BLANKET FOR SURVIVAL

A FIRE FIGHTING TECHNIQUE FOR COMBATTING AIRCRAFT FIRES

AIRPORTS SERVICE
Federal Aviation Agency

For additional information, copies of the test report No. RD-65-50, "Post-Crash Fire Fighting Studies on Transport Category Aircraft," are available from the U. S. Department of Commerce, Clearing House for Federal Scientific and Technical Information, Springfield, Virginia 22151. Department of Commerce No. AD 621676 at $2.00 per copy.

"Tower to fire station... tower to fire station."

"Come in tower."

"Flight No. 214, XYZ airline reports faulty landing gear. Flight due to land at 1535 hours on Runway 24L. Aircraft is a JB-120 N-15339; 150 passengers including crew. Estimated fuel--5000 gallons; stand by on the field."

"Roger."

Time alone will tell if this alert will result in a minor incident or a major accident as shown in Figure 1.

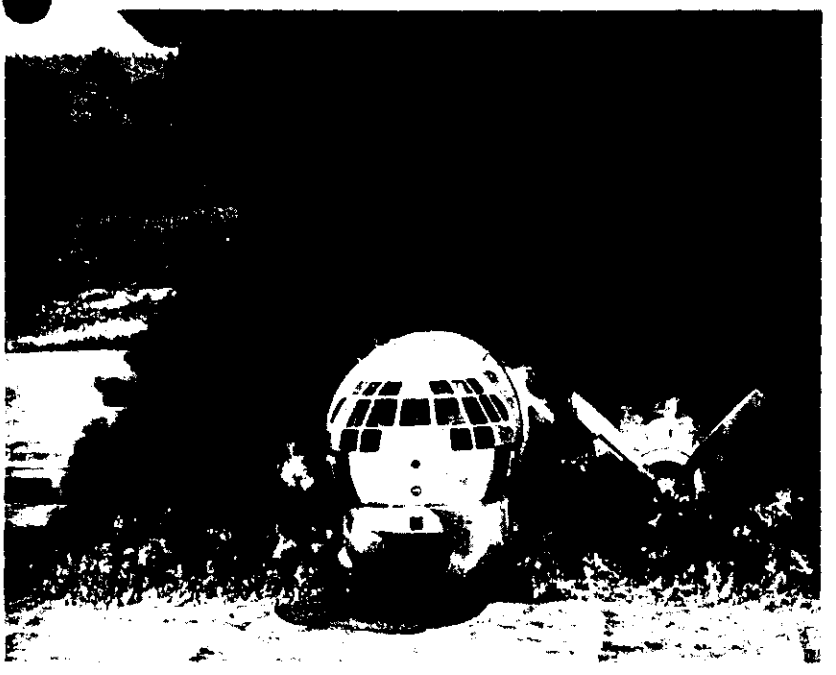

Figure 1

The firefighters responding to this alert know that they have the needed firefighting equipment and can develop its maximum fire suppression potential because they have been trained in extinguishing fires involving several thousand gallons of fuel.

A study, conducted several months ago at nine selected airports, indicated that on an average, fire departments were alerted once for every 717 aircraft movements. Fortunately, the majority of these alerts were for minor incidents; however, minor incidents may become major accidents due to lack of training, error in judgment, or mechanical failure in equipment.

There are few, if any, instances today where so few seconds may mean the difference between life and death to so many people as in a fire resulting from a major aircraft ground accident.

While the necessary equipment to suppress such a fire is essential, it may be of little value unless the assigned personnel have been sufficiently trained to obtain the maximum suppression capability from their equipment.

It has been truthfully stated many times that a firefighter's training should commence the day he joins the department and continue until he leaves. This is particularly true for the firefighter required to combat an aircraft fire, for he must be trained to function not only as an individual, but as a member of a team. Fires which develop as rapidly as those fed by aviation fuels do not allow for errors in judgment or technique or permit the issuance of detailed orders or instructions.

Accordingly, a comprehensive training program is a necessity. It should include:

1. Daily classroom sessions (Figure 2) covering aircraft familiarization, first aid, the handling of hazardous materials, preplanning for the approach to and operation at aircraft accidents, use of small tools, and procedures to be followed in the use of radio facilities.

2. Weekly action drills including the operation of mobile equipment on dry runs, familiarization with airport and surrounding environs, and combatting small fires (Figure 3).

