7. If the electric wiring has been exposed to fire or damage, the current should be shut off by pulling the main control switch. It may be advisable to have the electric company cut service lines to the building.

8. If natural or artificial gas is supplied to the building, and the system has been, or is, exposed to damage, the gas should be sut off at the street valve.

9. Unsafe conditions should be eliminated or proper warning notices posted before the building is turned over to the owner and occupants.

10. Place the building and its contents in the best possible condition.

11. Advise the owner and the occupants as to the hazards existing and recommend the necessary protection.

12. In case the building is equipped with an automatic sprinkler system, fused heads should be replaced with new ones and the system returned to service.

13. Obtain the necessary data for fire reports.

14. Turn the building over to the respective owners, authorized agents, or proper police officials.

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INSTRUCTION BULLETIN #4-H (Fire fighting Tactics)

SUBJECT: Estimate of the Situation - Revised 4 October, 1943

The Estimate of the Situation: Is the mental evaluation made by the officer in charge of a fire or other emergency. It is a continuous mental process which determines his course of action throughout the entire emergency.

The estimate of the situation, or the "size up", is the duty of the officer in charge of the first alarm units and becomes the duty of any superior officer who may later take command of operations at a fire or other emergency.

There are many factors which the officer must consider in arriving at a practical decision and in formulating an effective plan of operation. A trained and disciplined mind is required in the appraisal of the many factors involved in a complicated and rapidly changing situation. The necessary professional knowledge and complete self-control are essential to the officer in surveying the situation. It is here that his training and experience should provide him with the self confidence which is necessary in order to think logically under the stress of an emergency. He must quickly survey and analyze the situation, weight the various factors; apply basic principles, decide what should be done, formulate his plan of operation and exercise command. Upon the ability of the officer to perform these essential functions rests to a major degree his success or failure in dealing with a major fire or other emergency.

The following system of estimating the situation is suggested in view of simplifying the mental process of arriving at a decision and formulating the plan of operation. The purpose of this system is to train the mind to a habit of logical thinking in making an estimate of the situation.

SYSTEM

1. FACTS

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fessional knowledge and complete self control are essential to the officer in surveying the situation. It is here that his training and experience should provide him with the self confidence which is necessary in order to think logically under the stress of an emergency. He must quickly survey and analyze the situation, weight the various factors; apply basic principles, decide what should be done, formulate his plan of operation and exercise command. Upon the ability of the officer to perform these essential functions rests to a major degree his success or failure in dealing with a major fire or other emergency.

The following system of estimating the situation is suggested in view of simplifying the mental process of arriving at a decision and formulating the plan of operation. The purpose of this system is to train the mind to a habit of logical thinking in making an estimate of the situation.

SYSTEM

1. FACTS
2. PROBABILITIES
3. OWN SITUATION
4. DECISION
5. PLAN OF OPERATION

1. FACTS

(a) TIME OF EMERGENCY.....(Month
(Day
(Hour

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(b) LOCATION OF EMERGENCY.....(Location of building
(or materials involved
(
(Position of the Involv-
(ed building or materials
(in relation to streets,
(alleys, open spaces,
(other buildings, and
(combustible materials.
(
(General Physical
(Surroundings.

(c) NATURE OF EMERGENCY.....(Fire
(Accident
(Explosion Incendiarism
(
(Aerial Attack
(Smoke

(d) LIFE HAZARD.....To occupants of involved
building.

(e) EXPOSURE.....(Life-Occupants of
(exposed buildings.
(Property-Buildings or
(other material exposed

(f) BUILDING INVOLVED.....(Height-Size-Construction
(Age-State of Repair
(Windows
(Doors
(Openings into other
(Buildings
(Occupancy
(Contents
(Stairways
(Vertical Shafts
(Air Conditioning system
(Forced draft system
(Other essential facts.

(Smoke: Nature, Volume

(d) LIFE HAZARD.....To Occupants of Involved building.

(e) EXPOSURE.....(Life-Occupants of (exposed buildings. (Property-Buildings or (other material exposed

(f) BUILDING INVOLVED.....(Height-Size-Construction (Age-State of Repair (Windows (Doors (Openings into other (Buildings (Occupancy (Contents (Stairways (Vertical Shafts (Air Conditioning system (Forced draft system (Other essential facts.

(g) FIRE.....(Smoke: Nature, Volume (Floors involved. (Nature of Material (Burning (Location of the Fire (within the Building (Stage of Development (Area Involved (Location of Base of Fire (Other Essential Facts

(h) WEATHER.....(Wind: Direction, (Velocity (Temperature (Rain, Snow, Ice

2. PROBABILITIES

(a) LIFE HAZARD.....(Occupants of Involved (Building. (Occupants of Exposed (Buildings. (Bystanders (Own personnel

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(b) EXTENSION OF FIRE.....(To Exposed Buildings or
(Materials Within the
(Involved Building.

(c) EXPLOSIONS.....(Smoke Explosion
(Dust
(Contents
(H. E. Bombs

(d) WEATHER CHANGES.....(Wind Direction - Velocity
(Temperature
(Rain, Snow, Ice

(e) UNNECESSARY DAMAGE.....(Water
(Smoke to (Involved Bldg.
(Heat (
(Other Causes (Exposed Bldgs.

3. OWN SITUATION

(a) Manpower - Apparatus - Equipment - Hose Supply

(b) Additional Help Available - Help Needed

(c) Water Supply - Mains - Hydrants - Auxiliary Supply - Other Extinguishing Agents.

(d) Sprinkler Systems - Standpipe Systems - Other fire protective devices which can be used to protect exposures, confine and extinguish the fire.

(e) Action that has been taken - Number of companies already at the scene, hose lines laid, and ladders raised.

4. DECISION

(a) The decision shall be based on the consideration of the "Facts", "Probabilities", and "Own Situation".

5. PLAN OF OPERATION

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(b) Additional Help Available - Help Needed

(c) Water Supply - Mains - Hydrants - Auxiliary Supply - Other Extinguishing Agents.

(d) Sprinkler Systems - Standpipe Systems - Other fire protective devices which can be used to protect exposures, confine and extinguish the fire.

(e) Action that has been taken - Number of companies already at the scene, hose lines laid, and ladders raised.

4. DECISION

(a) The decision shall be based on the consideration of the "Facts", "Probabilities", and "Own Situation".

5. PLAN OF OPERATION.

(a) The plan of operation is the decision developed into definite steps.

1. FACTS

(a) Time of emergency.

The officer should consider the time of the emergency since the number of persons in a building involved by fire will vary at different times of the day; i.e., office buildings will be unoccupied on Sundays and at night, whereas, the life hazard in an apartment house fire would be much higher late at night. Traffic conditions, which will affect the response of additional apparatus, vary at different hours of the day.

(b) LOCATION:

First: The officer should locate the building or other property which is involved in the emergency. The alarm may have been received in such a manner that only the general locality of the emergency is known.

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Second: He should obtain a clear mental picture of the building or property involved in relation to the streets, alleys, open spaces, other buildings, and combustible materials.

Third: He should observe any conditions which may interfere with or obstruct operations such as over-head wires, high voltage lines, railroad tracks, parked vehicles or other obstructions.

(c) NATURE:

The officer should ascertain if the emergency is the result of fire, explosion, smoke, or some other occurance. If possible, he should determine if it is the result of accident, incendiarism or aerial attack.

(d) LIFE HAZARD

Here the officer should consider the nature of occupancy, the number of persons within the involved building, and the immediate danger to the occupants.

(e) EXPOSURES:

The officer should consider the buildings and combustible materials which are exposed. He should estimate the immediate danger of both life and property. The facts which should be given consideration are set forth in the lecture on "Exposures".

(f) BUILDING INVOLVED:

There is but limited time and opportunity for the officer to inform himself of the essential facts; therefore, the more he knows regarding the building or buildings involved and exposed, the better qualified he is to draw a clear mental picture of

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(d) LIFE HAZARD

Here the officer should consider the nature of occupancy, the number of persons within the involved building, and the immediate danger to the occupants.

(e) EXPOSURES:

The officer should consider the buildings and combustible materials which are exposed. He should estimate the immediate danger of both life and property. The facts which should be given consideration are set forth in the lecture on "Exposures".

