustion. Nevertheless, many materials used in production and in maintenance are potential sources of this type of combustion.

PRECAUTIONARY NOTES

1. For this experiment, use only the stainless steel crucible cover as prescribed.

2. Use the amount of materials specified, and in the specific manner set forth.

3. After the combustion occurs, **do not** attempt to extinguish the fire. If prescribed amounts of materials are used, the flame will last only a few seconds.

4. Be very careful in disposing of the residue. The crucible cover will remain hot until it is allowed a few minutes to cool.

5. Potassium permanganate is a powerful oxidizing agent. Always store the potassium permanganate and the glycerine in the containers supplied, and, when not in use, keep these containers in the storage compartments provided. Although both of these materials are available in almost any drug store, medical supply outlet, or chemical supplier, there are federal and international restrictions with regard to trans-shipping or carrying potassium permanganate via mail or airplane and ship. These restrictions vary according to the quantity of material involved, the form of the material (crystalline, powder, etc.) and the container in which it is transported.

NOTE

The potassium permanganate as supplied with the trainer is in a relatively course crystalline form and

continued —

will not, therefore, react readily with the glycerine. It is recommended that you pulverize a small amount (no more than ¼ teaspoon or 1 ml) prior to the demonstration so as not to detract from the presentation by grinding the crystals in the presence of the trainees or audience, thus reducing the impact of the demonstration. Since potassium permanganate is a skin and eye irritant, it should be handled with a (measuring) spoon.

PROCEDURE:

1. Place the stainless steel crucible cover, with the depressed area fitting downward into the crucible, on top of the crucible. To stabilize the crucible on the table cover, it is recommended that the crucible be placed on the piece of hardwood or in the (clean) 8" pan.

2. Place the powdered potassium permanganate in the center of the stainless steel crucible cover. Form this material into a circle approximately ½ to ¾ of an inch (12.7 to 19.1 mm) in diameter with a small depression in the center, using a spoon or match.

3. Fill the depression formed in the preceding step with glycerine from the squeeze dropper bottle.

CAUTION

After adding the glycerine, keep your hands away from the crucible. Depending on how finely the potassium permanganate has been ground (more finely ground material will react more rapidly), the mixture will soon begin to smoke, and with increasingly violent reaction will suddenly break into a most dramatic fire. The residue should be examined to be sure that complete combustion has occurred. If any amount of potassium permanganate powder appears to be unaffected, it is advisable to place another drop or two of glycerine to assure complete reaction and combustion.

Equipment should be cleaned with copious amounts of water following demonstration.

LESSON 4: OXYGEN: ITS ROLE IN THE COMBUSTION PROCESS | TIME: 2 H(

OBJECTIVES

By the end of this lesson the participant will be able to:

1. Explain how oxygen contributes to the fire tetrahedron.
2. Describe how certain materials generate their own oxygen.

METHODOLOGY

After an explanation of the oxygen element of the fire tetrahedron, this lesson will explore how oxygen can initiate a backdraft explosion, and how certain materials can give off their own oxygen. Lecture and group discussion will be used. Live demonstrations using the Carmody Combustible Hazards Trainer will emphasize key points.

DEMONSTRATION #12

INSTRUCTIONAL NEEDS

- One Overhead Projector
- One Screen
- Flip Chart or Black Board
- Carmody Combustible Hazards Trainer
- Materials Listed In #6 Below

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	10 min	1. ADMINISTRATIVE MATTERS.
		2. PRESENT LESSON OBJECTIVES.

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
Use the Carmody Fire Factor Display	1 hour	3. EXPLAIN THE OXYGEN ELEMENT OF THE FIRE TETRAHEDRON. A. Atmospheric oxygen is 21 of our atmosphere at sea level. B. In order to have combust there must be a reducing agent (fuel) and an oxyd agent (oxygen source). C. Most fuels need a minimur of 15% oxygen concentrat to burn. D. Oxygen in excess of a 20 concentration may cause a more rapid, more intense or possibly even an expl combustion. E. As seen in lesson 6, the removal of oxygen can be factor in the extinguishr of fire.
Visual #1 - DEFINITIONS		4. THE FOLLOWING DEMONSTRATION WILL SHOW THE NEED FOR OXYG IN SUPPORT OF THE COMBUSTIO PROCESS. A. Demonstration #12 The Need for Oxygen
Visual # 4 - BACKDRAFT Fire Factor Display		5. DESCRIBE HOW OXYGEN BECOMES THE INITATING FACTOR IN A BACKDRAFT EXPLOSION. A. Hot fire in a confined area B. Fuel and heat present C. Oxygen is depleted D. Sudden influx of oxygen E. Therefore rapid combusti
NOTE:Please read and follow safety precautions on pages 3-3 through 3-5.		6. SUPPLEMENTAL DEMONSTRATION OXYGEN DEFICIENCY. THE FOLLOWING DEMONSTRATION WILL SHOW HOW FIRE CONSUMES OXYGE A. Needs -Candle -Glass bowl (clear) -Straight sided clear gla bottle (1 quart or 1 lit -One quart or liter of wa -Fire extinguisher

DEMONSTRATION No. 12

TITLE: The Chemistry of Fire (D)

OBJECTIVES:

1. To demonstrate the need for air or oxygen to support combustion.
2. To demonstrate that "heat-energy" must be present if fire is to result.

EQUIPMENT:

1. Fire Factor Display
2. High-voltage sparking unit and power supply
3. Beaker containing 40 ml of gasoline
4. Beaker cover

FLIP CHART DISPLAY: "Definitions"

INTRODUCTION:

Air, or the oxygen in the air, is essential for the creation of a fire. Consequently, whenever air is present along with flammable liquids or combustible materials, a potential fire hazard exists. Partially empty gasoline drums, discarded waste material, stacks of old newspapers, and accumulated dust and dirt fall into this category.

The important thing to remember is that fuel vapors and temperature alone will not cause the ignition of a fire, but that air or oxygen must be mixed with the fuel vapors to form a flammable mixture.

WARNING

High Voltage
5000V

Be sure high voltage is off when connecting leads. Turn high voltage off immediately after experiment.

PROCEDURE:

1. Attach the high-voltage sparking unit to the power supply, using appropriate matched plugs and receptacles.

NOTE

The power switch on the right side of the power supply must be turned on in order to operate the high-voltage equipment from the covered switch on the left side of the unit.

continued —

PROCEDURE (cont)

2 Hold the electrodes of the high-voltage sparking unit about 1/8 inch (3.2 mm) above the surface of the gasoline in the beaker

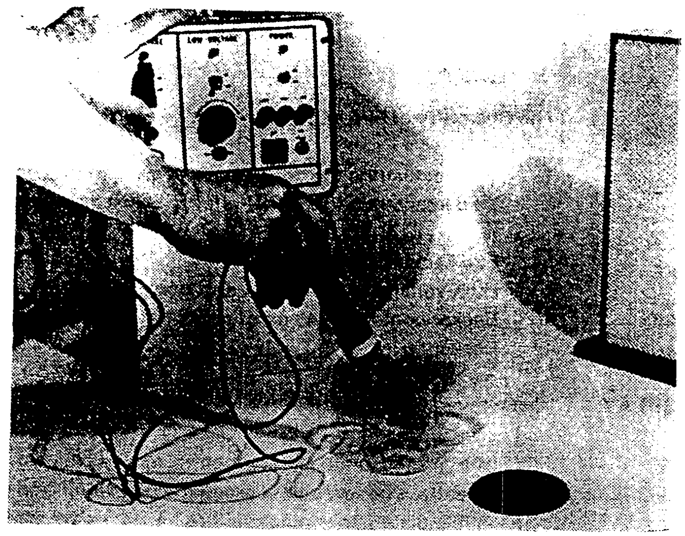


Figure 11. Combustion Cannot Occur Without Air or Oxygen.