3. Quarterly drills in the extinguishment of large fires (Figure 4) which call for full utilization of the firefighting potential from the equipment assigned.

Figure 2

Figure 3

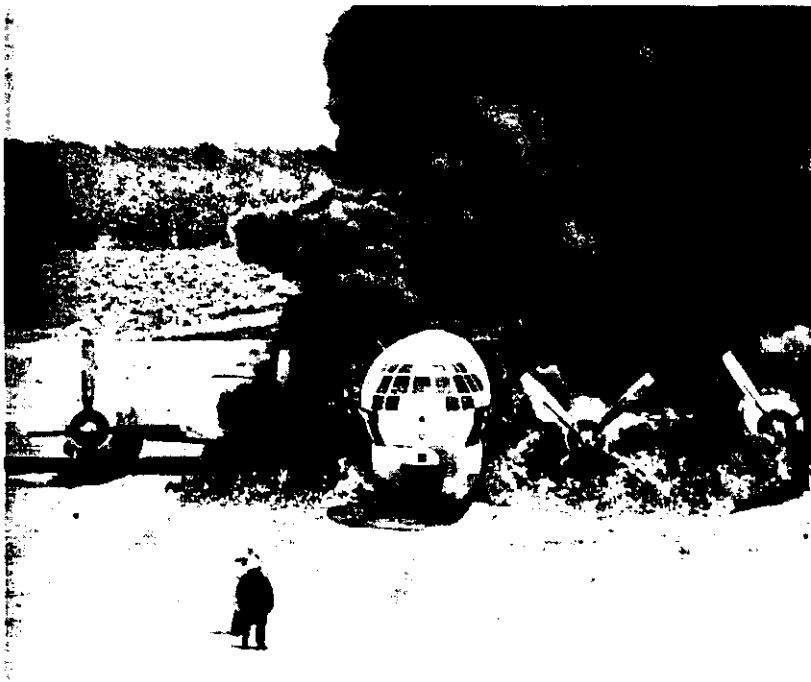

Figure 4

The need for drills involving large fires was clearly demonstrated during the 1964 tests conducted at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, New Jersey. The participating firefighters had rarely been exposed to fires greater than those recommended for action drills. It was interesting to note that as they gained experience through the tests, their proficiency and confidence increased correspondingly.

Prior to developing guidance material needed for training, the Agency determined that it was first necessary to obtain valid information about survival conditions within an aircraft involved in a major fire and about the effectiveness of fire suppression and rescue techniques commonly used today.

To obtain this information, extensive test fires were conducted during 1964 at NAFEC. A special pad, as shown in Figure 5, was constructed for these tests.

Figure 5

In addition to the instrumented data collected, all fires were thoroughly documented on color film. It was felt that the information contained in this film, together with other information similarly documented, was of sufficient value to warrant the production of a training film entitled "Blanket for Survival." This film demonstrates a successful technique for combatting major aircraft fires based on the premises of reaching the full length of the fuselage, cooling the metal, and blanketing the fire area.

The following pages describe various aspects of the firefighting techniques shown in the film.

First, let's discuss trucks. Only through a thorough knowledge of the equipment can its use and maximum potential be obtained.

The aircraft fire and rescue trucks commonly used to combat fires resulting from aircraft accidents are:

1. A light-weight dry chemical truck often called the rescue truck.
2. Water/foam trucks.
3. Tank or nurse trucks.

The light-weight dry chemical truck, shown in Figure 6, normally carries from 500 to 1000 pounds of dry chemical and a complement of rescue tools for forcing entry into an aircraft. Dry chemical is a highly effective agent for quick extinguishment of electrical, engine, or small fuel spill fires. It is also helpful in containing larger fires, pending arrival of the water/foam trucks.

