# *PROCEEDINGS:*

# RECONVENED INTERNATIONAL CONFERENCE ON FIRESAFETY IN HIGH-RISE BUILDINGS

OCT. 5, 1971

GENERAL SERVICES ADMINISTRATION

PUBLIC BUILDINGS SERVICE

UNITED STATES OF AMERICA
GENERAL SERVICES ADMINISTRATION
WASHINGTON, D.C. 20405

JAN 12 1972

ADMINISTRATOR

To the Reader:

The General Services Administration, the civilian construction arm of the Federal Government, has a vital interest in the development of improved methods and technology concerned with firesafety in buildings.

During April 1971 GSA sponsored the International Conference on Firesafety in High-Rise Buildings. The report of that conference was issued in May 1971 and over 10,000 copies distributed. If any reader of this document desires a copy of the May 1971 report, he may obtain it through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (stock number 2204-0005).

This document is a record of the Reconvened International Conference on Firesafety in High-Rise Buildings. This meeting was held on October 5, 1971, in the General Services Building, Washington, D.C. The purpose of the meeting was to report on the progress and activities of GSA since the initial conference and to provide a general forum for the review of actions and plans of others working for firesafety in high-rise buildings.

It is felt that the presentations made on October 5, demonstrate a significant step forward. There is, however, still considerable development needed before a total firesafety system is fully evolved. We in GSA will continue our efforts in this area and will keep the interested public informed of our progress. The ultimate solution, however, will require the dedicated efforts of the entire buildings design and operation industries. We urge all design engineers, architects, fire researchers, code officials, fire protection engineers, and other interested parties to accept the challenge of developing the total system that will revolutionize firesafety in buildings throughout this country.

Sincerely,

Robert L. Kunzig

Robert L. Kunzig
Administrator

# SECTION I

Remarks of Arthur F. Sampson, Commissioner, Public Buildings Service introducing GSA's Firesafety system as applied to the new Seattle Federal Building.

MR. SAMPSON:

Administrator Robert L. Kunzig asked me to reconvene GSA's International Conference on Firesafety in High-Rise Buildings today -- during Fire Prevention Week.

GSA has made significant progress implementing the recommendations of the Airlie Conference held in April and in following through on the Commitment we made before the Fire Protection Association annual meeting in San Francisco in May.

During today's seminar you will hear what GSA plans for improved fire protection in future Federal high-rise buildings.

Later today you will hear from others who are deeply concerned with firesafety in high-rise buildings and will report the plans they have made.

Before we go into the reports scheduled for this seminar, General Services Administrator Robert L. Kunzig has asked me to make the following announcement:

The first total firesafety system designed specifically for a Federal high-rise building will be installed in the 36 story Seattle Federal Building which is now under construction.

The experience that GSA will gain from this prototype system will be integrated into all future Federal high-rise buildings. The new total firesafety system which will be installed in the Seattle Federal Building will provide improved protection for the thousands of visitors and employees who work in all Federal buildings. It will aid our protection of the buildings themselves and their surrounding neighborhoods.

Also they are efforts to improve what we consider to be the best firesafety program in American buildings today. We are continually evaluating our protection and strongly feel that we can improve firesafety in high-rise buildings.

The Seattle building will contain a total sprinkler system, a specially designed smoke control system, automatic control of elevators and a comprehensive emergency control and communication center. The emergency control center, a new concept for American Federal buildings, will provide fire or emergency personnel complete control of the building. There will be a two way communications system from each floor, automatic and immediate voice direction for all types of emergencies, and thorough plans of the building available. Voice directions will replace traditional alarms in all cases.

This application of the total firesafety system concept is just a beginning. We will continue to modify our building designs and fire and emergency systems until we have the safest Federal buildings possible, given today's technology.

The Seattle Federal Building substructure is now under construction. The superstructure, including the new firesafety system, is expected to go under construction next April with completion estimated for early 1974. A model of this high-rise building is right here in the center of the stage. It will be a 36 story building almost 500 feet tall, housing over 3,000 Federal employees from 19 Federal agencies.

The keystone of the total firesafety concept in the Seattle Federal Building is the emergency control center. A model of this is on the stage behind me and its capabilities will be demonstrated in a moment.

The importance of the emergency control center is that it provides a safe location from which all elements of the protection system are controllable.

GSA's architects, engineers and firesafety personnel took a look at the design of this building with the recommendations of the Airlie Conference in mind. Let's review the elements of a total firesafety system as they were developed in April.

*Total emergency evacuation of the Seattle Federal Building is not practical.

*Therefore the building must provide fully protected areas of refuge.

*Fire size must be limited through control of the fuel for a fire; compartmentation of the building and early extinguishment of the fire.

*The building must have structural integrity.

*There must be control of smoke and fumes.

*There must be an emergency control center if the total firesafety system is to work.

*Occupants must be trained to make best use of the building firesafety system.

*Finally a building maintenance manual will be prepared by the building designer prior to occupancy of the building.

Our plans for the Seattle Federal Building are based on these main elements of a total firesafety system. All of these elements have been thoroughly discussed with fire and safety officials in Seattle and I am pleased to point out that the Fire Chief of the City of Seattle, Chief Gordon Vickery, is with us this morning for this announcement.

Here's how the design of the Seattle building looks:

*Total evacuation is out

<u>FUEL LOAD</u> - Building construction finish will be of materials that do not contribute to the spread or severity of fire. The total system has been designed to protect rather than restrict the furniture and equipment normal to a Federal building.

COMPARTMENTATION - The Seattle Federal Building is vertically compartmented with each floor an individual fire resistant component.

EXTINGUISHMENT - The building will be completely protected with an automatic sprinkler system.

FIRE LIMITATION - Given all of the fire provision elements it is expected that during the next 50 years there will be about 100 fires in the building. It is further predicted that one will extend beyond the work station with a 1% probability of that one fire involving an area larger than one room.

STRUCTURAL INTEGRITY - The integrity of the structural system is being provided at a level three to four times the potential of the most severe situation likely to occur.

PERSONNEL MOVEMENT - Emergency movement of employees is based on vertical movement from floor of danger to a remote floor of safety. The elevators will be automatically returned to the lobby in case of emergency.

SMOKE CONTROL - A specially designed smoke control system will be installed.

EMERGENCY CONTROL CENTER - As I have indicated earlier, this is the keystone of the total firesafety system in the Seattle Federal Building.