3. Turn on the high-voltage switch. The sparking device will arc, but combustion will not occur.

4. Turn off the high-voltage spark.

NOTE

Do not reposition the sparking electrodes before turning the current off

5. Ask the trainees if they know why no ignition occurred. Point out that vapors were present, because gasoline has a vapor temperature of -45° F. (-42.8° C.). Heat energy was available from the 5,000-volt arc, yet there was no fire because of the lack of sufficient air or oxygen.

6. Repeat the demonstration, but hold the electrodes of the high-voltage sparking device up near the mouth of the beaker, rather than down near the surface of the gasoline. Because of the suitable air-fuel vapor mixture, ignition will take place. Extinguish the fire immediately by placing a cover over the beaker

continued

LESSON 5: EXPLOSIONS TIME: 2 HOURS

OBJECTIVES

By the end of this lesson the participant will be able to:

1. Describe how an explosion occurs.
2. Differentiate between an detonation and a deflagration.
3. Explain the term B.L.E.V.E. and discuss its importance.

METHODOLOGY

A detailed explanation of an explosion will be given followed by a differentiation between a detonation and a deflagration. This will be followed by a discussion on dust explosions and a film and group discussion on the Boiling Liquid Expanding Vapor Explosio Live demonstrations using the Carmody Combustible Hazards Trainer w reinforce key points.

DEMONSTRATIONS 13,14

INSTRUCTIONAL NEEDS

- One Overhead Projector
- One 16mm Movie/Sound Projector
- One Screen
- Flip Chart or Black Board
- Carmody Combustible Hazards Trainer

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	10 min	1. ADMINISTRATIVE MATTERS. 2. PRESENT LESSON OBJECTIVES.
Use the Carmody Fire Factor REF. FPH. pp 3-15 - 3-18	50 min	3. DEFINE THE TERM EXPLOSION. A. An explosion is combusti that occurs in a confine space. It can also be be defined as a sudden and violent expansion of a gas.
Visual # 5 -DETONATION DEFLAGRATION		4. DEFINE THE TERMS DETONATIOI AND DEFLAGRATION. A. Detonation: A reaction that produces heat characterized by a shock traveling at a speed gr than the speed of sound. B. Deflagration: A reactio that produces heat characterized by a rapi spreading of the heat at a speed less than the speed of sound.
Provide the participant other examples of explosive ranges using materials common to their work environments.		5. FOR AN EXPLOSION TO OCCUR OXYGEN, FUEL, AND TEMPERATI MUST BE IN THEIR CORRECT PROPORTIONS. A. The term flammability r or explosive range refe to the relationship of to oxygen. B. Gasoline vapors, for ex. have a flammability ran of 1.4% to 7.6% gasolin vapors in air. Concentr above 7.6% or below 1.4 will not ignite.
Visual #1 - DEFINITIONS		6. THE FOLLOWING DEMONSTRATIO WILL SHOW AN EXPLOSION AND EXPLOSIVE RANGES A. Demonstration #13. Explosion and Flammabil Range.

DETONATION

A REACTION THAT PRODUCES HEAT CHARACTERIZED BY A SHOCK WAVE TRAVELING AT A SPEED GREATER THAN THE SPEED OF SOUND.

DEFLAGRATION

A REACTION THAT PRODUCES HEAT CHARACTERIZED BY A RAPID SPREADING OF THE HEAT AT A SPEED LESS THAN THE SPEED OF SOUND.

DEMONSTRATION No. 13

TITLE: Explosion and Flammability Range (A)

OBJECTIVES:

1. To demonstrate that explosion is combustion in a confined space.
2. To demonstrate that the air-vapor ratio for a given fuel must be within its flammability range before it will burn or explode.

EQUIPMENT:

1. Fire Factor Display
2. Power supply
3. High-voltage connecting leads
4. Spark plug ignition chamber
5. Rubber stopper
6. Length of small chain
7. Eyedropper
8. Large cover (Use aluminum disc w/handle)
9. Gasoline

FLIP CHART DISPLAY: Definitions

INTRODUCTION:

The term "flammability range" relates to the air-fuel or air-vapor mixture required for ignition. A previous demonstration (#12), by means of the high-voltage arc near the surface of the gasoline, proved that gasoline vapors will not ignite unless sufficient air (oxygen) is available. In the case of gasoline, the concentration of gasoline vapors in air must be between 1.4 and 7.6 to produce an explosion or fire. The term "explosion" means nothing more than combustion occurring in a confined space.

WARNING

High Voltage
5000 V

1. Be sure high voltage is off when connecting leads.
2. Turn high voltage off immediately after demonstration.
3. Do not touch spark plug ignition chamber while high voltage is on.

PROCEDURE:

1. Place two or three drops (no more) of gasoline in the chamber along with the length of chain

2. Cork the tube with the rubber stopper and shake the entire assembly briskly to ensure vaporization of the gasoline.

continued —

PROCEDURE (cont.):

3. Hold the large cover 8 to 10 inches (20.3 to 25.4 cm) above the rubber stopper and turn the high-voltage switch to ON. A very dramatic explosion will occur.

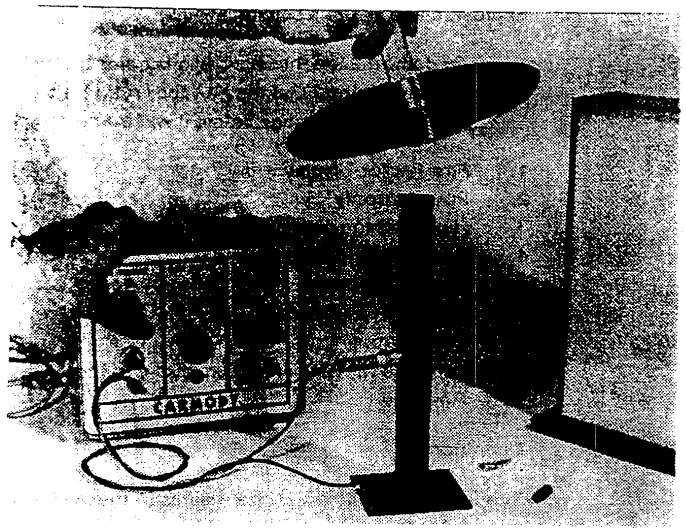


Figure 12. Explosion is Combustion in a Confined Space.

4. Suggest that, since this explosion resulted from just two drops of gasoline — why not have a "really big" explosion by tripling the number of drops used.

5. Blow the residual products of combustion from the first explosion from the tube and repeat the demonstration, using six drops of gasoline. Under normal circumstances, no explosion will occur. (Actuate the high-voltage switch several times to positively establish that current is being applied to the spark plug.)

6. Turn off the high voltage and remove the connecting wires. Then remove the cork from the tube and invert the tube for a few seconds. Reinsert the cork, reassemble the equipment, and again actuate the high-voltage switch.

7. Normally, a sufficient amount of gasoline vapors will have fallen from the tube when it was inverted to adjust the air-vapor mixture in the tube to the combustible range of gasoline. If an explosion does not occur, empty more vapor from the tube and try again.

continued —

PROCEDURE (cont.):

8. It is possible of course, to empty too much gasoline vapor from the tube and reduce the air-vapor mixture below the combustible range. With a little practice, however, you will have no difficulty in performing this demonstration.

9. Using the flip chart, review the term "flammability range" and discuss.

DEMONSTRATION No. 14

TITLE: Explosion and Flammability Range (B)

OBJECTIVES: To provide a visual demonstration of an explosion.

EQUIPMENT:

1. Fire Factor Display
2. Glass tube
3. Two rubber stoppers
4. Piece of chain
5. Friction sparker
6. Eyedropper
7. Gasoline

FLIP CHART DISPLAY: "Definitions"

INTRODUCTION: Observe that, having just heard an explosion, it might be interesting to see one. Many persons are unaware that an explosion can be seen.