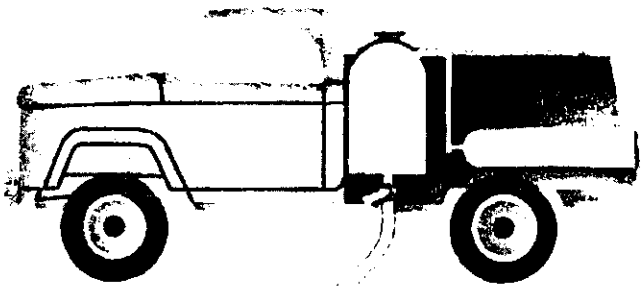

Figure 6

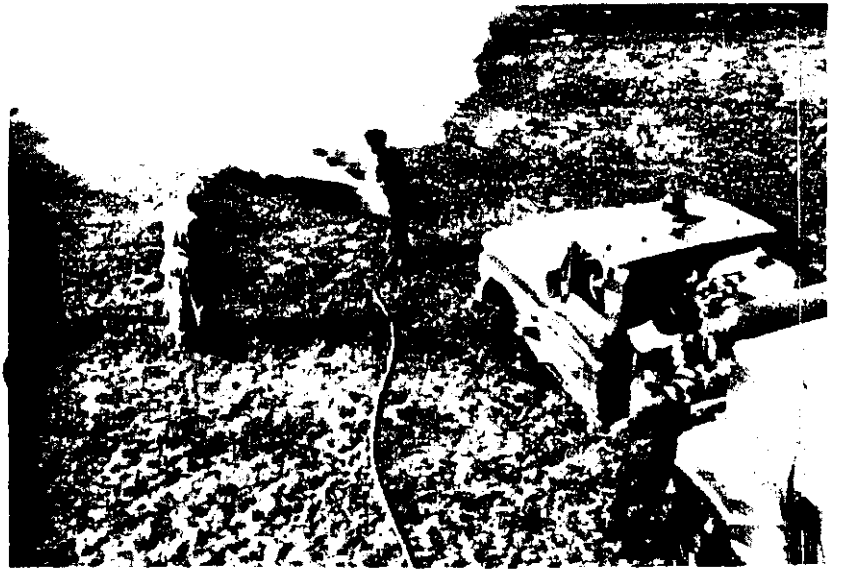

Figure 7

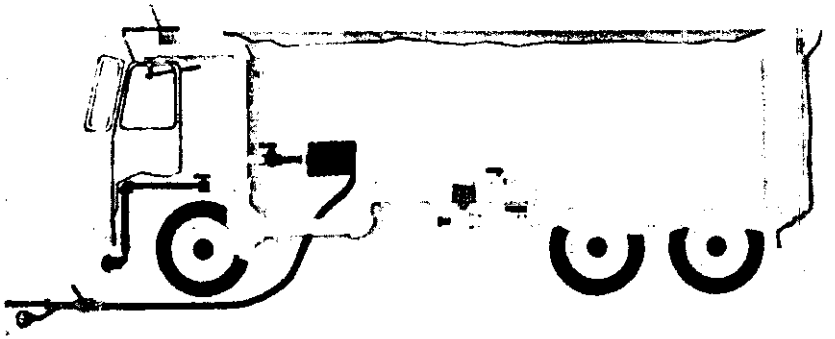

Figure 8

Dry powder is applied, as shown in Figure 7, by approaching the fire from the upwind side with the hose nozzle held waist high and slightly elevated for maximum reach. The nozzles should be moved slowly from side to side until all the flame is completely suppressed. Dry powder has no blanketing or holding characteristics; therefore, another agent, "foam", is required to assure complete extinguishment.

The water/foam truck, shown in Figure 8, is the mainstay for "knocking down" and extinguishing a major fire. The turrets on this type of truck can be remotely controlled from within the cab which provides protection for the operator. If desired, turrets may also be operated from the cab roof.

The solid stream from the turret, as shown in Figure 8, should normally be used in the initial approach to a fire. With proper use, it should have a reach of not less than 135 feet. The solid stream can quickly cool a fuselage and blanket the fire adjacent to the aircraft. Wider blanketing action is obtained by using a dispersed pattern which will reach about 60 feet and lay a blanket approximately 35 feet wide. The water foam nozzles, therefore, have the dual capability of discharging either the solid stream or the dispersed pattern needed in extinguishing a major fire.

When approaching a fire, the turret discharge should be started about 100 feet from the fire, discharging a solid stream. These solid streams are used to reach and cool the entire fuselage and blanket the fire on both sides of the aircraft. As the trucks move closer to the fire, the turret streams are changed to the dispersed pattern which materially increases the width of the foam blanket as it is laid. As soon as the main body of fire is "knocked down", the turret discharge should be curtailed and used only as necessary to permit the safe evacuation of aircraft occupants. Remember--the agent carried on the trucks is the only supply that can be depended upon, so it must be used wisely.