The Seattle Federal Building had already been designed prior to the time all of these new firesafety features were incorporated. I want to announce that the redesign of the building resulted in additions and deletions. The net dollar effect for the trade-offs was no increase in the total cost of the building. The estimated additional cost of the total firesafety system is $485,000, and it includes a complete sprinkler system.

Now we're going to demonstrate the type of installation that we're talking about. Let me point out that there will be no traditional alarm bells in the building--it is a voice communications system.

Here's what will happen if somebody discovers a fire in the Seattle Federal Building. A signal from the emergency signal box, sprinkler flow alarm, or smoke detector automatically initiates the following actions:

*The alarm signal is transmitted to the Fire Department and the control center.
*Pre-recorded instructions are given to the occupants of the fire floor.
*Air flow is adjusted to prevent smoke and other products of combustion from spreading outside the fire zone.
*Elevators serving the fire area are captured and reserved for use by emergency personnel.
*Two-way voice communications are established with the caller.
*Emergency instructions and information about the building are given to the control center operator.

Let me introduce Bud Nelson, GSA Chief of the Firesafety Branch, who will demonstrate and explain the purpose of all of this equipment. Bud, will you also talk about what happens when the Fire Department arrives.

(A demonstration of the control center was given.) (Description of the firesafety system including the control center will be found in Appendix A.)

MR. SAMPSON:

Ladies and gentlemen, this demonstration has been designed to emphasize that GSA is serious about its commitment to implement the total firesafety system concept of the Airlie Conference. We have just begun -- we will continue to refine our plans in the future.

Now, Bud and I will be happy to answer your questions.

(Questions and answers are found in Section 8.)

## SECTION II

Discussion by Irwin A. Benjamin, Chief, Fire Research Section, National Bureau of Standards, dealing with a decision-tree analysis approach to determining firesafety features in high-rise buildings with special emphasis on the elevator problem.

# A METHOD OF ANALYSIS FOR CONTROL OF BUILDING FIRES

A fault tree is an event logic diagram. It is a tool which has been used for many years in accident analysis and shows the interrelationships of events that will affect the occurrence of an accident. The branches and limbs of the fault tree relate the nature of occurrences which must be completed in order to produce the total accident.

We can start by defining the type of accident which we wish to prevent - in this case, the building fire which causes loss of life or loss of operation. The causes contributing to the event are connected by what we call gates and broken down into the individual causes contributing to the accident. The gate can be an "and" gate or an "or" gate. The "and" gate tells the events which must occur concurrently in order for the accident to occur. The "or" gate in turn indicates events which may occur separately or concurrently in order for the accident to occur.

The fault tree shows interrelationships:

- what events have to occur together or independently
- which events can contribute to most effectively control the accident
- where choices or trade-offs can be made in our design to prevent the accident.

As an example, we have developed a fault tree analysis of the control of the building fire to show the factors involved in this control and also to provide a picture of the problem as a whole so that we could get an overall concept rather than having to look at individual pieces.

The fault tree has two branches: one dealing with factors controlling safety to life, and the other dealing with those which affect continuity of operation of the facility. This does not mean that the two are complimentary and are so shown on the fault tree diagram. The two are connected by an "and" gate to show that both aspects are necessary to provide adequate control of the building fire. To provide continuity of operation one should attempt to provide:

- control of the ignition source
- control or limitation of the fuel load
- limitation of the fire and smoke spread potential.

Control of the ignition sources and limitation of the fuel load are not truly very well under control of the building designer. However, he can do something to limit the fire spread and smoke potential. By material controls and by either extinguishment, compartmentation or a combination of both, the "or" gate means that we have come to where one can make a decision. We now need an analysis to provide some picture of the economic trade offs between compartmentation or extinguishment and how they may be most effectively used in combination.

If we go the extinguishment route, then of course we need a detection and alarm system to get the extinguishment activated and of course we have a choice of several different methods of extinguishment, one or all of which may be used. The little triangles with numbers in them, by the way, refer to matching points in other parts of the fault tree where the same types of events are involved.

Now let's go back to the safety to life branch. You will note that there are two parts that are needed to provide safety to life, a system of personnel communications and a plan for the movement of people.

The plan for the movement of people should be conditioned by some knowledge of how people will react in a fire situation. Unfortunately, knowledge in this area is rather skimpy, if not negligible. Note here that we have a choice of using vertical movement, horizontal movement, an area of refuge, or again some combination of the three. If we use the area of refuge, particularly in the high rise building, then we need a life support system which requires, in some way, limitation of the fire spread potential which is also required for continuity of operation so you see the two branches are tied together. Also, we need provisions for moving fire fighting personnel into the building and again a detection and alarm system which might be the same one we were using for extinguishment systems.

If we chose vertical movement then we have to think about travel distances, the nature and construction of the exit ways and a system for guiding people. We have a choice of moving people vertically using stairways, or elevators, or both.

The other branch of the safety to life system is the need for personnel communications. This breaks down into four areas: external, that of the building to the fire department; and the internal communications between the fire department and their personnel, the fire department to the occupants in the building and the management to the occupants.

Note that the internal communication system requires both a center for communications and also some training of the occupants of the building. At the bottom of the tree there is a choice to be made between audio or visual communications or both. Again an area that needs to be explored is to what is the most effective means of communication.

Now going back to the vertical movement branch, note that there is a box for elevators. Each box in the tree can be broken down into a whole separate system. I would like to show you what we have done with just one phase of this particular box.

This is a study of a possibility of an accident occurring in an elevator during a fire.

To have such an accident we need to have occurring simultaneously either:

- fire or smoke in the elevator lobby
- the elevator coming to the fire floor and stopping at the fire floor
- and doors opening and exposing the occupants.

It is important to know that all three of these conditions must be satisfied and that if we can prevent any one of them we can prevent the occurrence of the accident. For example, if we can keep the elevator from coming to the fire floor or stopping at the fire floor it is possible to prevent the accident.

One branch pertains to the elevator being called to the fire floor. It can be called there by the occupant of the car pushing the button, by activation of the button at the fire floor, or by the elevator responding to an automatic programming system. The activation of the button at the fire floor can in turn be caused by elevator response to the occupant at the fire floor or by some effect of fire on the button itself. However, it is worth noting that if we can put in an automatic detection system to control the elevator we can prevent the elevator from stopping at the fire floor regardless of any of the subsequent events happening.