PROCEDURE:

1. Using the eye dropper, place 4 to 6 drops of gasoline in the tube, along with the length of chain.

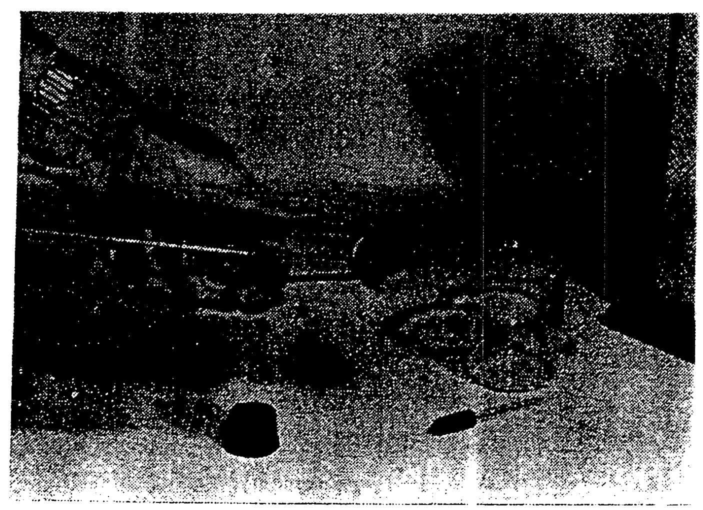


Figure 13. With Appropriate Equipment, An Explosion Can be Seen

continued —

PROCEDURE (cont.):

2. Place the remaining stopper tightly in the open end of the tube and shake the chain vigorously throughout the entire length of the tube to effect even distribution of the gasoline vapors.

3. Hold the tube in a horizontal position, remove one of the corks and strike the sparker at the open end of the tube. It may be necessary to t the tube slightly toward the spark.

NOTE

Keep the tube pointed away from yourself and parallel to the class. Also keep your hands away from the open end of the tube when striking the friction sparker.

4. The resulting explosion can be readily seen by the trainees as the flam burns rapidly through the tube. It may be noted that the rate of burnin is approximately 60 miles (96.6 kilometers) per hour.

LESSON 6: EXTINGUISHMENT OF FIRE TIME: 2 hours

OBJECTIVES

By the end of this lesson the participant will be able to:

1. Using the tetrahedron, describe how fire may be extinguished.
2. Explain the four classes of fire and fire extinguisher selectio
3. Discuss the dangers of the various extinguishing agents.

METHODOLOGY

This lesson will start with an explanation of the four standard classifications of fire by the source of fuel. An in depth discussion will follow regarding ways fire can be extinguished by controlling heat, oxygen, fuel, and the chemical chain reaction. A film detailing the proper use of fire extinguishers will be followed by a discussion on the dangers of different extinguishing agents. Live demonstrations using the Carmody Combustible Hazards Trainer will reinforce key points.

DEMONSTRATIONS 15,16,17,18,19

INSTRUCTIONAL NEEDS

- One Overhead Projector
- One 16mm Movie/Sound Projector
- One Screen
- Flip Chart or Black Board
- Carmody Combustible Hazards Trainer

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	10 min	1. ADMINISTRATIVE MATTERS. 2. PRESENT LESSON OBJECTIVES
Visual #6-CLASSES OF FIRE	1 hour	3. DISCUSS THE FOUR CLASSIFI OF FIRE BY THEIR FUEL SOU A. Class A= Combustible M B. Class B= Flammable Liq C. Class C= Live Electric D. Class D= Metals
Use the Carmody Fire Factor Display		4. INTRODUCE THE FOUR WAYS F CAN BE EXTINGUISHED. A. Removal of Heat B. Removal of Oxygen C. Removal of Fuel D. Disruption of the Chair Reaction 5. REMOVAL OF HEAT A. Principle agent is wate B. For use in extinguisher water is considered a Class A agent only C. Water has the ability t absorb large quantities of heat D. Water is the principle extinguishing agent of the fire service, and through automatic sprin systems, it is the agen that protects most indu
NOTE:In this demonstration water will be used on a Class B fire as a cooling agent. Although this may be practiced by fire control professionals, unskilled personnel should be strongly discouraged from this technique.		6. The FOLLOWING DEMONSTRATIO WILL SHOW THE VALUE OF WAT AS AN EXTINGUISHING AGENT. A. Demonstration #15 7. HEAT MAY BE CONTROLLED BY O MEANS. A METAL SCREEN IS US IN FLAMMABLE LIQUID SAFETY

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
NOTE: Demonstration #17 will also show the removal of oxygen as a means of controlling fire by means of the spring loaded cover		TO PREVENT FLAME FROM SPREAI INTO THE CAN. THE FOLLOWING TWO DEMONSTRATION: WILL SHOW ANOTHER METHOD OF REMOVING HEAT. A. Demonstration #16 B. Demonstration #17 8. REMOVAL OF OXYGEN A. Oxygen is principally rer by one of two methods. - Controlling the source - Using a gas that displaces oxygen B. Gases such as Carbon Dio› are frequently used to displace oxygen. - CO2 is considered a Class BC agent. C. Controlling ventilation c covers of containers holc fuels will also limit oxy as shown in Demo #17 abov
	20 min	9. REMOVAL OF FUEL A. Controlling the flow of f in a fire area will limit or extinguish the fire. -This may be done physica -It may also be done by separating the fuel fron the oxygen be a film of foam. 10. THE FOLLOWING DEMONSTRATION WILL SHOW HOW A CLASS B FIRE CAN BE EXTINGUISHED BY USINC FUEL CONTROL. A. Demonstration # 18 Fuel Control 11. DISRUPTION OF THE CHEMICAL CHAIN REACTION A. Although the chain reaction is not totally understood, certain

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
		chemicals and gases are able to interrupt the chain reaction and extinguish the fire. B. These substances are rated as Class ABC or Class BC agents and include: - ABC Dry Chemical - BC Dry Chemical - 1211 Halon Gas - 1301 Halon Gas
		12. THE FOLLOWING DEMONSTRATIO: WILL SHOW THE EFFECT OF ABC DRY CHEMICAL ON A CLASS B FIRE. A. DEMONSTRATION # 19
NOTE: **Please read and follow safety precautions** on pages 3-3 through 3-5.		13. SUPPLEMENTAL DEMONSTRATION FIRE SUPPRESSION USING HAL(A. Needs: -Pan (20.3cm) -Gasoline -Two Beakers and one Co\ -Small amount of Halon 1 -Protective Table Cover -Small ABC Fire Extingui B. Method: -Place 10 ml of gasoline into one beaker in pan. -Place a small amount of Halon gas into other be -Ignite gasoline and the pour halon into beaker containing the gasoline fire. -Explain to the particip that the Halon breaks t chemical chain reaction
REF: FBTM p.181	10 min	14. DANGERS OF EXTINGUISHING AG A. Water -Electrocution -Drowning -Water Reactive Chemical

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
		B. Carbon Dioxide -Displaces Oxygen -Frostbite with skin con C. Dry Chemical -Temporary inability to D. Halon -Toxicity at high temper
Introduce and show film Using Fire Extinguishers The Right Way (NFPA)	25 min	15. FILM: USING FIRE EXTINGUISH THE RIGHT WAY
	5 min	16. SUMMARIZE KEY POINTS OF LESSON 6

FOUR CLASSES OF FIRE

CLASS A	COMBUSTIBLE MATERIALS
CLASS B	FLAMMABLE LIQUIDS
CLASS C	LIVE ELECTRICAL
CLASS D	METALS

Visual #6 - CLASSES OF FIRE

DEMONSTRATION No. 15

TITLE: Extinguishing Fire by Removal of Heat (A)

OBJECTIVE: To demonstrate that water mist or fog will absorb or remove heat and extinguish a fire.