Handlines should be used primarily to extinguish fires in areas shielded from the turret streams or in mopping up after a large fire has been suppressed. Normally, they should not be used in the initial "knock down" of a major fire.

A typical tank or nurse truck carries a supply of water, normally either 1000 or 2000 gallons, to augment that carried on the water/foam trucks. The water in these trucks can be transferred to the water/foam trucks at the same rate as the liquid can be discharged from the water/foam trucks (see Figure 9).

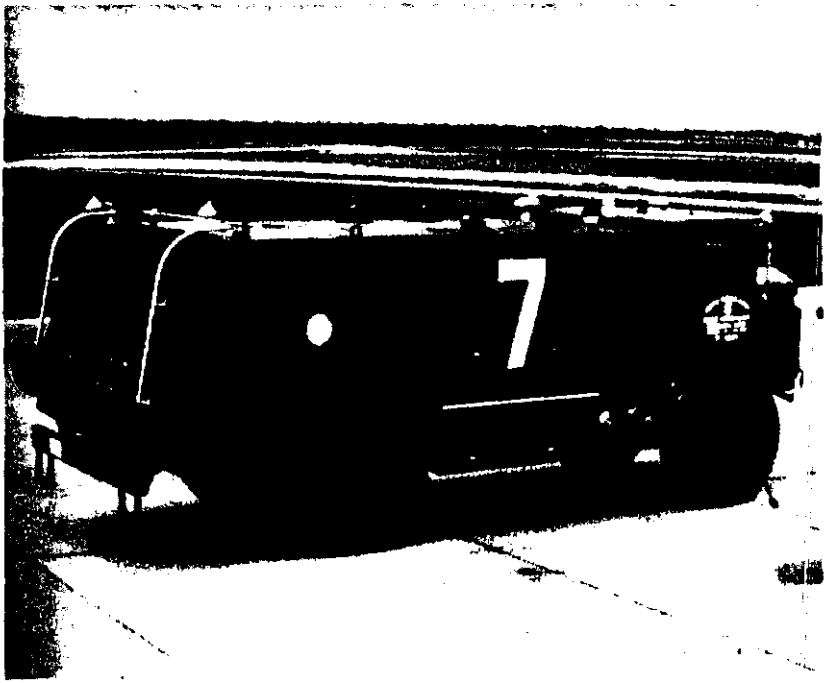

Figure 9

Does training and emergency planning pay off?

A minor emergency shown in the film occurred at Washington National Airport. The film shows how well-trained firefighters and effective emergency plans are used in an actual aircraft emergency.

The tower controller, when notified of an emergency by the aircraft captain, alerts the fire department. According to plan, the responding units take their predetermined positions on the field. This particular incident involved a fire in No. 4 engine; but remembering that each aircraft emergency could result in a major fire, mutual-aid off-airport fire departments were also alerted. In responding, these units laid hose lines from the nearest hydrant to supply additional water to the aircraft fire and rescue trucks for use if necessary. In this instance, the fire was quickly extinguished by blanketing the burning engine with foam. The

success of this operation was made possible by the rapid response of emergency vehicles. Preplanning, training, and proper application of foam permitted quick extinguishment of the fire. Aircraft passengers were safely evacuated.

Now let's consider the procedure which the FAA tested and proved to be the best method for providing the maximum protection possible to occupants involved in a major aircraft fire. This procedure followed the formula of reaching the entire length of the fuselage, cooling the metal and blanketing the fire area. These three objectives--reach, cool, and blanket--provide a "Blanket for Survival."