If the elevator does come to the fire floor, the doors may open exposing the occupants or the doors may stay closed and still expose the occupants to an intolerable situation.

When the elevator doors open they may not reclose because of mechanical failures or failures in the control system.

In summary, I would like to say there is nothing magical about the fault tree system, in fact, it doesn't even solve any problems for you. What it does do is help you to:

- organize your thoughts
- and show what is important.

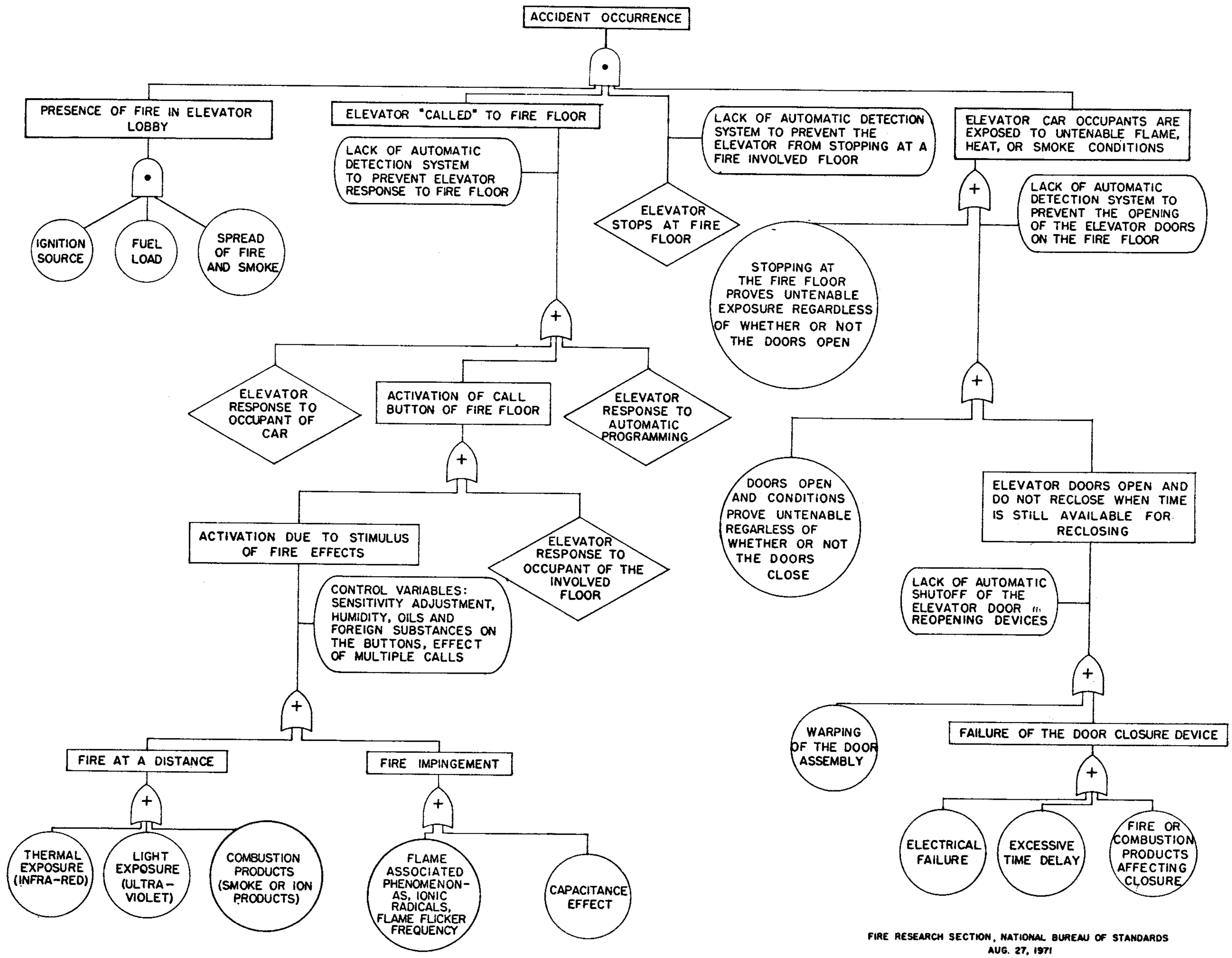
For example, to study the elevator accident problem we would not start with a study of doors warping since this is really too far down the fault tree. Rather we will go back up the tree and work on how we can stop the elevator from stopping at the fire floor.

In other words, the obvious becomes more obvious when it is laid out effectively on the fault tree. We have learned as we have developed these trees the relative importance of the various events. In turn, this has been a guide as to the areas where we should do our planning and research activity.