(f) BUILDING INVOLVED:

There is but limited time and opportunity for the officer to inform himself of the essential facts; therefore, the more he knows regarding the building or buildings involved and exposed, the better qualified he is to draw a clear mental picture of the situation. With the exception of small buildings, this knowledge should be obtained previous to the time of emergency through systematic surveys and inspections of the buildings under his protection. A simple system of mapping, together with a brief of essential facts, should be used in order to bring to mind the necessary data at the time of the emergency. With the essential facts pertaining to the involved and exposed buildings in his mind, the problem of estimating the situation will be greatly simplified. If the officer does not have these essential facts, he must depend upon obtaining as many as possible from a quick survey of the involved and exposed buildings at the time of the emergency. Many conditions may be encountered which will forbid more than the most superficial survey. Then it becomes necessary for the officer to estimate the unknown facts from the information which he has been able to obtain.

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(g) FIRE:

Most of the essential facts pertaining to fire are set forth in the outline. It is not always possible to obtain these facts at the time of the fire; therefore, it becomes necessary for the officer to estimate the unknown or partly known facts. The accuracy of his estimations will depend upon his ability to draw a mental picture of the fire in relation to the interior of the building, based upon his own observations and such information as may be supplied from reliable sources at the time. His ability to draw this mental picture will depend to a major degree upon his professional knowledge, experience and the facts he has regarding the building and contents.

(h) WEATHER:

The officer must give due consideration to weather conditions at the time of the fire. Attention is directed to this factor in the lectures on "Rescue", "Exposures", and "Ventilation".

2. PROBABILITIES:

Here the officer in charge considers and estimates, step by step what may occur as the natural sequence of what is taking place.

(a) Life Hazard

There are four groups of persons to be considered in this step; occupants of the involved building, occupants of exposed buildings, bystanders, and his own personnel. Attention is directed to the lectures on "Rescue", "Exposures", and "Confine Fire".

(b) Extension of Fire

There are two points to be considered and estimates to be made: First, the extension of the

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"Rescue", "Exposures", and "Ventilation".

2. PROBABILITIES:

Here the officer in charge considers and estimates, step by step what may occur as the natural sequence of what is taking place.

(a) Life Hazard

There are four groups of persons to be considered in this step; occupants of the involved building, occupants of exposed buildings, bystanders, and his own personnel. Attention is directed to the lectures on "Rescue", "Exposures", and "Confine Fire".

(b) Extension of Fire

There are two points to be considered and estimates to be made: First, the extension of the fire to the exposed buildings or combustible materials; Second, the extension of the fire within the involved building. These have been covered in the lectures on "Exposures", "Confine Fire", and "Ventilation".

(c) Explosions

There are four types of explosions which may occur. These are governed by the nature of the emergency, the type of occupancy, the contents, or if the emergency is the result of an aerial attack. Attention is directed to smoke explosions in the lecture on "Ventilation".

(d) Weather Changes

The officer should consider the probable effect of any indicated weather change on the situation,

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(e) Unnecessary Damage

Consideration should be given to the probable damage to the involved building and contents and also to exposed buildings, buildings and contents. Attention is directed to lectures on "Exposures", "Ventilation", "Salvage", and "Overhaul".

3. OWN SITUATION

Here the officer considers the facts of his own situation, as are set forth in the outline, and he estimates what he can accomplish with the resources which he has at his command.

(a) Man Power - Apparatus - Equipment - Hose Supply.

In this step the officer considers the personnel, apparatus, equipment, and the amount of hose which is on the fire ground or enroute. He must determine if this is sufficient to deal with the situation.

(b) Additional Help Available - Help Needed.

If, in his estimation he has not sufficient man power, apparatus, equipment, or hose supply, he should consider what additional resources are available. In view of this entire situation he should estimate the additional requirements.

(c) Water Supply - Mains - Hydrants

Auxiliary Water Supply - other extinguishing agents.

Here he considers these items in reference to the situation and their locations.

(d) Sprinkler Systems - Standpipe Systems - Other fire protective devices which can be used to protect exposures, confine and extinguish the fire.

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(c) Water Supply - Mains - Hydrants

Auxiliary Water Supply - other extinguishing agents.

Here he considers these items in reference to the situation and their locations.

(d) Sprinkler Systems - Standpipe Systems - Other fire protective devices which can be used to protect exposures, confine and extinguish the fire.

The officer should review the primary fire protective equipment of the involved and exposed buildings. He should estimate the effectiveness of these resources in view of the situation, and how they can be used most effectively. He should consider what steps will be required to place such equipment in service and to insure its effective operation.

(e) Action that has been taken:

At most fires routine action is taken upon the arrival of early units, such as starting rescue operations, laying in lines, and laddering of the building. The officer should consider the action that has been taken to meet the early requirements of the situation and the positions of his units and apparatus.

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4. DECISION

On the fire ground the decision is formed through an evolutionary process. As the officer accumulates the essential facts, his initial decision is in the process of formation and it should be the logical decision resulting from the consideration of the "Facts", "Probabilities", and "Own Situation". He should keep in mind the principles of firefighting tactics and his mission. His mission is to prevent further loss of life and property. The officer in charge may be forced to make his initial decision on the basis of incomplete information. If possible, this should be avoided. Care should be taken not to commit units to action until the initial decision has been made and a definite plan of operation has been formulated.

On the fire ground the "Estimate of the Situation" is a continuous mental process. Here the officer reviews the "Facts", "Probabilities", and "Own Situation", filling in this mental picture with the essential details of the changing situation. He makes such secondary or supplemental decisions as may be required to deal with the changing situation. He makes such extensions and adjustments to the plan of operation as may be required to carry his supplemental decisions into effect.

An intelligent decision is the product of the officer's ability to see the situation as a whole with clarity and vision, considering it in the light of his professional knowledge and experience. The decision should be a clear and precise mental picture of the action he intends to take.

5. PLAN OF OPERATION

The plan of operation is the decision developed into definite steps: i.e., the steps which are necessary to put the decision into effect. The plan should be as simple as possible under the circumstances.

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5. PLAN OF OPERATION

The plan of operation is the decision developed into definite steps: i.e., the steps which are necessary to put the decision into effect. The plan should be as simple as possible under the circumstances.

(a) Orders and Instructions

Orders and instructions should be clear and concise. If possible, the junior officers should be advised regarding the situation existing, the decision, and the plan of operation. With this information they will be able to use better judgment and to render more intelligent cooperation in the execution of their orders and instructions.

(b) Supervision

Supervision of operations is important. The officer in charge should be kept in constant contact with the entire situation. He should keep himself informed as to the progress of operations and of new developments. Coordination and effective use of his forces are essential and this can be accomplished only through proper supervision.

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At small fires, the problem of supervision is not difficult, for the officer can personally look over the situation from time to time and talk with his officers and men. At large fires, the problem of supervision is complicated by the problem of providing suitable means of communication between the officer in charge and the units of his command. It may be necessary to establish a command post at an advantageous point and to supervise operations through junior officers who are qualified and trained to perform staff duties. The problem of providing an effective service of communication may be answered in part by the use of two-way radio, portable telephone, and amplifier systems. In case such systems are not provided the service of communication may be maintained by visual signals and runners.

The five basic steps of this system, namely: "Facts", "Probabilities", "Own Situations", "Decision" and "Plan of Operation" may be used as a guide by the officers assigned to take charge of salvage or other operations in making an estimate of the situation.

This system may be applied to any emergency as effectively as it can be used in estimating the fire situation in the classroom or on the fire ground. Once this mental habit has been formed, the individual should automatically ask himself: What are the facts of the situation? What are the probabilities which these facts indicate? What is my own situation - my capabilities of dealing with the facts and probabilities? From these three simple mental steps, he should decide what action should be taken and how he will use his forces most effectively to that end.

In conclusion, it must be emphasized that this system of estimating the situation has for its purpose the training of the mind to the habit of logical thinking under emergency stress. It outlines the mental steps by which the officer in

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as a guide by the officers assigned to take charge of salvage or other operations in making an estimate of the situation.

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In conclusion, it must be emphasized that this system of estimating the situation has for its purpose the training of the mind to the habit of logical thinking under emergency stress. It outlines the mental steps by which the officer in charge assembles and classifies the essential facts of a complicated problem, thinks out for himself a solution which these facts compel, and thereby arrives at a decision and formulates a plan by which his decision can be executed.

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INSTRUCTION BULLETIN #5 - Revised 3 May 1944
SUBJECT: Practical Hydraulics

Hydraulics is the science which deals with the mechanics of fluids at rest or in motion. It is not an exact science and for all practical purposes of fire fighting, need not be.