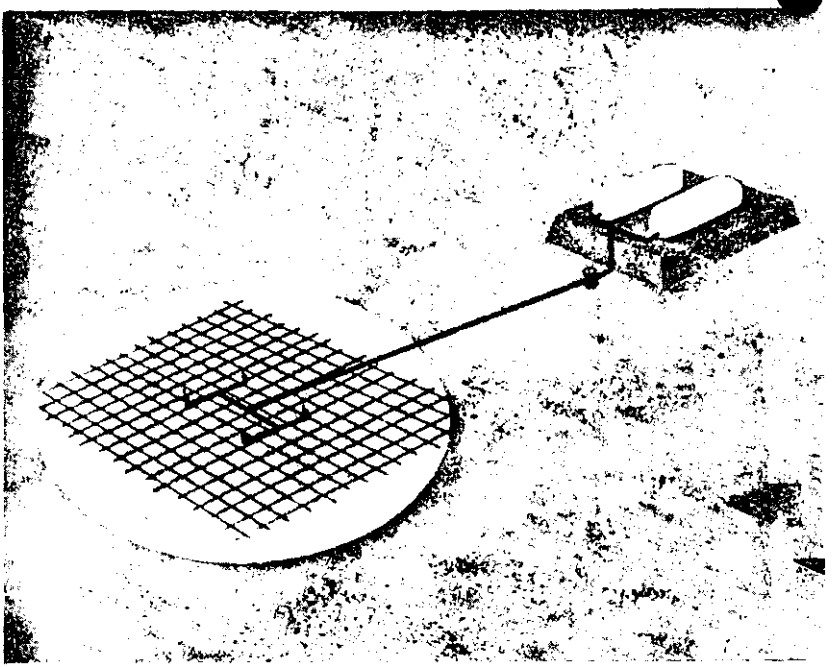

Figure 10

Several test fires were necessary to prove the effectiveness of this procedure. This required establishing a set of conditions which would produce fires of similar characteristics and development of a site for conducting these tests. This test site (Figure 10) consisted of:

1. A 200-foot diameter pad with 10-foot grids.
2. Two, 5000-gallon elevated fuel tanks.
3. A piping system and controls to regulate the flow of fuel at the established flow rates of 200, 500, or 1000 GPM.
4. A 5000-gallon water reservoir.

The aircraft used in these tests were military C-97's, insulated to make them thermally equal to a modern air carrier aircraft. These test aircraft were equipped with 78 instruments to record vital interior and exterior temperatures and toxic gas concentrations within the cabin area. The insulation is shown in Figure 11.

Aircraft fires of this magnitude had never before been filmed or documented for detailed study and analysis.

When these fires were ignited, fuel was flowing at the rate of 200 GPM which simulated an aircraft accident in which a single-wing tank was ruptured permitting fuel to spill under the aircraft.

Fire, fed by fuel which is constantly being replenished and increased to simulate an actual accident condition, is a flowing spill fire which is more difficult to suppress than a static spill fire.

Forty-five seconds after ignition the flow of fuel was increased to 500 GPM simulating the rupture of an additional fuel tank. This increased the fire area and intensity.

In this fire, seventy seconds after ignition about 450 gallons of fuel had flowed covering approximately 3800 square feet of area. Fire suppression began. To achieve the reach necessary to cool the entire length of the fuselage and blanket adjacent areas, a solid stream discharge was used first.

One hundred seconds after ignition the flow of fuel was increased to 1000 GPM and; as shown in Figure 12, the trucks moved closer to the fire area.