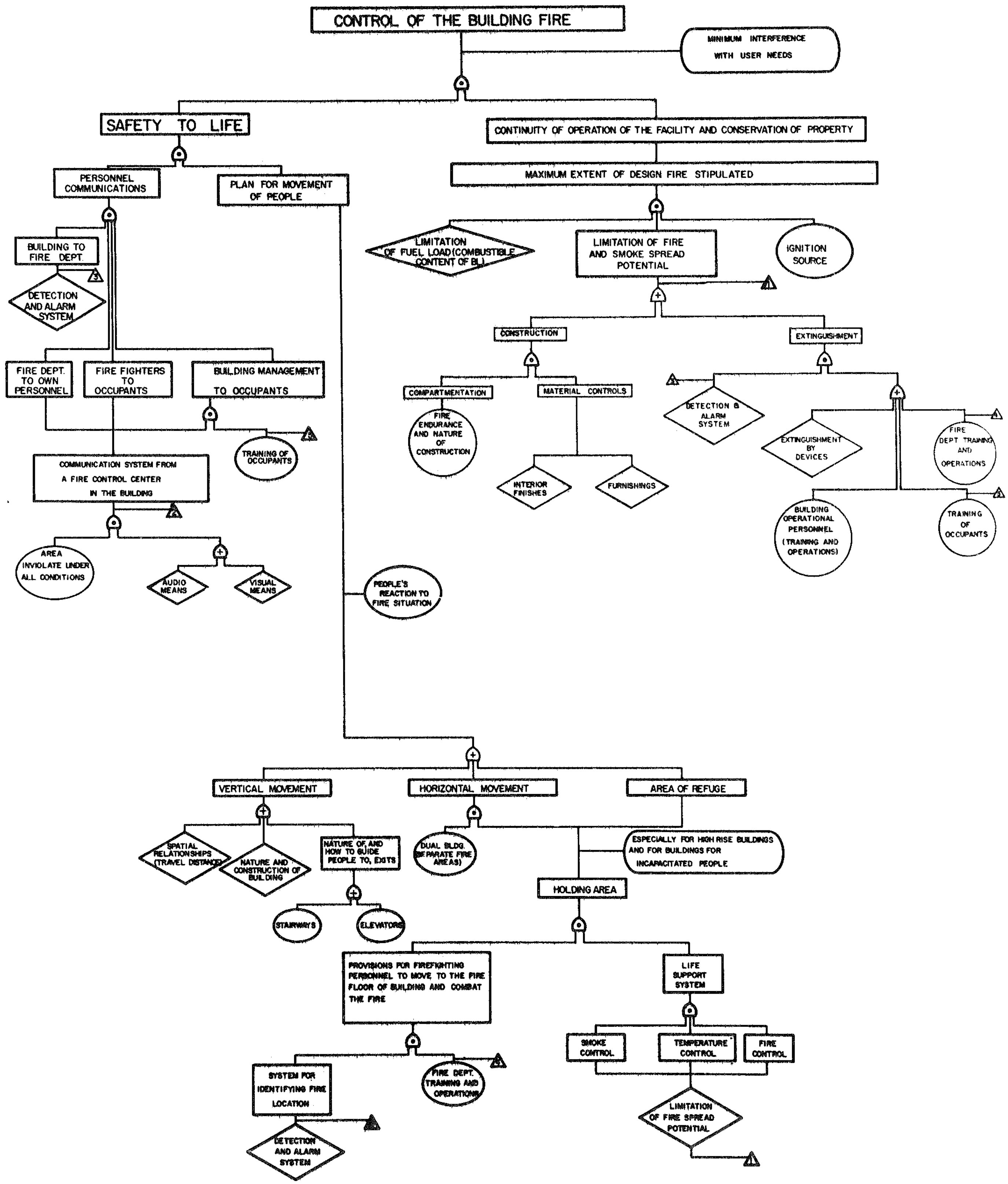
I suggest that the fault tree can be used here today as an overall guide to the systems that are necessary to prevent tragedy in the high rise buildings.

(Questions and answers are found in Section 8.)

FIRE ACCIDENTS INVOLVING ELEVATOR CARS
STOPPING AT FIRE INVOLVED FLOORS

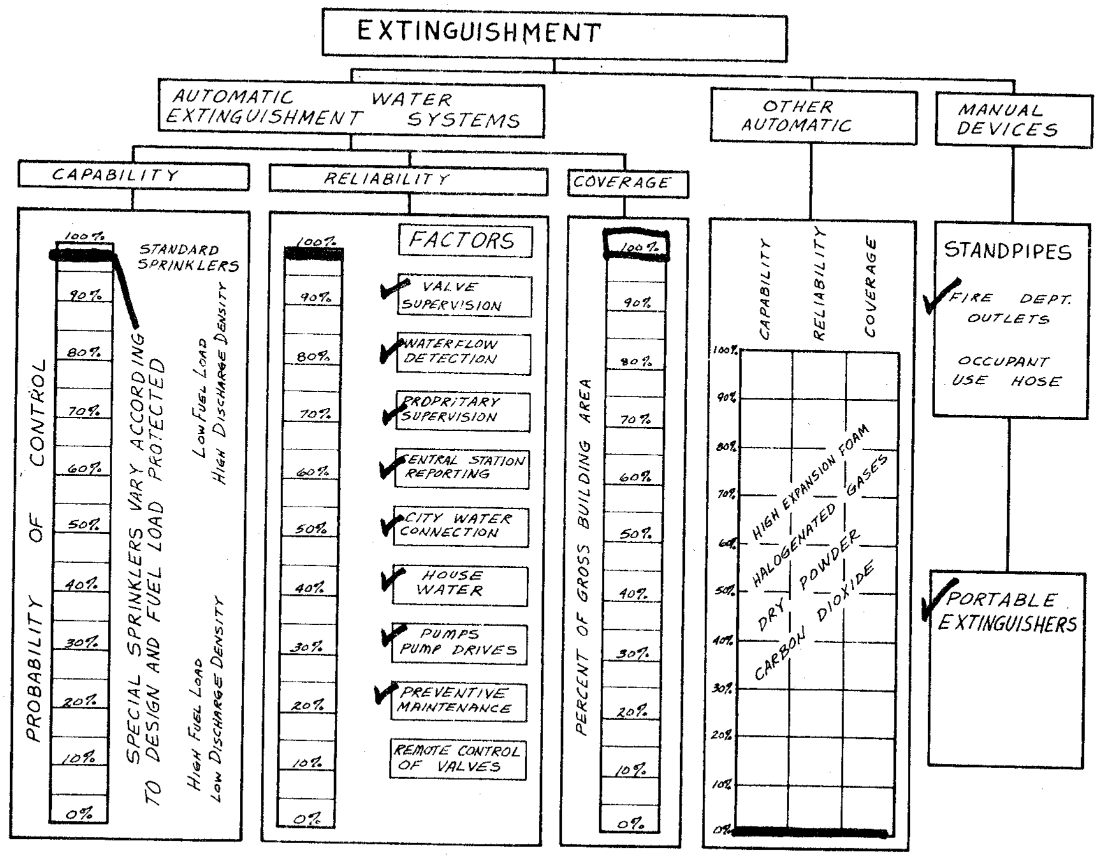



FIRE RESEARCH SECTION, NATIONAL BUREAU OF STANDARDS
AUG. 27, 1971




Fire Research Section
Building Research Division
June 1971

# EXTINGUISHMENT




The Seattle Federal Building will be completely protected with automatic sprinklers specifically designed for the range of Federal occupancies that may be housed over the life of the building. Maximum application has been made of those features that insure reliability such as supervision of all valves, waterflow detection, an emergency supply of water in the building and emergency drive for the fire pumps. A unique looping arrangement of the standpipes will permit usage of these pipes for both fire department hose streams and sprinkler water supply. The loop system will also increase reliability.

EXTINGUISHMENT

The Seattle Federal Building will be protected throughout its entire structure by a specially designed automatic sprinkler system developed for the purpose of providing in excess of 99% probability of full control of fires in normal office and office support type arrangements. Coverage is based on the delivery of approximately 0.1 gallons of water per square foot per minute or greater throughout any office space likely to be involved. The water supply and vertical distribution system are such that greater coverage can readily be provided in any space where the type of occupancy or operation conducted is such as to impair this high probability of control.