EQUIPMENT:

1. Fire Factor Display
2. Steel crucible
3. Cover
4. Fogging gun filled with water
5. Gasoline
6. Friction sparker
7. Pan - 8 in. (20.3 cm)

INTRODUCTION:

Water is not generally considered to be one of the more effective means of extinguishing a petroleum fire. As a matter of fact, it is only because the water is atomized to a fine mist with a relative minimum of air, that it actually extinguishes the fire. The water mist, or fog, absorbs the heat. The possibility that air is being removed by the blanketing effect of the fog is very minor. You can support this statement by pointing out that steam is used to atomize fuel oil in large furnaces and actually aids and abets burning of the oil. Also, water injection in high performance internal combustion engines (particularly aircraft engines) is often used to increase power.

As a final explanation, you can state that the extremely fine droplets of water produced by the fogging gun only succeed in cooling (as compared with a large drop spray) because they are being converted to steam vapor (going through a change of state) and therefore are able, in doing so, to absorb 970 times as much heat as water is capable of doing, as it rises in temperature below its vaporizing point.

In this demonstration, you should emphasize that the amount of cooling available from a given mass of water (or fog) is limited and that in this instance the relatively small flame, and the heat being developed by it can be cooled by the fogging ability of this spray gun. If the fire had been lighted in a beaker full of gasoline, the demonstration would be less likely to succeed.

PROCEDURE:

1. Place the steel crucible in the pan and fill the steel crucible about 2/3 full of gasoline.

2. With the friction sparker, ignite the gasoline vapor above the crucible.

3. Hold the fogging gun about one foot (30.5cm) from the crucible and spray the water mist over the flaming vapor (see Figure 14.) Come in at low angle, directing the spray at the base of the flame.

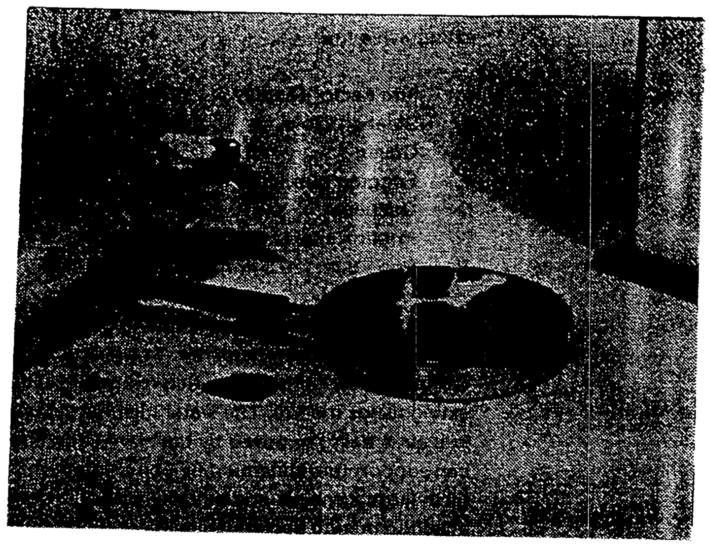


Figure 14. Water Mist or Fog Absorbs or Removes Heat and Extinguishes the Fire.

NOTE

Should you, for any reason, such as plugging of the fogging gun, have difficulty in extinguishing the flame, place the cover on the crucible promptly, remove the difficulty and repeat the demonstration.

DEMONSTRATION No. 16

TITLE: Extinguishing Fire by Removal of Heat (B)

OBJECTIVE: To show that removal of heat extinguishes a fire.

EQUIPMENT:

1. Fire Factor Display
2. Beaker — Spoutless (200ml)
3. Cooling screen
4. Friction sparker
5. Beaker cover
6. Gasoline

INTRODUCTION: In this demonstration, a fire will be extinguished by removal of one of the four factors of the Fire Factor Display: temperature. This demonstration, and those following are not intended to teach fire fighting techniques. Instead, they are intended to present the principles on which fire-fighting techniques and equipment are based.

If the heat of the fire (which enhances its propagation as long as the other factors necessary for combustion are present), is reduced below the ignition temperature of the fuel, the fire will go out.

PRECAUTIONARY NOTE

It is advisable not to let too large a flame develop. Remember a considerable amount of gasoline is available in the beaker, and the ever-increasing heat will cause more and more vapor to be emitted and this vapor will support a larger and larger flame. As the flame increases in magnitude the relative heat absorbing ability of the screen is reduced.

PROCEDURE

1. Fill the beaker with gasoline to within ¼ inch (6.4 mm) of the upper rim.

NOTE

You may be questioned as to why the beaker is filled nearly to the brim (thus increasing the fuel

continued --

PROCEDURE (cont.):

quantity and, as a matter of fact, the relative hazard in performing the presentation). If the beaker were only half filled, or less, it would not be possible to cool the flame close to the gasoline surface, as is necessary to completely extinguish the fire. If the small container were used, such as the stainless steel crucible, the demonstration would be far less impressive.

2. Light the gasoline vapors with the friction sparker.

3. Bring the wire mesh square down over the flame as shown in Figure 1 simultaneously switching off the "temperature" section of the Fire Factor Display. Note that the flame does not pass through the screen, and as the screen is positioned on top of the beaker, the fire actually goes out. (Note also that the Fire factor Display "Fire" lights have been extinguished.)

4. With the screen in place on top of the beaker, re-light the gasoline. No that the flames do not pass through the screen, illustrating the screen's ability to prevent flashback, as further shown in Demonstration #17. Remove the screen and extinguish the flame promptly, using the beaker cover.

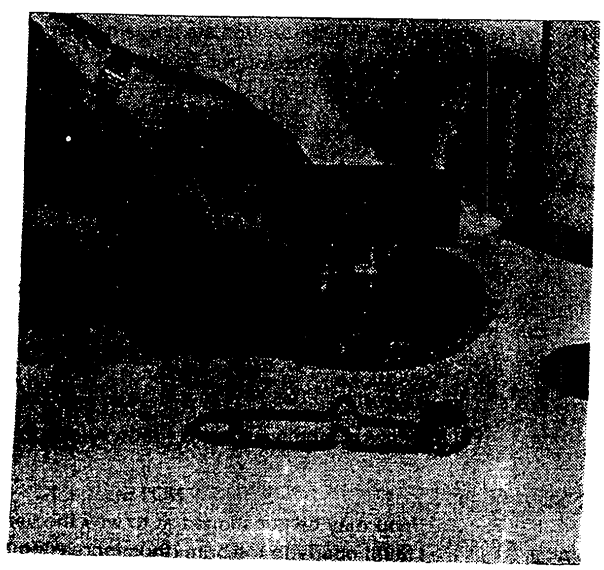


Figure 15. A Wire Mesh Removes the Heat Necessary for Combustion, Thus Extinguishing the Fire.

continued –

PROCEDURE:

1. Pick up the gasoline (red label) can and, using the hand trigger, hold the cover open.

2. Using the friction sparker, light the gasoline vapors at the mouth of the can.

NOTE

> A lazy flame will burn at the mouth of the container; it will not propagate into the container for two prime reasons. First, the limited amount of air in the throat of the chamber is reduced below the combustible range of the gas flame (see Demonstration No. 3).
>
> In addition, the safety screen inside the throat of the can acts as a flame arrester, equivalent to the cooling screen demonstrated just a few minutes ago.

3. Again point out the safety screen inside the throat of the can and review how it acts as a flame arrester.

4. Close the cover of the safety can to extinguish the flame immediately and permanently.

DEMONSTRATION No. 18

TITLE: Extinguishing Fire by Removal of Fuel Supply.

OBJECTIVE: To demonstrate that the removal of fuel extinguishes a fire.

EQUIPMENT:

1. Fire Factor Display
2. Ring stand
3. Separatory funnel
4. Flask
5. Stopper assembly (hose, stopper, vent tube)
6. Gasoline
7. Matches

INTRODUCTION: This demonstration is one of the most important in the entire presentation because it shows the vapor hazards present when filling a tank truck or a storage tank. You should point out that gasoline vapors can be forced out around the filling hose, as well as out of whatever vent may be provided. The hazard caused by the presence of static electricity should be pointed out, with emphasis on the necessity for proper grounding to prevent a spark from developing between the nozzle of the filling hose and the tank opening. (See Demonstration No. 10.)