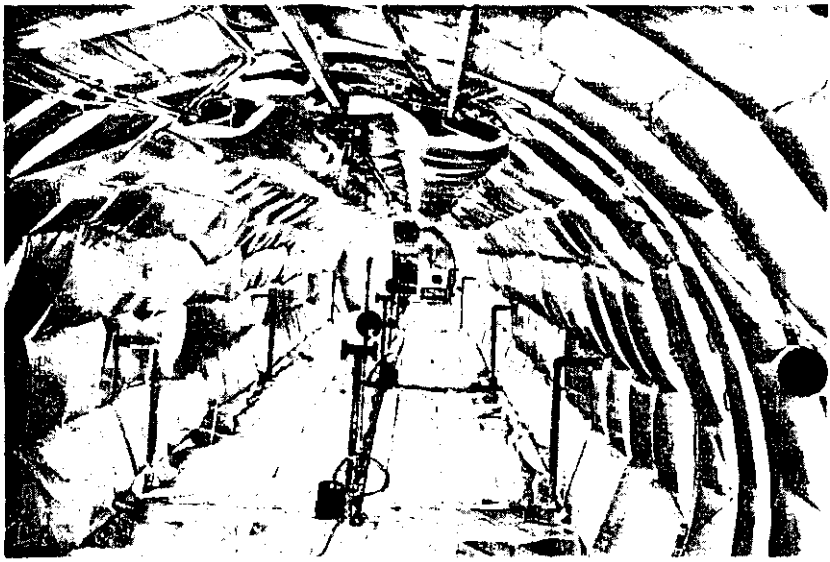

Figure 11

Figure 12

The turrets were now changed to the dispersed foam stream pattern to provide wider coverage and lessen the tendency to break the foam blanket through use of a solid stream. Ground-sweep nozzles were actuated to suppress fire under the wings and around the forward fuel outlets. This 1000 GPM flow rate continued for the 5 minutes remaining in this major fire test. During this 5-minute period, the fire intensity and area were not materially increased. Within 30 seconds after application of the dispersed pattern, evacuation paths 15 feet in width had been cleared on each side of the aircraft, as shown in Figure 12. The fire was no longer influencing temperatures within the aircraft. The turrets were cut to a single-barrel stream to conserve agent, as the fire was considered under control. Once the turret discharge has been changed to a dispersed pattern, the solid stream should not normally be used again, [redacted]s reach is essential. A solid stream used at close range will break the integrity of the foam blanket already laid and cause a reflash. Foam blankets of about 2 inches in depth were found effective. Needlessly, increasing the depth of the blanket wastes valuable agent.

At 210 seconds (3-1/2 minutes) after ignition, fuel was still flowing at 1000 GPM. Two thousand seven hundred and fifty (2750) gallons of fuel had been fed to the fire. Remaining fires at the fuel outlets and on the periphery of the fire area did not endanger aircraft occupants or hinder evacuation.

At 255 seconds (4-1/4 minutes) after ignition, turrets were shut off. Remaining small finger-like fires should be ignored, as the action of the foam already laid, which flows like heavy cream, will seal exposed fuel. The needless use of handlines may scatter the foam blanket exposing a larger fuel area to possible reignition. At this stage in the operation, the handline men can assist in the evacuation of occupants.

At 285 seconds (4-3/4 minutes) after ignition, 3700 gallons of fuel had been fed to the fire. Fuel flow continued for the next two minutes to equal the maximum quantity normally carried on a large jet aircraft when landing. The ground-sweep nozzles continued in use to maintain the foam blanket around the fuel outlets.

Throughout the entire 420 seconds (7 minutes) of the test, interior temperatures did not exceed 120°F except in the rear section of the aircraft. Initially, temperatures in this section reached 180°F but, as foam was applied, were gradually reduced to 120°F. A lethal level of toxicity was never reached. As shown in Figure 13, the aircraft remained intact.

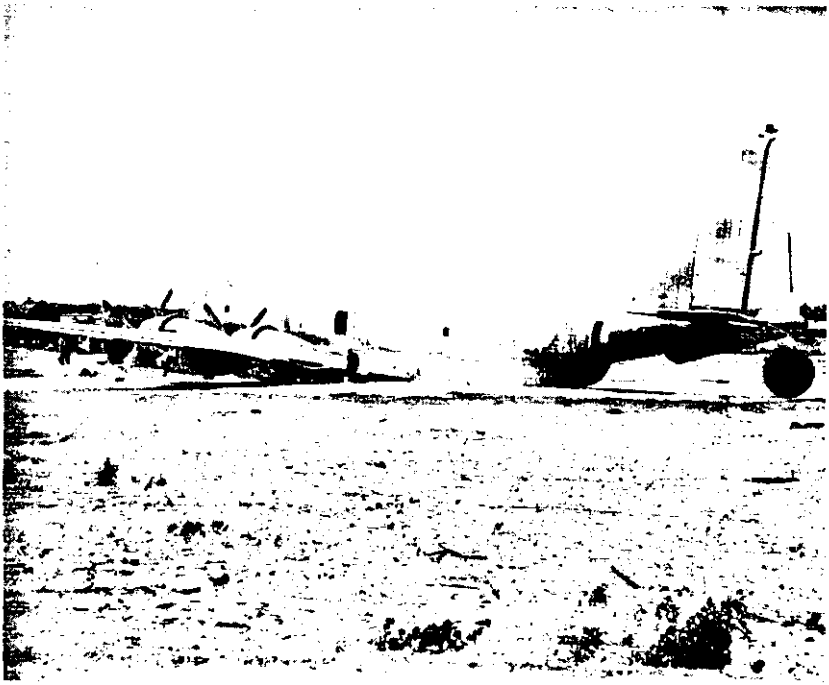

Figure 13

From these tests, it was apparent that:

1. To provide maximum protection to occupants of an air carrier aircraft involved in a major fire, suppression action should first be directed to the fuselage and the fire immediately adjacent thereto. This necessitates applying foam to both sides of the fuselage and then to the adjacent fire areas, gradually extending the width of the controlled area between the aircraft and the fire.
2. The controlled area between the aircraft and the fire can be used effectively in evacuation as rescue paths or areas.