The reliability of the system is assured by multiple water sources, emergency drives, and a complete array of supervisory devices reporting both to the building emergency control center, and to the fire department through central station service.

Manual fire fighting capability for the occupants will consist only of first aid fire extinguishers located near the exits. Where a special process hazard occurs, or more commonly, for an office where a special high valued piece of equipment indicates a need, additional fire extinguishers will be provided.

In view of the proximity of the Seattle Fire Department it is considered impractical to train building occupants to use standpipe hose. As a backup procedure in case of wide-spread problems where the Seattle Fire Department cannot respond, a supply of lined 1 1/2 inch hose with shut-off nozzles will be provided in strategic locations for use by personnel trained in small fire attack and organized under the building Self-Protection Organization.

The standpipe connection and arrangement is developed and located specifically to meet the needs of the Seattle Fire Department. Full capability of use of the internal standpipe system is provided for this fire department.

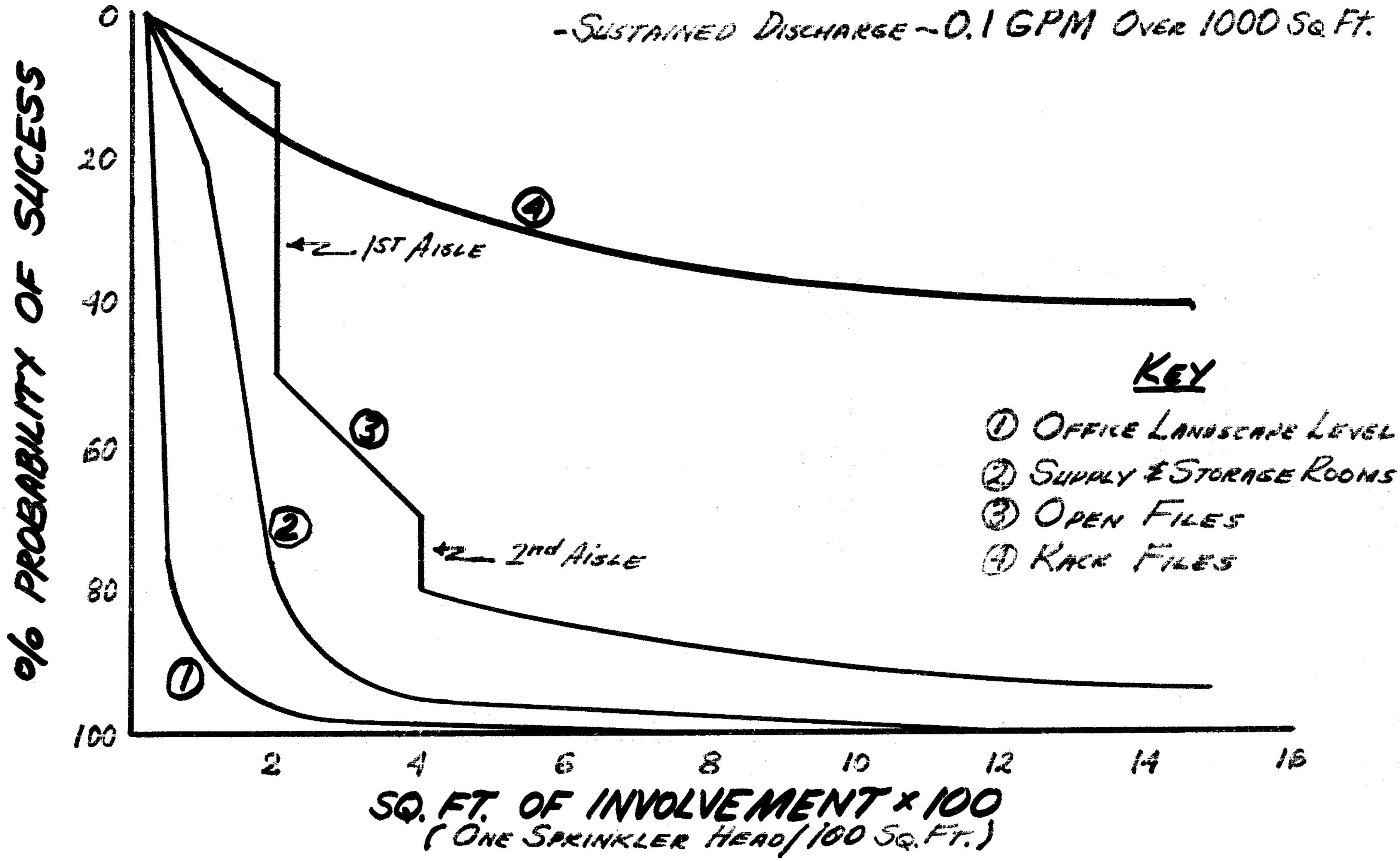
The vertical standpipes are 6-inch in size and looped at the top. These will be used for both standpipe and sprinkler supply.