For a complete understanding of the problems to follow, certain commonly-used terms must be clearly understood.

One of the first terms a fireman must understand is "pressure". Pressure is an expression used to indicate the press of water against a retaining element and is always expressed in pounds per square inch. The term "pressure" is seldom used without a prefix such as static, residual, or pump.

Static comes from the word "stationary" and means "still" or "at rest". Static pressure may then be understood to mean the pressure of water at rest.

Residual comes from the word "residue" meaning "that which is left", or "the remainder". Residual pressure is therefore the remaining pressure and is a term employed to describe the remaining pressure in a hydrant or pump as a flow of water is being taken from it.

Atmospheric pressure is the pressure exerted by the various gases that comprise air, and at sea level it is 14.7 pounds per square inch. This 14.7 pounds of pressure decreases with altitude.

Pump pressure is the pressure at which water leaves the discharge side of a pump and must never be confused with either static or residual pressure. Nearly all fire pumps have two pressure gauges, one of which is called a compound gauge and the other a pump pressure gauge.

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COMP GAUGE

PRESS GAUGE

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The compound gauge indicates static and residual pressures while the pump pressure gauge indicates pump pressure only. The compound gauge is connected to the intake side of a pump and the pump pressure gauge is connected to the discharge side. The compound gauge is sometimes called a vacuum gauge and this will be explained later on in this lecture.

"Head" is a term used to indicate the water level above the point being considered in a vertical container such as a standpipe, hose, storage tank, etc. This measurement is indicated in feet; e.g.: There is a storage tank on top of a four-story building containing water, the level of which is 70 feet above street level. If street level is the point being considered, we would say that there was a 70 foot head of water in the tank.

When water is contained in a vertical or inclined container it exerts a downward pressure of .434 pounds per foot of height in the case of fresh water and .445 pounds per foot of height in average salt water. These decimal figures are applied to the head measurement to find the static pressure in standpipe systems and storage tanks.

As in the case of the tank with a 70-foot head, the static pressure at the bottom would be 70 x .434 = 30.380 per square inch. A quick way to estimate the static pressure in a vertical column of water is to use 5 pounds for each 12 feet. Although 5 pounds is not exact, it is an easy figure to remember and is practical when dealing with either fresh or salt water. Also, the average story of a building is approximately 12 feet in height and 5 pounds additional pressure is added for each story that a nozzle is elevated above the pump. Likewise 5 pounds pressure will be subtracted for each story a nozzle is placed below the level of the pump.

Drafting water is the action of lifting water from below the level of a pump up to the pump itself. This is accomplished by first attaching a hard suction hose to the pump and submerging the end with the strainer attached below the water level. Due to the mechanical design of the pump it is possible to develop a partial vacuum in the pump and suction hose. (These mechanical features of pumps are cov-

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Drafting water is the action of lifting water from below the level of a pump up to the pump itself. This is accomplished by first attaching a hard suction hose to the pump and submerging the end with the strainer attached below the water level. Due to the mechanical design of the pump it is possible to develop a partial vacuum in the pump and suction hose. (These mechanical features of pumps are covered in the lecture on fire pumps and need no explanation at this time). Atmospheric pressure presses downward on the surface of the water, causing it to rise in the suction hose up to the level of the pump. From here the pump mechanism forces it out on the discharge side.

Let us note that it is necessary to use hard suction hose when drafting water in order to resist the atmospheric pressure on the outside once a partial vacuum is developed on the inside. If regular cotton-jacketed rubber-lined fire hose or soft suction hose were used, atmospheric pressure would force the walls of the hose together, preventing the passage of water.

Another important item is the fact that only a partial vacuum is developed and not a perfect one. If it were possible to develop a perfect vacuum, water could be drafted about 34 feet at sea level. Inasmuch as this is not possible, the maximum height in actual practice is about 25 feet.

It is due to the pump's ability to draft water that the compound gauge is sometimes called a vacuum gauge.

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Theoretically, one inch of vacuum will permit the water level to rise 13.6 inches, and the greater the difference between water level and pump level, the greater the number of inches of vacuum required. The number of inches of vacuum developed is indicated on the compound gauge reading in a counter-clockwise direction from the zero mark. As the compound gauge also registers static and residual pressures, these are indicated in a clockwise direction from the zero mark.

When attempting to draft water at temperatures about 60° F. difficulty will be experienced due to vaporization of the water. When a vacuum is applied over a body of water vaporization is increased. The higher the degree of water temperature, the greater the amount of vaporization. As the vapor density within the pump and suction hose is increased, a vapor lock is formed, thereby stopping the rise of the column of water within the suction hose.

The following is the relative draft height of water at varying temperatures:

Temperature of Water	Approximate Draft Height
75° F	24 feet
100° F	23 feet
125° F	21 feet
150° F	16 feet
175° F	8 feet
180° F	5 feet
190° F	None

If a pump is accepting water from a hydrant or another pump in relay, and the discharges are closed, preventing a flow from taking place, the pressure reading is then a static pressure. When the discharges are opened or a flow of water is passing through the pump, the pressure reading is then residual pressure. If the difference between the static pressure and residual pressure is great it indicates that the major portion of water from the source of supply (hydrant or pump) is being consumed and no more additional lines can be supported. A residual pressure must be maintained on the compound gauge at all times when accepting water from a hydrant or another pump in relay.

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Nozzle pressure is the pressure at which the water is discharged from a nozzle.

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FIRE STREAMS

Fire Streams may be divided into the following groups:

1. Solid Streams:

   (a) From small lines - these include all hose of less than 2½ inches in diameter. Nozzle tips from 1/8 to 5/8 inch.

   (b) From 2½ inch hand lines - Nozzle tips from 3/4 to 1¼ inch.

   (c) From heavy stream appliances. Nozzle tips from 1 to 5 inches.

2. Special Streams

   (a) From fog nozzles

   (b) From distributor nozzles

   (c) From cellar pipes

   (d) From foam nozzles

   (e) From other special nozzles

SOLID STREAMS

A good fire stream (solid) is one which reaches the desired distance in almost a solid mass and which retains sufficient force to splatter well.

The effectiveness of a solid stream may be destroyed by any or a combination of the following conditions:

(a) Too much nozzle pressure

(b) Not enough nozzle pressure

(c) Short bend in hose just back of nozzle

(c) From cellar pipes

(d) From foam nozzles

(e) From other special nozzles

SOLID STREAMS

A good fire stream (solid) is one which reaches the desired distance in almost a solid mass and which retains sufficient force to splatter well.

The effectiveness of a solid stream may be destroyed by any or a combination of the following conditions:

(a) Too much nozzle pressure

(b) Not enough nozzle pressure

(c) Short bend in hose just back of nozzle

(d) Protruding shut-off

(e) Protruding gasket in nozzle

(f) Damaged tip

(g) Foreign object in nozzle or tip

(h) A strong wind

SHUT-OFF NOZZLES

Shut-off nozzles should always be opened and closed slowly. If a shut-off nozzle is opened quickly, when the line is charged, the reaction may be sufficient to jerk the nozzle out of the hands. If a shut-off nozzle is closed quickly a water hammer will be developed within the hose line which causes an increase of pressure that may be sufficient to burst the hose or blow a coupling.

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NOZZLE PRESSURES

The following nozzle pressures are recommended:

Solid stream from small lines - 30 to 40 pounds.

Solid streams from 2½ inch hand lines - 40 to 60 pounds.

Heavy streams - 60 to 100 pounds.

Higher nozzle pressures can be used with nozzle tips of greater diameter than 2 inches.

Fog nozzles - 100 to 125 pounds.

Distributor nozzle (Bresnan) 30 to 50 pounds.

Cellar pipes - 30 to 50 pounds.

Mechanical foam nozzle (Aero foam) - 75 pounds.

Chemical Foam Playpipe - The nozzle pressure is taken care of by providing proper pressure at the generator.

FRICTION LOSS

Friction loss is that loss in pressure between the source of supply and the point of delivery caused by the rubbing of the water against the sides of the conductor. This loss depends upon the construction, diameter, and length of the conductor, and the volume of water per minute which is flowing through the conductor.

All other factors being equal the friction loss per hundred feet of hose or pipe is dependent upon the volume of water being delivered. If the volume of flow is increased the friction loss is also increased.