3. Handlines are ineffective in the initial control of a major fire and, if carelessly used, can cause flame flare-ups which could result in injury to occupants evacuating the aircraft. They can, however, be beneficial when used during "mop-up" after a fire is under control or in the extinguishment of small fires in engine nacelles or the fuselage not accessible to turret streams.

4. A solid stream from the turrets should be used only in those instances where reach is essential.

5. A comprehensive training program is essential if firefighters are to attain the desired degree of confidence in their equipment and proficiency in its use. *Training programs* should include the extinguishment of at least four fires annually which are large enough to utilize the full fire-suppression potential of the equipment assigned.

While minor emergencies frequently occur, days, months, or years may go by before a major fire occurs to challenge the firefighter. This further justifies a requirement for the *major drill fires recommended*, as in many instances it is only through these that firefighters can gain the knowledge and experience so essential when every second counts, every drop of agent is needed, and life itself is dependent upon an operation that is rapid and flawless.

Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: 150/5210-4
AIRPORTS
EFFECTIVE: 10/27/65

SUBJECT: FAA AIRCRAFT FIRE AND RESCUE TRAINING FILM, "BLANKET FOR SURVIVAL"

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1. PURPOSE. This advisory circular provides information on the purpose, content, and availability of the subject training film.

2. THE FILM, "BLANKET FOR SURVIVAL." This 22-minute color film shows firefighting procedures which the FAA tested and found to be the most effective in providing safety to occupants of an aircraft involved in a major ground fire. In addition, the film covers various factors which should be taken into consideration in developing an effective firefighting and rescue unit. Much of the action footage used in the film was taken for documentary rather than dramatic purposes. Errors made during the firefighting have been retained in the film to show what happens when these occur.

   a. Suggested Use. Primarily, the film is intended as a training aid for personnel who participate in the actual firefighting and rescue operations. In addition, it provides guidance to airport management in developing an effective aircraft firefighting and rescue unit and to supervisors in establishing a training program. The film may also be used to stimulate the interest of individuals or groups that are either directly or indirectly responsible for providing fire protection or in improving the effectiveness of existing units.

   b. Availability. The FAA will make this film available to airport management, airline operating units, municipalities, and other groups interested in aircraft firefighting and rescue operations. Requests for showing the film should be made to the nearest FAA area office.

   c. Acquisition of Copies by the Public. Anyone may purchase copies of this film from the Capital Film Laboratories, Inc., 470 E Street, S.W., Washington, D.C. 20024. The cost per copy is $57.45; including reel and carrying case, excluding postage, shipping costs, and

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taxes as applicable. A prospective purchaser should make any and all arrangements with that corporation.

3. FILM BROCHURE. A limited number of brochures will be available from the FAA area offices when the film is loaned. This brochure, which contains much of the film narration, may be retained for reference in training sessions held subsequent to the film showing. The brochure can also be used as a training aid without viewing the film.

4. HOW TO OBTAIN THIS PUBLICATION. Obtain additional copies of this publication, AC 150/5210-4, FAA Aircraft Fire and Rescue Training Film, "Blanket for Survival," from Federal Aviation Agency, Printing Branch, HQ-438, Washington, D. C. 20553.

Chester G. Bowers
for Cole Morrow, Director
Airports Service

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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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   c. Acquisition of Copies by the Public. Anyone may purchase copies of this film from the National Audio Visual Center, General

Initiated by: AS-570

Services Administration, National Archives and Records Service, Washington, D.C. 20409. The cost per copy is $80.25, including reel and carrying case, including postage, shipping costs, and taxes as applicable. Film can be shipped anywhere in the United States and its possessions. A prospective purchaser should make any and all arrangements with National Audio Visual Center.

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Chester G. Bowers

CHESTER G. BOWERS
Director, Airports Service