## SEATTLE FEDERAL BLDG.

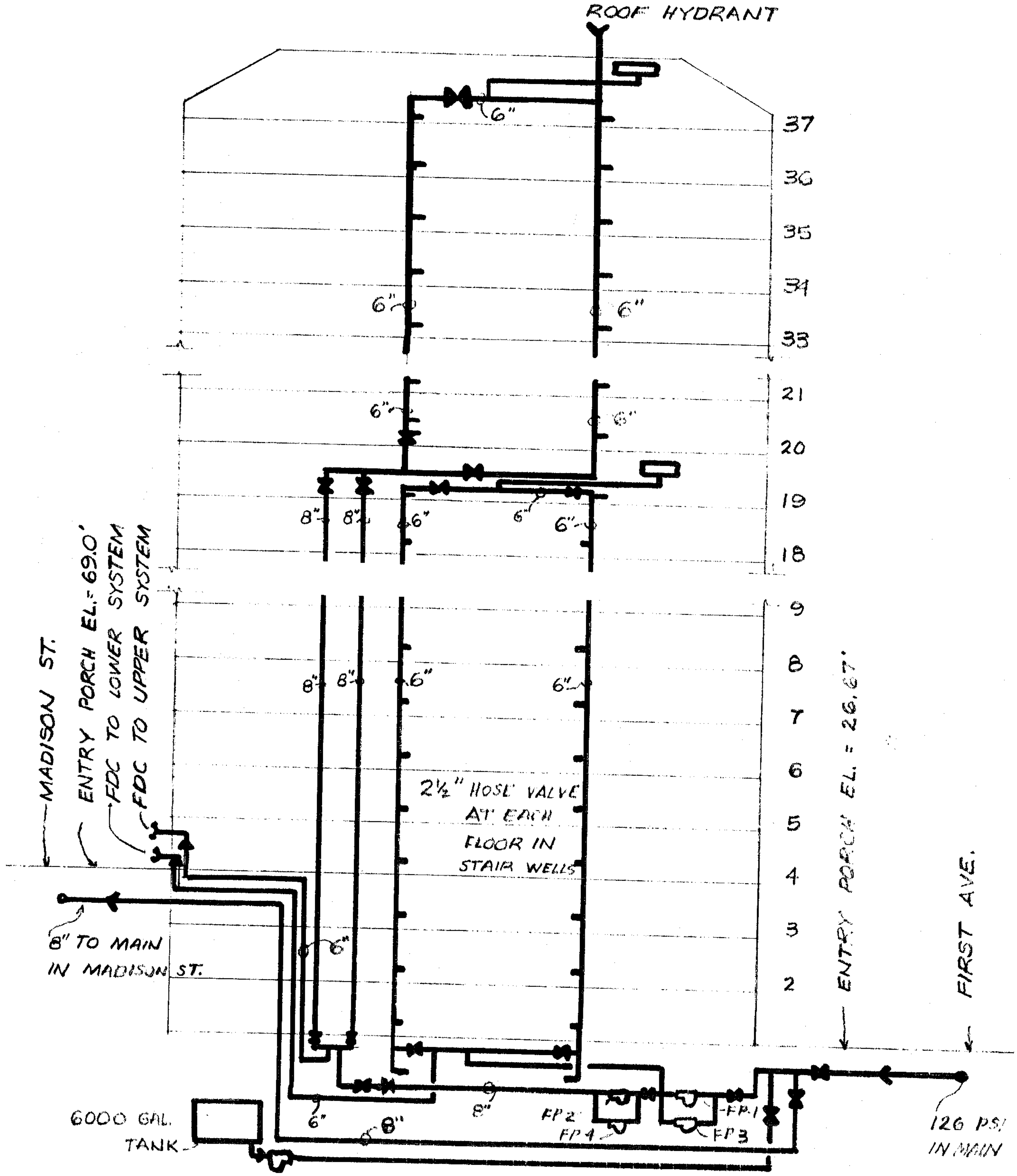
## CAPABILITY OF SPECIAL SPRINKLER SYSTEM

DENSITY - INITIAL HEAD - 0.3 to 0.4 GPM PER SQ. FT.

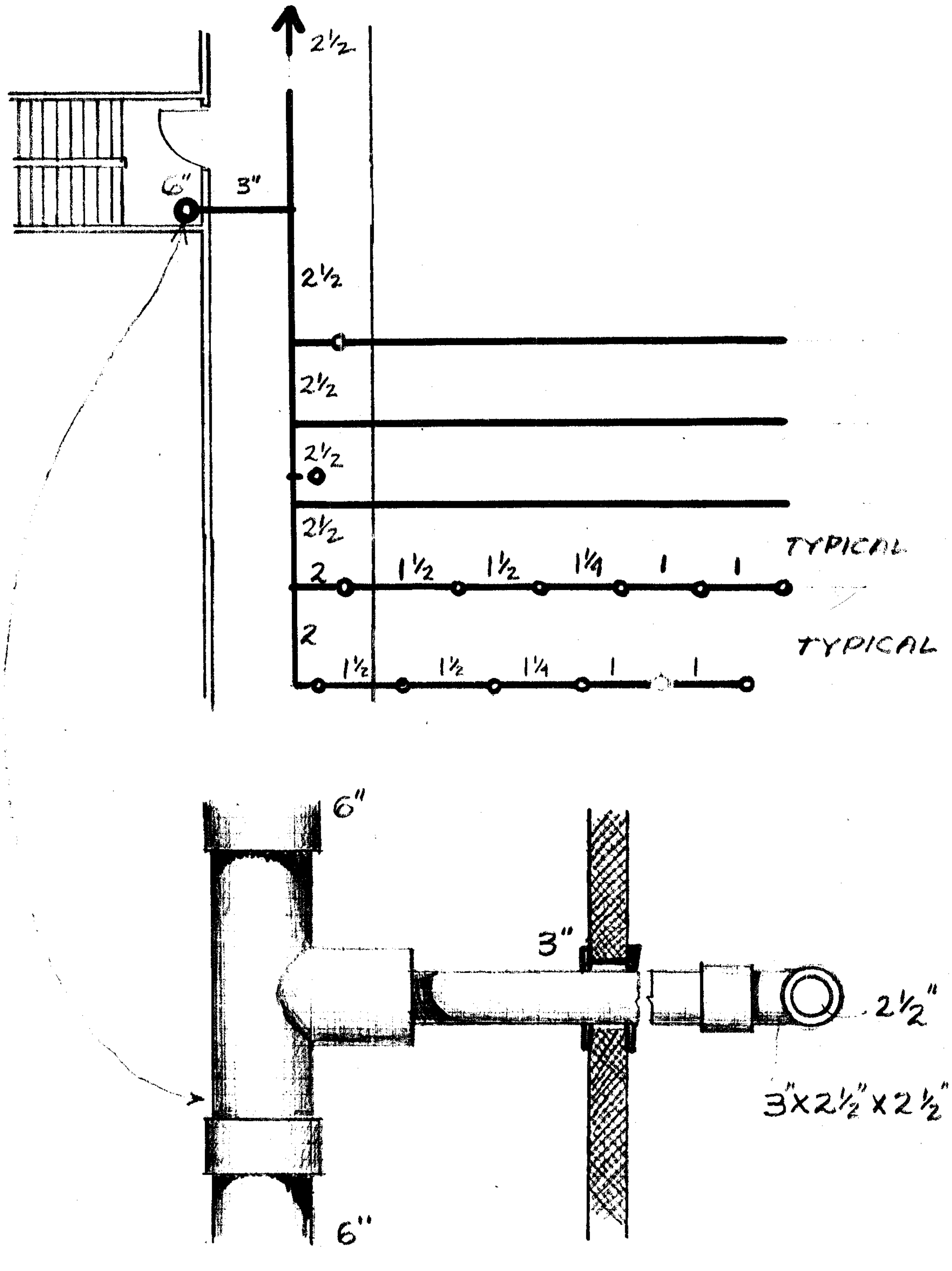
- SUSTAINED DISCHARGE - 0.1 GPM OVER 1000 SQ. FT.