Approximate friction loss in 2½ inch rubber-lined hose may be obtained by the use of the following formula: "Q" represents the quantity of water in hundreds of gallons flow per minute.

Mechanical foam nozzle (Aero foam) - 75 pounds.

Chemical Foam Playpipe - The nozzle pressure is taken care of by providing proper pressure at the generator.

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All other factors being equal the friction loss per hundred feet of hose or pipe is dependent upon the volume of water being delivered. If the volume of flow is increased the friction loss is also increased.

Approximate friction loss in 2½ inch rubber-lined hose may be obtained by the use of the following formula: "Q" represents the quantity of water in hundreds of gallons flow per minutes.

2 x Q x Q plus Q equals pounds of friction loss per hundred feet.

Example: A 1¼ tip with a nozzle pressure of fifty pounds will deliver about 326 gallons per minute. 3.26 is the quantity of water in hundreds of gallons per minute.

2 x 3.26 x 3.26 equals 24.5152 or 25 pounds friction loss per 100 feet of 2½ inch rubber-lined hose.

If the quantity is less than a hundred gallons per minute, the following formula may be used:

2 x Q x Q plus 1/2 Q equals pounds friction loss per 100 feet of hose.

Friction loss per 100 feet of 1½ inch rubber lined hose can be determined by the above formula and the result divided by the factor 0.074.

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3/4"	[illegible]	85
1/2"	[illegible]	70
1/8"	13	75

1½ Inch All Purpose Nozzle at 100 Pounds Nozzle Pressure, For Position.

Friction Loss per 100 Ft. of 1½ Inch Hose	GPM (actual)
13	54

2½ Inch All Purpose Nozzle at 100# Nozzle Pressure-For Position

Friction Loss per 100 Feet of 2½ Inch Hose	GPM (actual)
4	114

Cellar Pipe (Baker) at 50# Nozzle Pressure - Single 2½ Inch Hose Using One Siamese

Friction Loss Per 100 Ft.	Friction Loss in Pipe	GPM (actual)
10#	10#	209

Using Two Siamese

40#	30#	418

Distributor Nozzle (Brassman)

Nozzle Pressure	GPM (Actual)	Friction Loss per 100 Ft. 2½ In. Hose
30#	234	15#
40#	271	18#
50#	303	21

Mechanical Foam Nozzle 1½ Inch at 75 Pounds Nozzle Pressure

Friction Loss per 100 Ft.	Friction Loss in Proportioner - Single 1½ In. Foam Line
13#	10#

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Using Single 2½ In. Hose Line to Supply Two 1½ In. Tyed Lines

Friction Loss in the 2½ In. Supply Line Friction Loss in Proportioner

4#.....20#

HOW TO DETERMINE PUMP PRESSURE?

Note: The single jacket 2½ inch hose (emergency issue) is tested to 300 pounds per square inch when new. It is recommended that pump pressures in excess of 200 pounds be avoided.

Nozzle Pressure plus friction loss, plus or minus elevation loss or gain equals pump pressure.

P.P. = Pump pressure	Pos. P. = Positive Pressure
E.L. = Elevation Loss	F. L. = Friction Loss
N.T. = Nozzle Tip	= Pumper
N.P. = Nozzle Pressure	= Pressure Proportioner
E.G. = Elevation Gain	

Examples: Single Lines

500 Ft. 2½" hose 1¼" N.T.

N.P.....50#
F.L. 4 x 25.....12½#
P.P. 175#

800 Ft. 2½ in. hose 1" N.T.

N.P.....50#
F.L. 2 x 10.....20#
P.P. 130#
800 Ft. 2½ in. hose

1" N.T.

1" N.T.

N.P.....50#

Examples: Single Lines

500 Ft. 2½" hose 1¼" N.T.

N.P. .....50#
F.L. 4 x 25.....125#
P.P. 175#

800 Ft. 2½ in. hose 1" N.T.

N.P. .....50#
F.L. 8 x 10.....80#
P.P. 130#
800 Ft. 2½ in. hose

1" N.T.

1" N.T.

N.P. .....50#
F.L. 8 x 10.....80#
P.P. 130#

Note: To determine pump pressure the nozzle pressure and the friction loss is calculated for one line only.

800 Ft. 2½ in. hose 7/8" N.T.

Nozzle is elevated to the roof of a three story bldg.

Note: A story of a building is estimated to be 12 ft. in height. Five pounds pressure is added to provide for elevation loss for each full story.

N.P. .....50#
F.L. 8 x 7.....56
F.L. 3 x 5.....15#
P.P. 121#

RELAYING WATER

Pumps are used in relay when it is necessary to deliver water a considerable distance from the point of supply.

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Note: All calculations are based upon pumps of 500 GPM capacity.

If any of the pumps are of the positive displacement type, lines should not be shut down while relaying water.

Pumps used in relay should be so spaced that the pump pressure of each is approximately equal.

Pumps are numbered starting with the one located at the point of supply.

How to determine pressures for pumps in relay: (For each pump except last pump).

Positive pressure of 20 pounds, plus friction loss, plus or minus elevation loss or gain equals pump pressure.
For last pump in relay:
Nozzle pressure plus friction loss, plus or minus elevation loss or gain equals pump pressure.

Examples:

100 ft. 2½ in. hose — 800 ft. 2½ in. hose — 1" N.T.

No. 1 Pump

Pos. P. ..... 20#
F.L. 11 x 10 ..... 110#
P.P. 130#

No. 2 Pump

N.P. ..... 50#
F.L. 8 x 10 ..... 80#
P.P. 130#

700 ft. 2½" hose — 700 ft. 2½" hose — 500 ft. 2½" hose — 1-1/8" N.T.

#1 Pump

Pos. P. ..... 20#
F.L. 7 x 10 ..... 126#

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No. 1 Pump

Pos. P.....20#
F.L. 11 x 10.....110#
P.P. 130#

No. 2 Pump

N.P.....20#
F.L. 8 x 10.....80#
P.P. 130#

700 ft.	700 ft.	500 ft.	1-1/2" F.T.
2½" hose	2½" hose	2½" hose	

#1 Pump

Pos. P.....20#
F.L. 7 x 18.....126#
P.P. 146#

#2 Pump

Pos. P.....20#
F.L. 7 x 18.....126#
P.P. 146#

#3 Pump

N.P.....20#
F.L. 7 x 18.....120#
P.P. 140#

CRAMPED LINES

To increase range to use two or more supply lines to supply a single working line or outlet.

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MECHANICAL FOAM PROPORTIONER

200 ft. 1½" hose — 1½" N.F.N.

N.P.	75#
F.L. 2x13	26#
F.L. in proportioner	10#
T.P.	111#

200 ft. 1½" hose — 1½" N.F.N.

Nozzle is elevated 24 ft. above level of pressure proportioner.

N.P.	75#
F.L. 3x13	39#
F.L. 2x5	10#
F.L. in proportioner	10#
T.P.	134#

1000 ft. 2½" hose — 100 ft. 1½" hose — 1½" N.F.N.
100 ft. 1½" hose — 1½" N.F.N.

N.P.	75#
F.L. 1½" wyed line	13#
F.L. 2½" Gumly line 10x4	40#
F.L. in proportioner	20#
T.P.	148#

Note: When producing foam, friction losses are consistent with the table on ordinary foam except that the loss in the proportioner tank must also be considered.

CELLAR PIPE (BAKER)

100 ft. 2½" hose — Two outlets.

N.P.	50#

1000 ft. 2½" hose — 100 ft. 1½" hose — 1½" S.P.N.

N.P.	75#
F.L. 1½" wyed line	12#
F.L. 2½" Supply line 10x4	40
F.L. in proportioner	20#
T.P.	147#

Note: When producing for foam, friction losses are consistent with the table on ordinary for except that the loss in the proportioner tank must also be considered.

CELLAR PIPE (BAKER)

100 ft. 2½" hose — Two outlets.