Figure 16.
Removal of Fuel
Extinguishes a Fire.

PROCEDURE:

1. Set up the ring stand, separatory funnel, interconnecting hose, stopper, vent tube and flask, as shown in Figure 16.

2. Make sure the petcock at the bottom of the separatory funnel is closed (in horizontal position). If protective paper is still in valve, remove it.

3. Fill the separatory funnel by pouring gasoline into a beaker and then into the funnel. Leave the stopper off the funnel.

4. Next, strike a match and hold it at the vent opening, above the flask, at the same time gradually opening the petcock on the separatory funnel. (Gasoline will flow from the funnel into the flask and gasoline vapor-laden air will be forced from the flask out the vent. These vapors will be ignited by the match.)

5. Partially close and open the petcock two or three times to show that the magnitude, or length of the flame may be varied by changing the rate of flow of gasoline from the funnel into the flask.

6. Explain that the magnitude of any fire, assuming a satisfactory ignition temperature and an adequate air supply, is limited only by the amount of fuel that can be made available.

7. Turn the petcock to its closed position to show that the flame will go out when the vapors are no longer being forced out of the vent by the gasoline, as it is poured into the flask.

ADDITIONAL COMMENTS:

If desired, you can demonstrate that gasoline flow will not continue out of the separatory funnel (or a tank car) unless air can enter to take the place of the gasoline leaving the funnel. To accomplish this, place the glass stopper securely in the separatory funnel. A partial vacuum will soon develop in the funnel above the gasoline, reducing the rate of flow into the flask. If this is done when the funnel is nearly filled, the flow may stop completely, thus extinguishing the fire.

Another possibility, depending on the flow of gasoline, and the difference in level between the flask and the funnel, is that air may be sucked intermittently from the flask into the funnel, due to the partial vacuum. Depending on the amount of air movement and the rate of flow, the flame will either be extinguished or act very erratically. In due course, however, the flame will most likely go out because of lack of fuel.

DEMONSTRATION No. 19

TITLE: Extinguishing Fire by a Combination of Methods

OBJECTIVE: To demonstrate that ABC Dry Chemical effectively extinguishes a fire by a combination of methods, including the interruption of the chain reaction.

EQUIPMENT:

1. Fire Factor Display
2. Pan - 8 in. (20.3 cm)
3. Stainless steel crucible and cover
4. Eyedropper
5. Sand
6. ABC Dry Chemical
7. Gasoline
8. Shakers (2)

INTRODUCTION: "ABC" identifies the dry chemical as being effective for extinguishing all three classes of fire — A, B, and C (see Page 3-92-A-1, Appendix A.)

The ABC Dry Chemical interrupts the chain reaction by chemically reacting with the combustion gases. Additionally, as a secondary effect, it somewhat reduces oxygen by its powder cloud, isolates the fuel by its coating effect, and absorbs a small amount of temperature via its fine particles.

PROCEDURE:

1. Fill one shaker with sand and one with ABC Dry Chemical, from the supply provided.

2. Place the pan on the table cover and set the crucible, with its cover in place, in the pan.

3. Discharge an eyedropper-full of gasoline into the crucible.

4. Ignite the gasoline with the friction sparker.

5. Shake a small quantity (two or three shakes) of sand on the burning gasoline, which will continue to burn, showing that, contrary to general opinion, sand is **not** a good medium for smothering a fire. (Of course, if you continue to shake sand on the fire, it will eventually smother it, but this is accomplished by the volume of sand, rather than by inherent isolating quality.)

PROCEDURE (cont.):

6. After you have demonstrated the effect of the sand, sprinkle a small amount (one or two shakes) of the ABC Dry chemical in the air directly above the crucible. The powder will form a non-toxic, non-combustible blanket of powder, which settles down onto the burning gasoline.

7. To make the demonstration as effective as possible, repeat the extinguishing and relighting procedure two or three times, or until all the gasoline is finally burned. A few trials will reveal just how much powder to use, as well as the best technique for using it.

NOTE

1. The ingredients used in dry chemical are non-toxic. The discharge of large quantities may cause temporary breathing difficulty during and immediately after discharge, and may seriously interfere with visibility. The small quantity involved in this demonstration should not cause any problem.

2. If the audience is appropriate, it may be desirable to repeat this demonstration using ordinary bicarbonate of soda (baking soda). This will illustrate the value of this household ingredient as a fire suppression material.

Figure 17. ABC Dry Chemical Effectively Extinguishes a Fire

TYPES AVAILABLE BY CLASSIFICATION ★

CLASS A FIRES . . . ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

CLASS B FIRES✳ . . flammable liquids/gases, and greases.

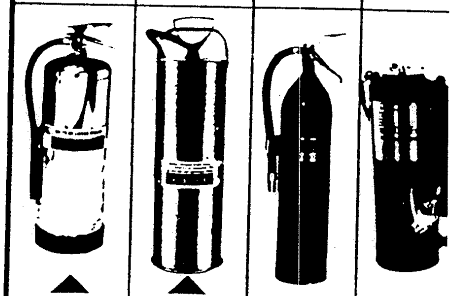
CLASS C FIRES . . . energized electrical equipment where the electrical nonconductivity of the extinguishing media is of importance.

CLASS D FIRES . . . combustible metals, such as magnesium, titanium, zirconium, sodium and potassium.

★ **NOTE:** See back page on Obsolete and Discontinued Types

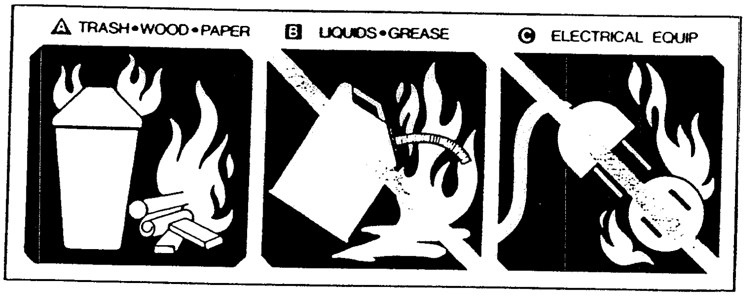
✳ **NOTE:** O-n-l-y Dry Chemical types effective on ***pressurized*** flammable gases/liquids; for cooking greases, Multipurpose A/B/C dry chemicals NOT acceptable.

▲ **NOTE:** Protection required below 40° F.

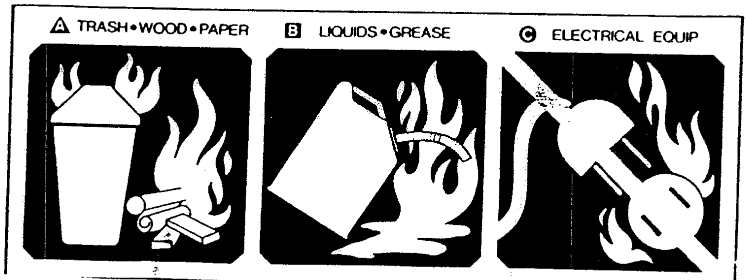


STORED PRESSURE	PUMP TANK	STORED PRESSURE	CARTRID OPERATI
▲	▲		
2½ Gal.	2½ and 5-Gal.	2½-30 lb. *ALSO* Wheeled 150-350 lb.	5-30 lb *ALSO* Wheelec 50-350 lk
30 to 40 ft.	30 to 40 ft.	10-15 ft., (Wheeled- 15-45 ft.)	10-20 ft (Wheele 15-45 ft
1 Min.	1 to 3 Min.	8-25 Sec., (Wheeled- 30-60 Sec.)	8-25 Sec (Wheele 20-60 Sec