# VERTICAL LOOP~MAIN WATER DIST. SYSTEM



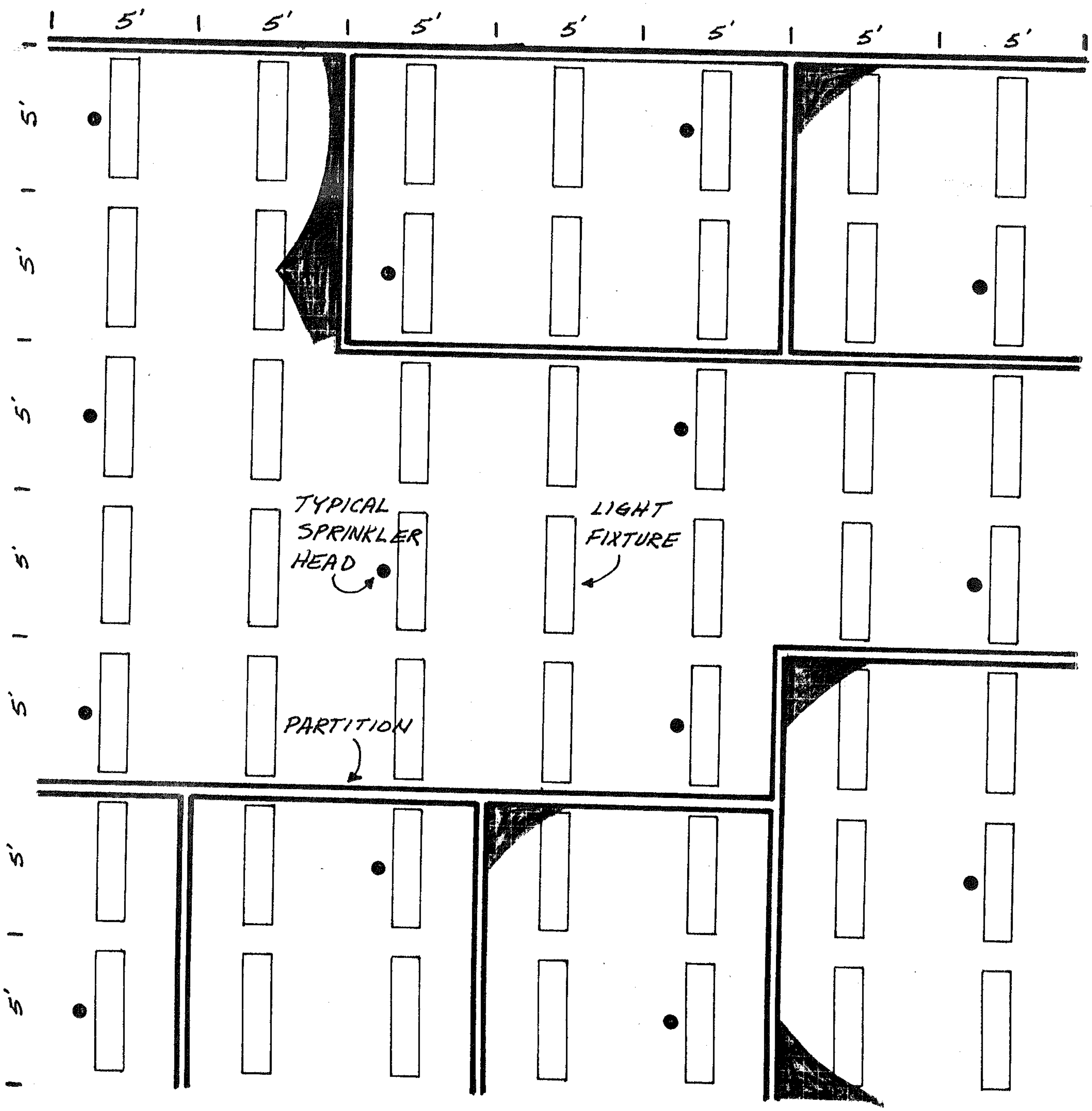

FP-1 - 750 GPM - 230 FT TDH
FP-2 - 750 GPM - 125 FT TDH
FP-3 - FP-4 JOCKEY PUMPS
FP-5 250 GPM - 290 FT. TDH



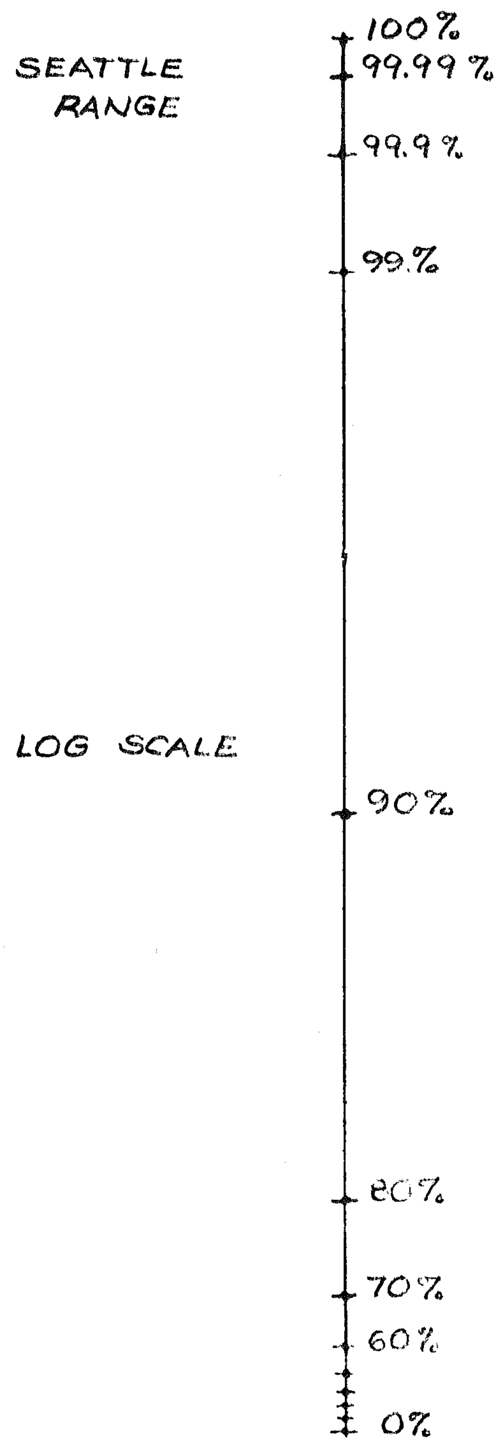

TYPICAL SPRINKLER PIPING

# STUDY OF SPRINKLER COVERAGE

1. SPRINKLERS STAGGERED ON 10 ft. SPACING, BASED ON 5 ft. CEILING MODULES.
2. SHADED AREAS ARE PORTION 4 ft. BELOW CEILING NOT COVERED BY SPRINKLER SPRAY PATTERN.
3. ALL FLOOR AREAS COVERED.