N.P.	50#
F.L. in wye	30#
F.L. in hose	40#
T.P.	120#

400 ft. 2½" hose — Two outlets

N.P.	50#
F.L. in wye	3
F.L. in hose 4x4=160x4	40#
T.P.	123#

500 2½" hose — One outlet

N.P.	70
F.L. in wye	10#
F.L. in hose 5x10	50
T.P.	130#

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DISCHARGE FROM HYDRANT OUTLETS AT VARIOUS PRESSURES

Hydrant Outlet Pressure in lbs. per sq. in.	Discharge from 2½ in. outlet in gal. per min.	Discharge from 4½ in. outlet in gal. per min.
1	170	550
2	240	770
3	290	940
4	340	1090
5	380	1220
6	410	1330
7	440	1440
8	480	1540
9	500	1630
10	530	1720
12	580	1890
14	630	2040
16	670	2180
18	710	2310
20	750	2440
22	790	2560
24	820	2670
26	860	2780
28	890	2880

10	530	1720
12	580	1890
14	620	2040
16	670	2180
18	710	2310
20	750	2440
22	790	2560
24	820	2670
26	860	2780
28	890	2880
30	920	2990
32	950	3080
34	980	3190
36	1010	3270
38	1025	3334
40	1055	3420
45	1120	3627

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INSTRUCTION BULLETIN #7
SUBJECT: Care of Fire Hose (Cotton Jacket Rubber-lined)
Revised 4 October 1943

A burst length of hose, and the consequent replacement of the defective length, means loss of time in attacking a fire which may be sufficient to permit the fire to get beyond control. Bursting of hose may also be responsible for serious injury to fire fighters. In order to guarantee that fire hose will give the service demanded of it under fire conditions, it is necessary that the hose be given suitable attention and periodic tests.

TESTS:

Cotton rubber-lined hose used on fire boats and trailer pumps should be tested twice a year to 200 lbs per square inch. Care should be taken to remove all the air from the hose and the pressure held for at least three minutes. Any defective lengths should be replaced at once.

CARE AND MAINTENANCE:

Care of hose is an important factor in its life. It should not be stored in hot dry places. The rubber lining becomes hard and cracks if water is not run through it about once in three months. After water has been run through it, the hose should be thoroughly drained because water remaining in contact with the rubber lining may form a weak sulphuric acid solution. This acid in contact with the cotton jacket causes serious deterioration.

Acid from storage batteries or from soda and acid chemical tanks acts on the cotton outer covering, usually destroying it but seldom injuring the lining. The stream from a soda and acid extinguisher may contain an excess of sulphuric acid and should this acid come in contact with the cotton jacket damage is sure to result.

Care must be taken that gasoline and oil do not come in contact with the hose. Gasoline is a solvent for rubber and if even a little of it works its way through the cotton jackets and reaches the rubber lining, it may dissolve the cement which holds the lining to the jacket. Then, when the hose is used again, the lining may break away

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Care must be taken that gasoline and oil do not come in contact with the hose. Gasoline is a solvent for rubber and if even a little of it works its way through the cotton jackets and reaches the rubber lining, it may dissolve the cement which holds the lining to the jacket. Then, when the hose is used again, the lining may break away and cause a failure.

CARE OF HOSE ON FIRE APPARATUS:

Where hose is carried on a fire truck it should be folded in such a way that air can circulate and prevent mildew. To aid in air circulation, hose bodies on fire apparatus usually have slatted bottoms. This may permit the lower layers of hose to become wet from the splashing of the wheels. This has to be watched. Once a month, the hose should be removed from the truck or reel, examined for mildew and other defects, and re-arranged on the truck in such a manner that the folds will occur in different places on the hose each time it is reloaded.

Spare hose should be kept rolled up loosely, preferably stacked horizontally, thereby avoiding all sharp bends which might injure both fabric and lining. In rolling, care should be taken to see that too sharp a bend is not made near the male coupling. Rolls of new hose should be unrolled and re-rolled loosely.

When hose is stored on a portable hose reel, it should be periodically removed and re-reeled so that the sag which is always present on the lower side of the reel will come in a different place on the hose. Where hose is wound on reels, it should be wound with the female end out ready for coupling to hydrant or other hose.

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USE AT FIRES:

At fires the hose is frequently subject to severe shocks and strains and to mechanical injury. Much injury to hose results from driving over it. In actual fire service it is sometimes necessary to drive apparatus over it, but when picking up or returning from a fire, there is no excuse for such action. Special care should be taken to prevent chafing of the hose near the pump. The vibration for the first length or two is often such as to cut quickly through the fabric if there are stones, glass, or other rough material on the ground.

In the case of frozen hose, it is a good plan to handle it as little as possible and with the least amount of bending. Hose can be badly injured if folded when frozen. Get it into a warm place and let it thaw out before washing and drying.

WASHING AND DRYING:

After hose has been in use at fires or has been subjected to test, all dirt should be thoroughly brushed off. If the dirt cannot be removed by brushing, the hose should be washed with plain water and scrubbed.

When hose has been exposed to oil, the oil may be removed by washing with soap or a mild alkali and then properly rinsed. When salt water has been used, the hose should be flushed out with fresh water. The hose should then be dried, otherwise mildew may set in and destroy the cotton fibers.

Hose drying is best accomplished in a hose tower or other structure with sufficient ceiling height, by hanging the hose by the coupling or hanging it over saddles or pegs or the spokes of a rimless wheel. When ceiling heights are not sufficient to allow hose to be hung up full length or half length, hose may be drained and dried on inclined racks, so arranged that the water from the upper hose lines will not drip on the hose in the lower shelves or racks. Hose should not be dried in the sun on concrete roadways or sidewalks.

RECORDS:

Each length of hose should be numbered and a book record kept of the date of delivery, date of periodical testing and pressures, also remarks as to testing, repairs, unusual features, causes of failure

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scrubbed.

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RECORDS:

Each length of hose should be numbered and a book record kept of the date of delivery, date of periodical testing and pressures, also remarks as to testing, repairs, unusual features, causes of failure and so forth.

USE OF HOSE FOR OTHER THAN FIRE PURPOSES:

Fire hose must not be used under any circumstances for other than fire purposes. Violation of this principle may result in hose being missing, defective or useless at time of fire.

CARE OF NOZZLES, COUPLINGS, ETC.

Nozzles: Nozzles or play pipes that are bent or battered in any way should be carefully repaired if possible or else replaced. Bent or battered nozzles should not be used as the effective reach and fire extinguishing capacity of the stream will be much impaired. The slightest roughness of the tip will sometimes cause the stream to break or spray.

Couplings: Couplings should be kept in first class order and each time after the hose is tested, the threads should be examined and any injured or defective couplings should be removed or turned over to a machinist with proper facilities for making repairs. They should be so adjusted that they can be easily screwed up by hand. Couplings should not be greased or oiled if found to be stuck. Ordinarily they can be satisfactorily freed by immersion in warm soapy water and washing thoroughly.

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Washers: The rubber coupling washers should be also gone over at this time, and renewed as needed, as they deteriorate and break away. Care should be taken also that the rubber washers do not project into the waterway, particularly at the nozzle coupling, as this will frequently cause a ragged stream, thus reducing its effectiveness in combating fires.

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INSTRUCTION BULLETIN # 15
SUBJECT: Portable Fire Extinguisher - Revised 2 March 1944

Portable fire extinguishers are referred to many times as first aid fire appliances or hand extinguishers.

CLASSIFICATION OF FIRES:

Accepted standard practices have classified fires into three general classes for the purpose of designating the proper type of extinguisher to be used. These classes are as follows:

Class "A" - Class "A" fires are defined as fires involving ordinary combustible materials where the cooling effects of quantities of water or solutions containing large percentages of water, are essential. Ordinary combustible materials are wood, textiles, paper, rubbish, or like materials which leave an ash residue when burned.

Class "B" - Class "B" fires are defined as fires involving flammable liquids such as gasoline, oils, paints, lacquers, varnishes, greases, or like materials where a blanketing or smother effect is essential.

Class "C" - Class "C" fires are defined as fires involving electrical equipment, where the use of non-conducting extinguishing agents which are non-injurious to the equipment is essential.

TYPES OF EXTINGUISHING AGENTS:

Extinguishing agents used in portable fire extinguishers may be divided into five general classes:

1. Water, or solutions containing large percentages

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textiles, paper, rubbish, or like materials which leave an ash residue when burned.

Class "B" - Class "B" fires are defined as fires involving flammable liquids such as gasoline, oils, paints, lacquers, varnishes, greases, or like materials where a blanketing or smother effect is essential.

Class "C" - Class "C" fires are defined as fires involving electrical equipment, where the use of non-conducting extinguishing agents which are non-injurious to the equipment is essential.

TYPES OF EXTINGUISHING AGENTS:

Extinguishing agents used in portable fire extinguishers may be divided into five general classes:

1. Water, or solutions containing large percentages of water.
   a. Plain water.
   b. Antifreeze water solutions.
   c. Chemical type - soda and acid.