USE ON "A" TYPES



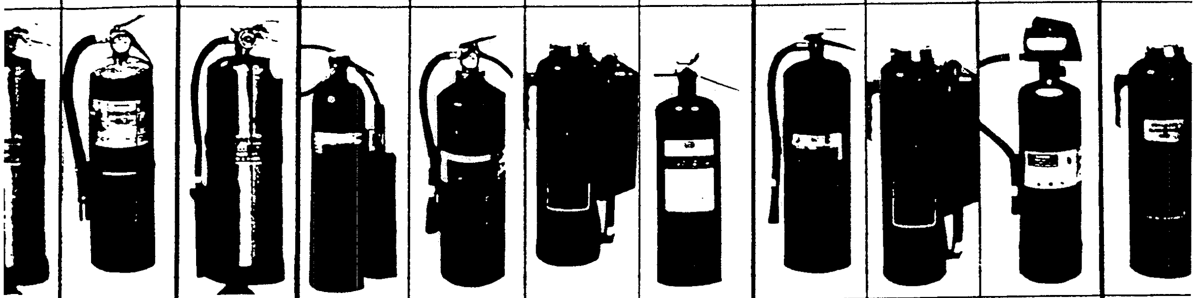
USE ON "A/B" TYPES



PORT FIR S

Courtesy of:
National Asso
Fire Equipmer

111 E. Wacker



RED SURE	STORED PRESSURE	STORED PRESSURE	SELF EXPELLING	STORED PRESSURE	CARTRIDGE OPERATED	STORED PRESSURE	STORED PRESSURE	CARTRIDGE OPERATED	STORED PRESSURE	CARTRI OPERA
[illegible]	9 to 22 lb.	2½ Gal.	5-20 lb. ***ALSO*** Wheeled 50-100 lb.	2½-30 lb. ***ALSO*** Wheeled 150-350 lb.	4-30 lb. ***ALSO*** Wheeled 50-350 lb.	2 to 22 lb.	2½-30 lb. ***ALSO*** Wheeled 150-350 lb.	5-30 lb. ***ALSO*** Wheeled 50-350 lb.	9 to 22 lb.	30 lb ***ALSC*** Wheel 150-35
[illegible]	14 to 16 ft.	20 to 25 ft.	3-8 ft., (Wheeled-10 ft.)	10-15 ft., (Wheeled-15-45 ft.)	10-20 ft., (Wheeled-15-45 ft.)	10 to 16 ft.	10-15 ft., (Wheeled-15-45 ft.)	10-20 ft., (Wheeled-15-45 ft.)	14 to 16 ft.	5 ft (Whee 15 f
[illegible]	10 to 18 Sec.	50 Sec.	8-15 Sec., (Wheeled-8-30 Sec.)	8-25 Sec., (Wheeled-30-60 Sec.)	8-25 Sec., (Wheeled-20-60 Sec.)	8 to 18 Sec.	8-25 Sec., (Wheeled-30-60 Sec.)	8-25 Sec., (Wheeled-20-60 Sec.)	10 to 18 Sec.	20 Se (Whee 150 lb. 7 350lb. 1

LE XTINGUISHER ECTION UIDE

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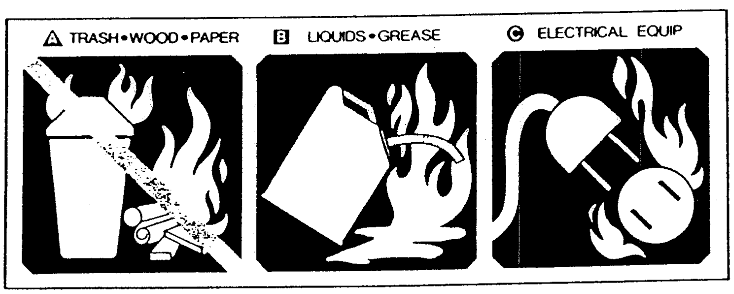
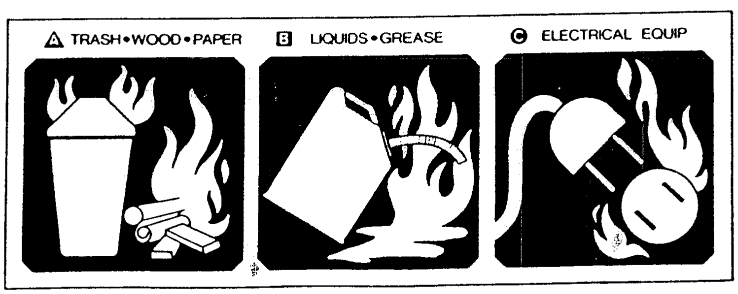


USE "B/ TYP



USE "A/ TYI

NON-ACCEPTABLE AND OBSOLETE TYPES

A. Non-Acceptable Types

(1) **Stored Pressure Water and/or Antifreeze** — Brass or Fiberglass shells;
(2) **Dry Chemicals (over 2½ lb. capacity)** — Brass shells;
(3) **Soda-acid** — Brass or copper shells;
(4) **Foam** — Brass or Copper shells;
(5) **Cartridge-Operated Water** — Brass or copper shells;
(6) **Cartridge-Operated Loaded Stream** — Brass or Copper shells;

"THE RELIABILITY AND SAFETY OF THE ABOVE TYPES CANNOT BE DETERMINED BY STANDARD HYDROSTATIC TEST METHODS"
NFPA Committee on Portable Fire Extinguishers

B. Obsolete Models

Soda-acid, foam, and cartridge-operated water types (including antifreeze and Loaded Stream) **with stainless steel shells** are recommended to be replaced because:
(1) Parts are no longer available; substitute parts should **NEVER** be used as they may create a serious danger.
(2) Method of operation is very difficult; does not have control valve for on-and-off operation.
(3) **Listing Approval has been withdrawn** by Underwriters Laboratories, Inc. (UL) and by Factory Mutual (FM).

TRAINING IN THE USE OF YOUR EXTINGUISHERS

A. In-Plant Training for Selected Personnel

(1) Acquaint this group with **all** extinguisher types and sizes you have on hand.
(2) Tour your facilities pointing out special fire hazard operations.
(3) Periodically practice a "dry run," discharging **each** type of extinguisher. Such practice is essential to...**learn how to activate each type...know the discharge ranges...realize which types are affected by winds and drafts...be familiar with discharge duration...learn of any precautions to take as noted on nameplate...**

B. Live-Fire Training
(1) At least yearly, practice fighting actual fires that reasonably duplicate your fire hazards. Immediately afterwards, hold a classroom session to review the results.
(2) Seek the assistance of a NAFED member to help you in this training as well as to recharge extinguishers used. (Any required repairs or hydrotest will then be noted.)

SOME TIPS ON PROPER MAINTENANCE

1. Inspect extinguishers at least once a month. (It's very common to find units that are missing, damaged, used, etc. Consider contracting for such a service.)
2. Contract for annual maintenance with a **qualified** service agency. (NAFED members receive on-going technical bulletins and manuals.)
3. **NEVER** attempt to make shell repairs to extinguishers. This is the chief cause of dangerous shell ruptures.

THE SAFE UTILIZATION OF FIRE EXTINGUISHERS

Every year in the United States, fire takes a severe toll. Lives are lost, people are severely disabled, millions of dollars in property are lost, and thousands of jobs go up in smoke.

Through fire prevention education and improved fire protection techniques, we can reduce the potentially devastating damage from fire.

If we were able to eliminate fire totally, there would be no need to know how to fight fire. However, we can not guarantee that there will never be fires.

The objective of this appendix to the **Instructor's Guide** is to provide some basic information on the minimum requirements regarding utilization of fire extinguishers in workplaces regulated by the U.S. Occupational Safety and Health Administration. Also covered are recommendations for safe fire extinguisher use that meet and exceed the minimum standards imposed by law.