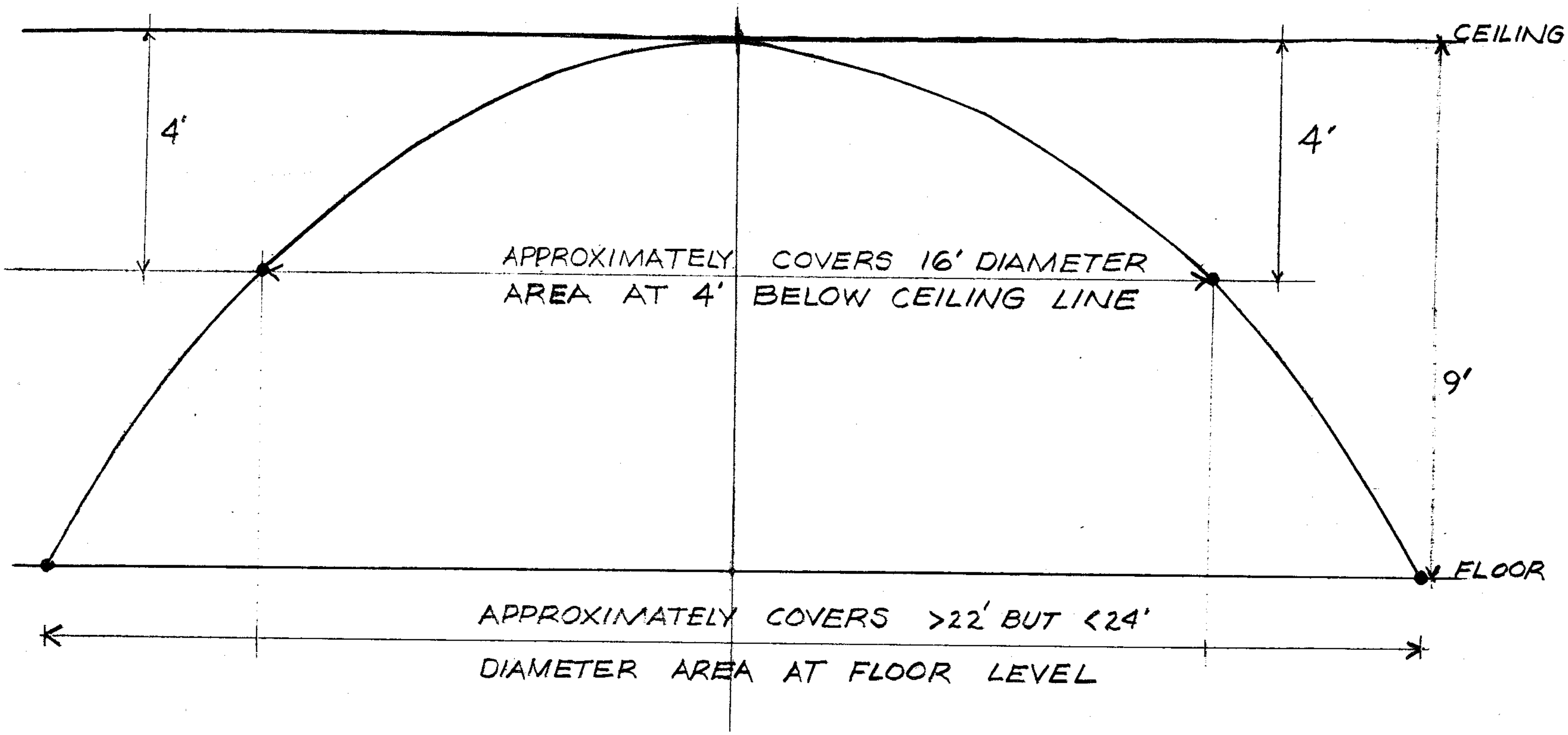
# SPECIAL SPRINKLER SYSTEM RELIABILITY INDEX FACTORS




SUPERVISED VALVES
WATER FLOW DETECTION
PROPRITARY SUPERVISION
CENTRAL STATION SUPERVISION
CITY WATER
HOUSE WATER TANK
PUMPS
EMERGENCY PUMP DRIVE
PREVENTIVE MAINTENANCE PROGRAM
POWERED VALVES*

*under consideration

APPROXIMATE DISTRIBUTION PATTERN FROM SPRINKLER HEAD



## PREVENTIVE MAINTENANCE

Under the Buildings Maintenance Management System, a preventive maintenance program has been established. From experience, maintenance frequencies have been established and manhours estimated for accomplishing the specified work as detailed in the preventive maintenance guide cards. Preventive maintenance in accordance with the guide cards listed below will enhance the reliability and effectiveness of the emergency water supply system and the sprinklers in the Seattle building.

Alarm Check Valves & Accessories
Dry Pipe Valves
Post Indicator Valves
Control Valves (4" or over) for Fire Water Supply
Fire Pumps (Motor or Engine Driven)
" " " " " "
" " (Motor Driven)
" " (Engine Driven)
Fire Dept. Hose Connections (Standpipes)
Fire Dept. Pumper Connections (Standpipe or Sprinkler)
Fire Doors - Stairwells and Exitways (Swinging)
Fire Doors - Sliding Type
Fire Supervisory Signals - Testing
Fire Automatic Detection or Alarm Devices
Fire Alarm System - Control Boards
Fire Alarm System - Recorders
Fire Alarm Boxes (Manual)
Fire Hydrants
Fire-Sprinklered Areas