2. Foam solution

3. Vaporizing liquid (carbon tetrachloride base).

4. Inert gas (carbon dioxide)

5. Dry compound (bicarbonate of soda treated with a moisture-repellent chemical).

LIMITATIONS OF PORTABLE FIRE EXTINGUISHERS:

There is no extinguisher which can be used effectively on all classes of fires. Each extinguisher has definite limitations. They are designed to provide a limited quantity of extinguishing agent to extinguish small fires while still in their early stage. It is, therefore, very important that the field of usefulness and limitations of each type of extinguisher be thoroughly understood.

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Personnel that may be called upon to use portable fire extinguishers should be given an opportunity to use these extinguishers to extinguish actual fires. The technical knowledge of fire extinguishers alone is not sufficient to enable an individual to employ them effectively. The individual must be allowed sufficient training to enable him quickly and efficiently to place the various types of extinguishers in operation a sufficient number of times to develop the necessary "know how". The proper type of fire extinguisher in the hands of a trained and experienced operator is worth more than a number of extinguishers in the hands of untrained persons. Lectures, study material, and demonstrations are useful but the effort is wasted if the individual is not afforded the opportunity to use the extinguisher under as nearly actual fire conditions as can be provided. Learning by doing is essential in fire-fighting training. Practical training in the use of the various types of extinguishers on the three classes of fires is necessary in order to develop the proper technique.

TYPES OF PORTABLE FIRE EXTINGUISHERS:

Plain Water Extinguishers

Pump Can Type
Sizes - 2½, 4, 5, gallons capacity

Method of Operation

1. Carry to the point of operation by means of top handle.

2. Place one foot on the foot holder.

3. Grasp Nozzle in one hand.

4. Grasp pump handle with other hand.

5. Unlock the pump handle.

6. Operate pump handle.

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Plain Water Extinguishers

Pump Can Type
Sizes - 2½, 4, 5, gallons capacity

Method of Operation

1. Carry to the point of operation by means of top handle.

2. Place one foot on the foot holder.

3. Grasp Nozzle in one hand.

4. Grasp pump handle with other hand.

5. Unlock the pump handle.

6. Operate pump handle.

7. Direct the stream at the base of the fire.

A continuous or intermittent stream may be obtained depending upon the operation of the pump handle. The 2½ gallon size will provide a continuous stream for approximately one minute; the 4 gallon for less than two minutes; and the 5 gallon size for approximately two minutes. The effective horizontal range of the stream is about 30 feet.

Suitability

These extinguishers are effective on Class "A" fires. They are not effective on Class "B" fires: they are not recommended for Class "C" fire, but in an emergency where no other means of extinguishment is available, they can be used. Care should be taken to cut off the current to the electrical equipment before applying the stream.

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These extinguishers must be protected from freezing and should not be installed at locations where they are subjected to temperatures below 40° F.

Recharging

Taking out and refill with plain water. See that all parts are clean and that the pump, hose, and nozzle are in serviceable condition.

Inspection

Should be inspected semi-annually or more often if practicable:

1. Check recharge tag
2. Operate pump to determine condition
3. Check hose and nozzle
4. Make sure that extinguisher contains water. Flammable liquids could be present in this type of extinguisher.
5. Refill to capacity with plain water
6. See that handle lock functions properly
7. Any parts not in serviceable condition should be replaced at once.

PACK PACK TYPE

Size - 5 gallons capacity

Similar to the pump can type except that it is carried on the operator's back by means of shoulder straps. A trombone-type pump is attached to the hose. Both hands are required to operate the pump.

Antifreeze Water Solutions

The plain water extinguishers which have been described are filled with antifreeze water solution.

[illegible] antifreeze solution, the

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5. Refill to capacity with plain water
6. See that handle lock functions properly
7. Any parts not in serviceable condition should be replaced at once.

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Size - 5 gallons capacity

Similar to the pump can type except that it is carried on the operator's back by means of shoulder straps. A trombone-type pump is attached to the hose. Both hands are required to operate the pump.

Antifreeze Water Solutions

The plain water extinguishers which have been described are filled with antifreeze water solution.

To provide 2½ gallons of antifreeze solution, the following table should be followed:

Temperature F.	Water	Calcium Chloride
10°	2 gals. 1 pt.	5 lbs.
Zero	2 gals. 1 pt.	6½ lbs.
10° below	2 gals.	7 lbs. 6 oz.
20° below	2 gals.	8 lbs. 6 oz.
30° below	2 gals.	9 lbs. 2 oz.
40° below	2 gals.	10 lbs.

Only granulated or flaked calcium chloride, free from magnesium chloride, should be used.

Chemical Type - Soda and Acid Extinguisher

This unit consists of metal tank, acid bottle, acid bottle rack, lead stopple, cap, discharge hose, and nozzle. When charged, the metal tank contains a solution of water and bicarbonate of soda, and the bottle contains sulphuric acid is retarded by means of a loose fitting lead stopple resting in the mouth of the bottle. When allowed to mix the chemical reaction produces carbon dioxide gas

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which provides the pressure to expel the solution from the nozzle. The carbon dioxide gas does not add to the extinguishing ability of the solution, but serves as a propelling force only. The extinguishing value of this solution is that of a like volume of water under the same pressure.

Method of Operation

1. Grasp hose near nozzle with right hand and grasp the ring top with the same hand. Use left hand to support the bottom.

2. Lift from bracket and carry to the point of operation in an upright position.

3. Grasp the bottom handle which is located inside the base of the extinguisher, with the left hand.

4. Invert the extinguisher

5. Release ring top with right hand, but keep a firm grasp on the hose near nozzle.

6. Direct the stream at the base of the fire.

This extinguisher will provide a continuous stream for approximately one minute. The effective horizontal range of the stream is about 30 feet.

Suitability

This extinguisher is effective on Class "A" fires. It is not effective on Class "B" fires. It is not recommended for Class "C" fires, but in an emergency where no other means of extinguishment is available, it can be used. Care must be taken to cut off the current to the electrical equipment before applying the stream. The solution is a good conductor of electricity and serious injury may result to the

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5. Release ring top with right hand, but keep a firm grasp on the hose near nozzle.

6. Direct the stream at the base of the fire.

This extinguisher will provide a continuous stream for approximately one minute. The effective horizontal range of the stream is about 30 feet.

Suitability

This extinguisher is effective on Class "A" fires. It is not effective on Class "B" fires. It is not recommended for Class "C" fires, but in an emergency, where no other means of extinguishment is available, it can be used. Care must be taken to cut off the current to the electrical equipment before applying the stream. The solution is a good conductor of electricity and serious injury may result to the operator if used on live electrical equipment.

This extinguisher must be protected from freezing and should not be installed at locations where it is subjected to temperatures below 40° F.

Recharging

Extinguisher should be recharged immediately after use. In order to insure against deterioration of the solution, extinguishers should be recharged annually.

Before recharging, the gasket, acid bottle, acid bottle rack, hose, hose connections, and nozzle should be inspected and any defective parts replaced. If the extinguisher shell has been subjected to excessive mechanical injury the unit should be taken out of service and replaced with another. The interior of the extinguisher shell should be thoroughly washed. Any accumulated sediment in the bottom of the shell should be removed. Water should be run through the hose.

The amounts and proportions of the ingredients which are required to recharge a 2½ gallon soda and acid extinguisher are, four (4) ounces of concentrated sulphuric acid,

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one and one-half (1½) pounds of bicarbonate of soda, and two and one-half (2½) gallons of plain water.

The following procedure is recommended:

1. Thoroughly dissolve in plain water the required amount of soda. The mixing should be done in a container other than the extinguisher shell. If this is not done mechanical injury may be caused to the anti-corrosion protective lining of the shell.

2. When the solution of the soda is completed, pour into the extinguisher shell.

3. Fill the acid bottle to the acid mark on the bottle (four ounces)

4. Replace the lead stopple in the mouth of the bottle and place the bottle in its rack.

5. Replace extinguisher cap, screwing it on until tight.

6. When in doubt refer to instructions on extinguisher shell.

7. Record charging date on record tag. Person responsible for supervision of recharging should sign or initial tag.

Inspection

Should be inspected semi-annually or more often is practicable:

1. Check record tag for recharge date.
2. Remove from bracket and remove cap.
3. Note acid level in extinguisher.
4. Note solution level in extinguisher.