WHO SHOULD UTILIZE FIRE EXTINGUISHERS?

It is necessary to understand who can be trained in the utilization of fire extinguishers and firefighting techniques. Obviously anyone can be trained and everyone should be trained to utilize fire extinguishers. However, the federal government does regulate who may fight fire and when. Employers have five different options available to them:

1. **All employees evacuate** on signal and no one fights the fire.[1]

2. **All employees respond** to the fire with fire extinguishers and fight the fire as long as it remains in an incipient stage.[2]

3. **Selected employees in a specific area respond** to the fire and fight the fire in the incipient stage.[3]

4. **An incipient stage fire brigade** (a group trained and organized to fight incipient stage fires) responds to fire and fights the fire in its incipient stage.[4]

5. **A structural fire brigade** (a group trained, organized and equipped to fight structural stage fires) responds and fights the fire.[5]

Any individual listed above who has the responsibility of utilizing a fire extinguisher must be trained at least annually in fire extinguisher utilization.

It must also be remembered that fires increase in severity over time, and the earlier an extinguishing agent can extinguish a fire, the less risk there will be to life and property.

EMPLOYEE EXTINGUISHER TRAINING PROGRAMS

Personnel that may use a fire extinguisher in the workplace must be trained in the use of the extinguisher as part of their orientation before they start work. The training must include principles of using fire extinguishers and the potential hazards of fire fighting during incipient stage fires.[6]

When employees are expected to utilize fire extinguishers to fight fire, certain information should be presented beyond the basic requirements listed above. These topics should include the following: The Nature of Fire; Classification of Fires by Fuels; Nature of Fire Extinguishing Agents; Types and Locations of Extinguishers; Operating Instructions of Extinguishers Present; Techniques of Extinguishment; The Hazards of Fire Fighting; and The Relationship of Fire Fighting to Other Emergency Activities.

The Nature of Fire

The employee should be taught what fire is, how it occurs, and how it is extinguished, utilizing the fire tetrahedron theory covered in this Instructor's Guide.

Classification of Fires

The employee must be able to recognize the difference among Class A, B, C, and D fires and understand that different types of extinguishers will fight different types of fires more effectively. Additionally, it is imperative that the employee recognize that the utilization of the wrong extinguisher on the wrong class of fire can be fatal. (Example: the use of a Class A (only) extinguisher (usually water based) on a Class C (electrical) fire can electrocute the operator.)

The Nature of Fire Extinguishing Agents

Different types of fire extinguishers use different types of agents. Some agents can be dangerous, while some can greatly damage property. For example a Carbon Dioxide (CO_2) Extinguisher utilized in a confined space can displace breathable air, and upon contact with human tissue can cause frostbite. One type of dry chemical powder will cake onto hot surfaces (ABC) while another type (BC) can be easily removed. Certain agents coat, while others interfere with the chemical chain reactions. The employee should understand the problems concerning some of these extinguishers using certain agents in certain situations.

Types and Locations of Extinguishers

Federal law and fire codes require the placement of extinguishers within certain distances of certain hazards. Employees should learn during their extinguisher training the location of the nearest type of extinguisher for Class A, B, C, or D hazards, and where to find a back-up extinguisher if necessary.

Operating Instructions for Extinguishers Present

With all of the different types and classes of extinguishers available, extinguisher manufacturers have found it necessary to print use instructions directly on the extinguisher. Unfortunately, during an emergency, few if any employees will take the time to read the directions. A thorough knowledge of how to operate the types of extinguishers present is important and saves valuable time in extinguishing the fire. This element of instruction should include explanation, demonstration and practice.

Techniques of Extinguishment

Employees need to be able to apply the appropriate extinguishing agent on the fire. Inappropriate technique can spread a fire and cause injury to the operator. Practice should be conducted outside, away from hazards in a safe environment. The practice should be done on the type of hazards normally found in the workplace. Again, explanation, demonstration, and practice should be included. Employees should also be aware of the need to stand by to make sure the fire does not rekindle.

Hazards of Incipient Fire Fighting

People die during fire fighting activities. There are hazards related to electricity; hazards associated with the by-products of fire, such as smoke, heat, gases, and decreased visibility; hazards associated with extinguishing agents; there is the ever-present danger of being trapped or confined; and finally there are hazardous materials in workplaces that may poison, explode or burn violently when heated.

Employees must fully understand the potential hazards of incipient stage fire fighting. They must know where to retreat, and to always have at least two ways out. If the employee utilizing a fire extinguisher can not utilize fire fighting equipment with minimum risk to himself or others, the employee should be encourage to simply evacuate.

The Relationship of Fire Fighting to Other Activities

Finally, the employee must understand if he has to make a choice whether to sound the alarm (summon help) or fight fire, the only choice is to sound the alarm first. Rescue or evacuation must also take priority over fire fighting as well as controlling utilities in the fire area. Employees should be aware of the need to stand by once the fire is out because of the danger of rekindle.

The safe use of fire extinguishers is a very important aspect of employee training. It should be taught by experienced personnel, capable of teaching the background information as well as coordinating the practical sessions. If internal personnel are not available help can be sought from your local municipal fire department, your county or state fire service training office, or private consultants.

Footnotes

1. U.S. Department of Labor, Federal Regulations, 29 CFR Part 1910.157, Subpart b:1
2. Ibid, Part 1910.157
3. Ibid, Part 1910.157, b:2
4. Ibid, Part 1910.156
5. Ibid
6. Ibid, Part 1919.157, g

LESSON 7: REVIEW, EVALUATION, AND CONCLUDING REMARKS TIME:

OBJECTIVES

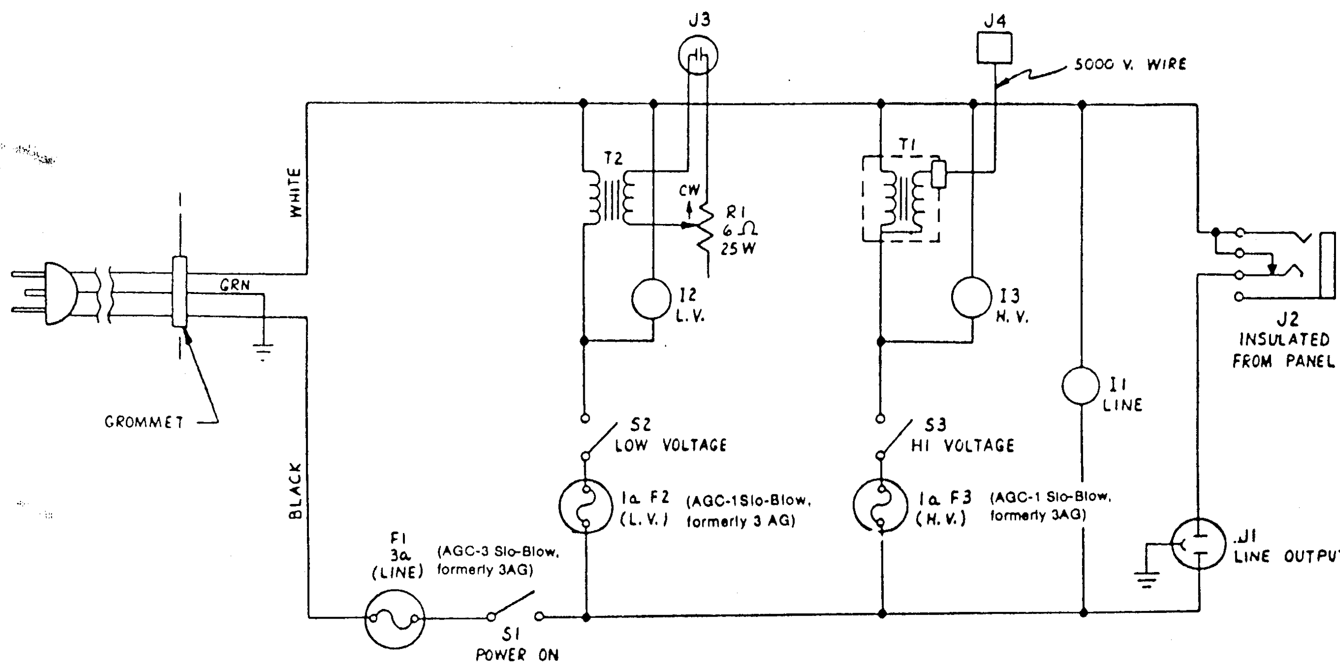
By the end of this lesson the participant will be able to:

1. Specify concepts learned during the program and their applicability to the participants' fire protection/ fire prevention responsibilities.