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bottle and place the bottle in its rack.

5. Replace extinguisher can, screwing it on until tight.

6. When in doubt refer to instructions on extinguisher shell.

7. Record charging date on record tag. Person responsible for supervision of recharging should sign or initial tag.

Inspection

Should be inspected semi-annually or more often as practicable:

1. Check record tag for recharge date.
2. Remove from bracket and remove can.
3. Note acid level in extinguisher.
4. Note solution level in extinguisher.
5. Check can gasket.
6. Check condition of hose.
7. Check nozzle opening to see that it is free from obstruction.
8. Any defect should be corrected at once.

Foam Solution Extinguishers

This type of extinguisher is usually of 2½ gallons capacity. It is very similar in appearance to the soda and acid extinguisher. Where it is practicable to do so, the can of the extinguisher should be painted with red paint in order to distinguish it from the soda and acid type.

This unit consists of a metal tank, discharge hose and nozzle, inner-chamber with loose lead stopple, and can. When charged, the metal tank or outer chamber contains a solution of bicarbonate of soda and a foam-stabilizing agent dissolved in water. The inner chamber contains aluminum or ferric sulphate dissolved in water. When allowed to mix, the chemical reaction produces carbon dioxide gas, which provides the pressure to expel the foam solution in the form of small bubbles which contain carbon dioxide gas. The foam bubbles, being much lighter in weight than any flammable liquid, will when properly applied

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flont on the surface of the liquid and form a blanket which prevents the release of vapors. A cooling effect is present due to the moisture content of the foam, but the major extinguishing effect is the sealing of the surface, which prevents the formation of a vapor and air mixture above the surface.

Method of Operation:

1. Grasp hose near nozzle with righthand and grasp the ring top with the same hand. Use left hand to support the bottom.

2. Lift from bracket and carry to the point of operation in an upright position.

3. Grasp the bottom handle which is located inside the base of the extinguisher, with the left hand.

4. Invert the extinguisher.

5. Release ring top with right hand but keep a firm grasp on the hose near nozzle.

6. Direct the stream against the inside of the wall of the container just above the burning surface, so as to allow the foam to flow back over the burning liquid. Where possible, the operator should move around the container while directing the stream against the inside wall in order to obtain maximum coverage during the discharge period. If this is not possible, the operator should stand far enough away from the fire to elevate the stream at such an angle to allow the foam to fall upon the burning surface. The stream should not be directed into the burning liquid.

This extinguisher will provide a continuous stream for

4. Invert the extinguisher.

5. Release ring top with right hand but keep a firm grasp on the hose near nozzle.

6. Direct the stream against the inside of the wall of the container just above the burning surface, so as to allow the foam to flow back over the burning liquid. Where possible, the operator should move around the container while directing the stream against the inside wall in order to obtain maximum coverage during the discharge period. If this is not possible, the operator should stand far enough away from the fire to elevate the stream at such an angle to allow the foam to fall upon the burning surface. The stream should not be directed into the burning liquid.

This extinguisher will provide a continuous stream for approximately one minute. The 2½ gallon extinguisher will produce about 20 gallons of foam. The effective horizontal range is about 30 feet.

Suitability

This extinguisher is effective on Class "B" fires, with the exception of alcohol, acetone, ether, and carbon disulphide. When this type of foam comes into contact with these flammable liquids the foam bubble disintegrate. This extinguisher is also effective on Class "A" fires due to the moisture content of the bubbles, but it cannot be used to bore into the interior of a quantity of Class "A" material. It is not effective as the water-type extinguishers. It is not recommended for Class "C" fires but in an emergency where no other means of extinguishment is available, it can be used. Care must be taken to cut off the current to the electrical equipment before applying the stream. The solution is a good conductor of electricity.

This extinguisher must be protected from freezing and should not be installed at locations where it is subjected to temperatures below 40° F.

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Recharging

The same procedure should be followed as is recommended in the first two paragraphs of recharging soda and acid extinguishers.

The following procedure is recommended:

1. Use approved recharge.

2. Dissolve the contents of package marked "B" in lukewarm water. Do not use hot water. Use the quantity of water specified on the package. Pour this solution into the outer chamber.

3. Dissolve the contents of package marked "A" in hot water. Use the quantity of water specified on the package. Pour this solution into the inner chamber.

4. Replace the loose stopple head on inner chamber and place the inner chamber in the outer chamber.

5. Replace the ex tinguisher cap, screwing it on until tight.

6. When in doubt, refer to the instructions on the extinguisher shell and on the recharge packages.

7. If a pressure release device is provided, determine if it is in serviceable condition.

8. Record recharging date on record card. Person responsible for supervision of recharging should sign or initial tag.

Inspection

Extinguishers should be inspected semi-annually or more often if practicable.

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4. Replace the loose stopple head on inner chamber and place the inner chamber in the outer chamber.

5. Replace the extinguisher cap, screwing it on until tight.

6. When in doubt, refer to the instructions on the extinguisher shell and on the recharge packages.

7. If a pressure release device is provided, determine if it is in serviceable condition.

8. Record recharging date on record card. Person responsible for supervision of recharging should sign or initial tag.

Inspection

Extinguishers should be inspected semi-annually or more often if practicable.

1. Check record tag for recharging date.

2. Remove from bracket and remove cap.

3. Note solution level in inner and outer chamber.

4. Check condition of hose.

5. Check cap gasket.

6. Check nozzle opening to see that it is free from obstruction.

7. Any defect should be corrected at once.

Carbon Dioxide Extinguishers.

Sizes - 2, 4, 7½, 10, 15, 20 pounds.

This unit consists of a heavy-duty steel cylinder, valve assembly, flexible reinforced hose, discharge nozzle with insulated hand grip, and carrying handle.

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In case of bus or truck fires it may become necessary to use a 2½ inch stream to extinguish the fire. A high nozzle pressure will be required if a solid stream is used to deal with flowing gasoline. In case of a broken connection or a ruptured tank, a 2½ inch stream can be used to dilute the gasoline and wash it away.

Vaporizing liquid or carbon dioxide extinguishers are effective on fires involving the motors of automobiles, buses, or trucks. The technique of application depends on the construction of the hood. If it is necessary to raise the hood in order to apply vaporizing liquid or carbondioxide and the quantity is limited, the best results will be obtained by applying the extinguishing agent to the base of fire and closing the hood. Vaporizing liquid is not an effective extinguishing agent when the fire is being fed by a flowing stream of gasoline. In case of a fire resulting from a short circuit, it may be necessary to disconnect the battery terminals.

4. LUMBER STORAGE

Where large quantities of lumber are stored in unsprinklered sheds or piled in the open, there is always the possibility of a rapidly spreading fire. The lumber piles may be of such a height, and with limited open spaces between them, that a fire, once it has a good start, will be difficult to control and extinguish. In order to combat a fire of this nature it will be necessary to have an adequate water supply, sufficient apparatus, equipment, and man power. Weather conditions, such as high wind, or a deficiency of rainfall, may contribute to the rapid spread of the fire.

The fire should be attacked from the lee side, or if this is not possible, the attack should be made from the flanks. Every effort should be made to confine the fire to the smallest possible area. Heavy streams from monitor nozzles and deluge sets can be used to attack the main fire, wet down exposed materials, and break up radiated heat. Care should be taken not to use heavy streams in such a manner as to topple over or tear with or endanger personnel operating hand lines. Hand lines

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4. Turn hand wheel counter-clockwise, as indicated by arrow, as far as possible. This opens the seat of the seat-type valve, and if, using the disc-type valve, it ruptures the sealing disc, allowing a maximum delivery of extinguishing agent which is very important. If equipped with squeeze grip valve, squeeze the release lever with sufficient force to open fully. Direct the carbon dioxide to the base of the fire.

5. Carrying the extinguisher in one hand by the carrying handle and directing the nozzle with the other, the operator can move to any desired position.

6. Direct the carbon dioxide at the base of the flame. If the fire involves a vertical surface, extinguish the fire at the bottom-most point, move the nozzle slowly from side to side and follow the flame upward as extinguishment is effected. If the fire involves a horizontal surface extinguish the nearest portion, then advance the discharge as the flame is extinguished. Do no haphazardly direct discharge over various sections of the fire. Extinguish one portion of the fire completely before attacking other parts. If in the open, attack the fire from the windward side; the wind will carry the heated smoke away from the operator and at the same time carry the carbon dioxide into the zone of combustion.