METHODOLOGY

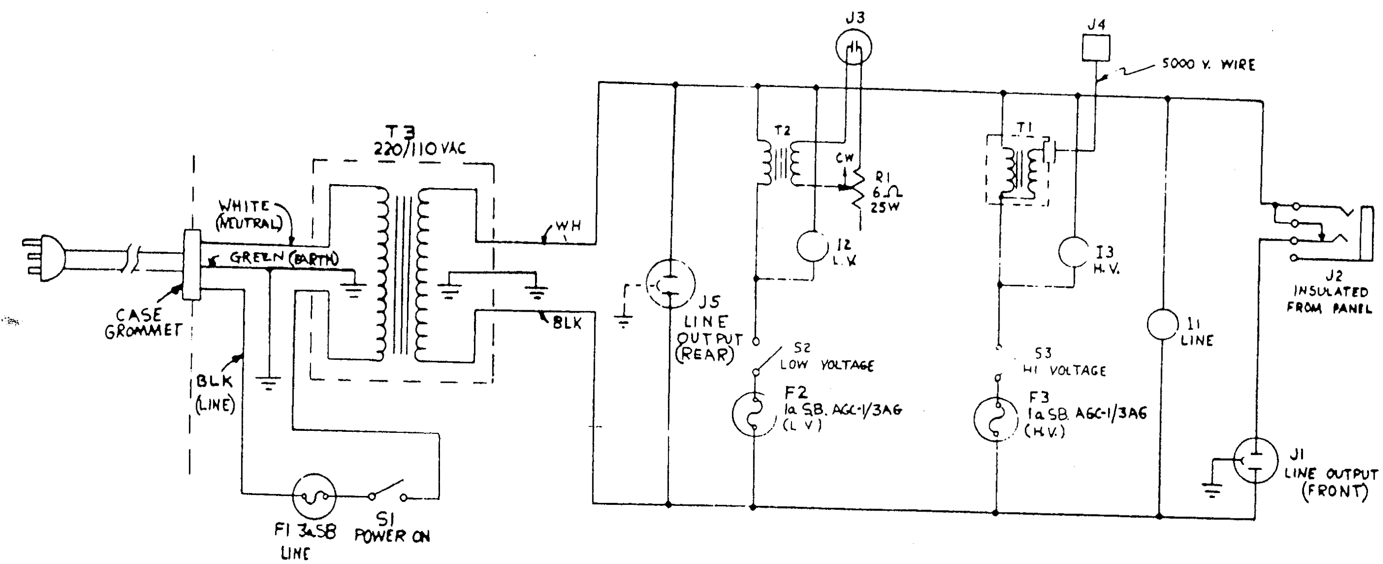
The instructor will conduct a discussion to obtain input from the participants. If written evaluations are used, they should be collected at this time. Instructor will then provide concluding remarks.

INSTRUCTOR NOTES	TIME	CONTENT/ACTIVITY
	10 min	1. ADMINISTRATIVE MATTERS. 2. PRESENT LESSON OBJECTIVES.
	40 min	3. DISCUSSION ON COURSE OBJECTIVES, LESSONS LEARNED AND PARTICIPANT EVALUATION OF PROGRAM.
	10 min	4. CONCLUDING REMARKS

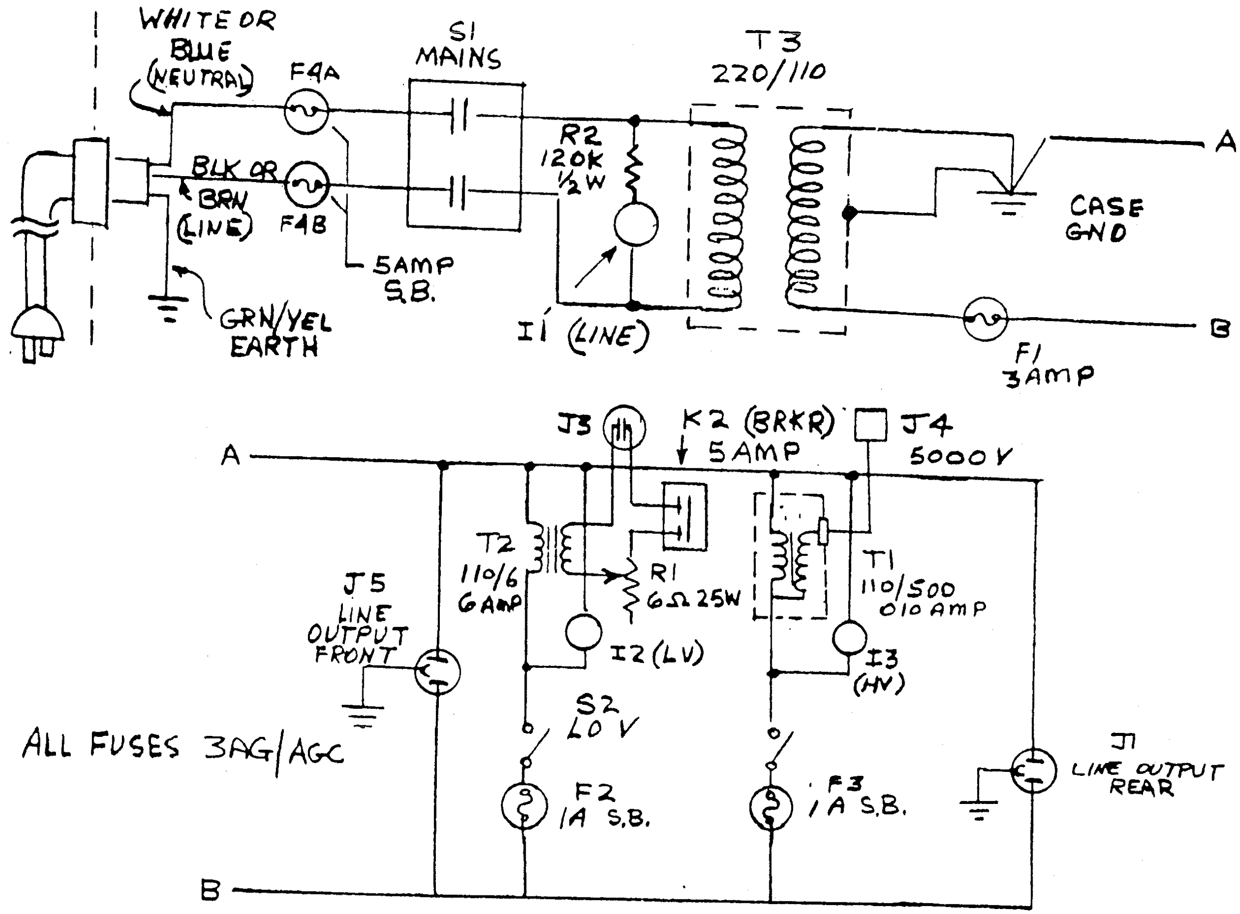


WIRING DIAGRAM—POWER SUPPLY

11C Volt 60 Cycle



WIRING DIAGRAM FOR POWER SUPPLY
MODEL 07-0S 220 VOLT 50 CYCLE INPUT



MODEL 201B-AUS
WIRING DIAGRAM — POWER SUPPLY
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