7. The discharge should not be stopped too soon. Where there is sufficient degree of temperature present, re-ignition will occur. Continue the application until the danger of re-ignition has been overcome.

8. The discharge from the seat-type valve can be permanently stopped by turning the hand wheel clockwise. Only a temporary stoppage of the discharge from the disc-type valve is possible by turning the hand wheel clockwise. When using the squeeze-grip type, the discharge can be permanently stopped by releasing the release lever.

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8. The discharge from the seat-type valve can be permanently stopped by turning the hand wheel clockwise. Only a temporary stoppage of the discharge from the disc-type valve is possible by turning the hand wheel clockwise. When using the squeeze-grip type, the discharge can be permanently stopped by releasing the release lever.

9. Effective extinguishing action is present only during the period when a part of the discharge is in the form of carbon dioxide snow. Although sufficient gas remains to cause considerable noise while the valve remains open, the volume of gas being delivered is not sufficient to produce effective results.

10. The extinguisher should be recharged as soon as possible and returned to its bracket.

The maximum effective range for a 15 pound extinguisher is about five feet measured from the outer end of the nozzle. When used in the open against the wind, this range is reduced; with the wind it is increased. Smaller sizes have less range.

The rate of delivery is an important factor when carbon dioxide is being used to extinguish fire. The quicker a given amount of carbon dioxide can be delivered into the zone of combustion, the more effective will be the extinguishing action. The following is a table published by one of the leading manufacturers of carbon dioxide extinguishers, giving the discharge time for various sizes:

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TIME OF DISCHARGE
Portable extinguishers.

Size in pounds	Time in seconds
2	13
4	18
7½	15
10	28
15	24
20	25

Suitability

Carbon dioxide is very effective on all flammable liquid fires (Class "B"). The combustion of such is a surface action only, a thin layer of the liquid being heated to the burning point, the bulk of the liquid being relatively cool in the early stages of the fire. Extinguishment can be effected almost instantaneously with carbon dioxide, unless the fire has been burning for a period of time in which case surrounding solid materials may be heated sufficiently to re-ignite the vapor and air mixture when the carbon dioxide has been dissipated by air currents.

Carbon dioxide is especially effective on fires involving electrical equipment (Class "C"). It is a non-conductor of electric current. The gas will penetrate into spaces within the equipment and will not cause additional damage beyond that caused by the fire.

On fires involving wood, paper, rubbish, and like materials, (Class "A"), carbon dioxide is not an effective extinguishment agent. A small fire involving such materials, while yet in its early stage, can be extinguished. Due to the limited cooling capacity of carbon dioxide, complete extinguishment is difficult and in many cases impossible because of the degree of temperature retained within the burning mass. Many times the surface flames can be extinguished and the fire held in check until suitable extinguishing agent can be obtained.

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Carbon dioxide is effective at all temperatures and will not freeze, therefore, it does not require protection at low temperatures. If carbon dioxide snow is allowed to come in contact with the skin, serious burns may result.

Recharging

Special equipment is required to recharge this type of extinguisher. Commercial recharging service is available in most localities.

Inspection

The extinguisher should be inspected semi-annually or more often if practicable:

1. To determine the content, it is necessary to weight the extinguisher. If the carbon dioxide charge is 10 per cent or more under rated capacity, it should be recharged at once.

2. The weight of the extinguisher is stamped on the valve. The manufacturer's instructions for determining the correct weight are stamped on the cylinder band and should be followed.

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3. Check condition of hose and nozzle.

4. Check locking pin and sealing wire. If sealing wire is broken extinguisher should be weighed.

Vaporizing Liquid Extinguisher

Sizes - 1, 1½, 1¾, 2 quarts; and 1,2,3 gallons.

The vaporizing liquid extinguishers are usually of double action hand pump design.

The extinguishing agent used is a high-grade carbon tetrachloride treated with other chemicals to depress the freezing point to about 50 degrees below zero and to prevent corrosion of metal. It is a non-conductor of electricity. This liquid vaporizes rapidly when exposed to the atmosphere. The vapors are non-combustible and are about one and one half times heavier than air. Its heat-absorbent capacity is far less than that of water and its principle extinguishing action is due to the vapor which dilutes the oxygen in the zone of combustion.

The vapors are toxic and if breathed may produce physical injury. This is especially true when used on heated metal or on a smouldering fire. The operator should avoid breathing the smoke and gases given off by the fire when using this extinguishing agent.

Operation - Quart sizes.

1. Remove from bracket holder and carry to point of operation. Approach as closely as possible to the fire.

2. Unlock the pump handle by turning handle a quarter turn in either direction and start pumping.

3. When attacking a fire involving electrical equipment (Class "C") direct the stream at the base of the fire. When used to attack a flammable liquid fire in a container, direct the stream to strike the opposite side

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1. Remove from bracket holder and carry to point of operation. Approach as closely as possible to the fire.

2. Unlock the pump handle by turning handle a quarter turn in either direction and start pumping.

3. When attacking a fire involving electrical equipment (Class "C") direct the stream at the base of the fire. When used to attack a flammable liquid fire in a container, direct the stream to strike the opposite side of the container above the liquid. Do not direct the stream into the burning liquid.

Where possible, the operator should move around the container while directing the stream so as to obtain the maximum coverage during the discharge period.

The effective range of the one-quart size is about 15 feet and the period of time required to discharge the contents is about 40 seconds.

Suitability

Vaporizing liquid is effective on Class "C" fires. It is a non-conducting agent and doesn't damage lectrical equipment. Its effectiveness on Class "B" fires will depend upon the skill of the operator and the surface area involved. It is not recommended except for very small quantities of flammable liquid. It is effective on fires involving the motors of automobiles and trucks. It is not recommended for Class "A" fires.

Recharging

The liquid does not deteriorate and any remaining liquid can be used. Directions for refilling are carried on the

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extinguisher. Only approved liquid should be used.

Inspection

1. Pump-type vaporizing liquid extinguishers should be inspected every third month to determine if they will operate properly and are charged. They may be inspected more often if practicable.

2. The extinguisher should be removed from holding bracket and a small amount of the liquid pumped out to determine if the pump operates properly and if the extinguisher contains vaporizing liquid. It is possible for flammable liquids or water to be substituted for the proper liquid. Liquid used should be replaced with new liquid.

3. The date of inspection should be noted in ink on the record card and signed or initialed by the inspector.

Dry Compound Extinguisher

Sizes - 15, 25 pounds

There are two types of dry compound extinguishers in common use. One type is provided with hose and control nozzle; the other type expels the compound through a small opening which is located near the bottom of the cylinder. Both use a carbon dioxide cartridge to provide the pressure to expel the compound from the extinguisher.

The extinguishing agent used is bicarbonate of soda treated with a moisture-repellent chemical. The extinguishing action of this compound is due to the following:

1. The small particles of soda absorb heat in the zone of combustions.

2. Bicarbonate of soda, when heated, breaks down and releases carbon dioxide gas.

Sizes - 15, 25 pounds.

There are two types of dry compound extinguishers in common use. One type is provided with hose and control nozzle; the other type expels the compound through a small opening which is located near the bottom of the cylinder. Both use a carbon dioxide cartridge to provide the pressure to expel the compound from the extinguisher.

The extinguishing agent used is bicarbonate of soda treated with a moisture-repellent chemical. The extinguishing action of this compound is due to the following:

1. The small particles of soda absorb heat in the zone of combustions.

2. Bicarbonate of soda, when heated, breaks down and releases carbon dioxide gas.

3. The many small particles of soda tend to displace air in the zone of combustion.

The type without the hose and control nozzle is equipped with a spring attachment which forms a control for the discharge opening located near the bottom of the extinguisher. To operate, it is necessary to grasp the extinguisher by the upper part of the cartridge case which is attached to the outside of the cylinder and to grasp the bottom of the cylinder with the other hand. The operator can stop the flow by closing the valve of the carbon dioxide cartridge and closing the discharge opening.

To obtain effective results with the dry compound extinguisher it is necessary that the operator be trained in its use on various types of fires.

The effective range of the 15-pound unit is about 10 feet. An effective flow of compound will be obtained for about 30 seconds.

Suitability

These extinguishers are effective on Class "B" and "C" fires. In the hands of trained and experienced operators they are effective on small spills of flammable liquids. They are not recommended for Class "A" fires.

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