

NFPA's

AIRCRAFT FIRE INVESTIGATORS MANUAL



COMPLIMENTS OF NAFEC (ANA-420)

Aircraft Fire Investigators Manual

NFPA No. 422M — 1972

This Edition of the Manual

This Manual has been produced for the purpose of (1) bringing together in one text information deemed useful by the sponsoring committee to aid personnel investigating aircraft accidents involving fire; (2) to assess the effectiveness of airborne and ground fire control equipment and its utilization; and (3) to provide data which will contribute to accident prevention and the saving of lives in future aircraft fire incidents and accidents. This is the first edition of this Manual to be officially adopted by the National Fire Protection Association (International), action having been taken at the Association's 76th Annual Meeting held in Philadelphia, Pennsylvania, U.S.A. on May 16, 1972.

Development of this Manual was initiated in 1963 and various drafts were made during the intervening years, culminating in the distribution of a complete draft which was circulated for comment and criticism before a meeting of the NFPA Committee on Aviation and its Sectional Committee on Aircraft Rescue and Fire Fighting held in London, England during the period October 9 to 23, 1971 in the form of NFPA Aviation Bulletin No. 385, dated July 1971.

Work on this Manual was originally assigned to a Subcommittee headed by Mr. D. A. Heine of the Air Line Pilots Association with Messrs J. C. Abbott (British Overseas Airways Corp.), J. J. Brennan (United Air Lines), J. W. Bridges (Federal Aviation Administration), J. J. Carroll (National Transportation Safety Board), H. P. Hogue (The Boeing Company), R. Macdonald (Canadian Air Line Pilots Association), H. B. Peterson (U.S. Naval Research Laboratory), and W. T. Schmidt (Indiana Fire Fighters Association) participating as Subcommittee Members. The Chairmanship of the Subcommittee was turned over to Capt. William L. Collier of the International Federation of Air Line Pilots Associations in 1969 and the final text is largely the result of Capt. Collier's dedicated work during the 1970-1972 period. The final draft was submitted to a considerable number of aircraft accident investigative agencies for review and suggestions (see page 4 herein).

Permission was granted at the 1972 NFPA Annual Meeting by the NFPA Board of Directors to authorize Official Adoption of this text when initially submitted instead of processing the Manual through a "Tentative" status.

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Scope: To promote fire safety during the operation, maintenance, servicing and storage of aircraft and in the operation of airports and associated functions. The Committee is a policy-making Steering Committee of the NPPA Sectional Committees organized to handle specific technical problems in the aviation field. Reports prepared by the Sectional Committees are circulated for letter ballot to the members of this Committee and the results reported to the Annual Meeting of the Association.

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Scope: To develop fire safety recommendations for aircraft rescue and fire fighting with particular attention to the rescue problem coincident to fires following impacts. This Sectional Committee is responsible for specialized equipment, facilities and training procedures for airport fire departments and guidance for handling aircraft emergencies by public fire services. This Sectional Committee reports to the Association through the Aviation Committee.

Acknowledgments

This text has been compiled by Capt. William Collier of the International Federation of Air Line Pilots Associations from the information of many experts in the field of rescue and fire fighting, accident investigation, the Federal agencies, universities, and flight crew members. Besides the members of the NFPA Committee on Aviation and its Sectional Committee on Aircraft Rescue and Fire Fighting (names shown in committee listings published herein), the following organizations were contacted and provided valuable assistance:

- Air Line Pilots Association; Flight Safety Foundation, Inc.;
- National Transportation Safety Board; The Federal Aviation Administration; Society of Air Safety Investigators, International Civil Aviation Organization; South Bend, Indiana Fire Department; United Kingdom Dept. of Trade and Industry, Fire Services Branch; The Port of Seattle (Washington) Fire Department; U. S. Naval Research Laboratory; *University of Southern California; Canadian Airline Pilots Association; United States Dept. of the Air Force (Inspector General); International Fire Service Training Association.

Space does not permit all of the personal acknowledgments to the people who contributed to the contents of this text.

* Extensive use was made of speech "Aircraft Fire Lesson Plan" by speaker from School of Aviation Safety.

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Aircraft Fire Investigators Manual

NFPA No. 422M — 1972

Foreword

a. In any aircraft accident investigation, the investigating team is invited to use not only pertinent publications of the State of registry of the aircraft, but also the Manual of Aircraft Accident Investigation, Doc 6920-AN/855/4, compiled and published by the International Civil Aviation Organization.

b. This Aircraft Fire Investigators Manual has been prepared for use by the investigating team during the investigation of an aircraft accident involving fire. Depending on the extent of the fire and/or the size of the investigating team, the "Aircraft Fire Investigator" may be a fire expert assisting the members of the team, or he may be one of the regular members of the team assigned to the fire aspects of the accident investigation.

c. Regardless of the actual role of the investigator handling the fire aspects of the investigation, the reference in the text of this Manual to the "Aircraft Fire Investigator" is not intended to preempt the scope or command of the investigation, but necessarily confines suggestions to such person on the team that is so designated. This person is usually a part of the Human Factors Group on aircraft accident investigation teams involving United States registry aircraft, while in ICAO Doc 6920-AN/855/4, the fire investigation is done by the Evacuation, Search, Rescue and Fire Fighting Group, although closely coordinated with the Witness Statement, Structures, and Human Factors Groups.

Introduction

1. **Purpose.** The purpose of the recommendations in this Manual is threefold:

- a. To assist the investigating team on all matters relating to fire;
- b. To assess the effectiveness of the airborne fire detecting and extinguishing systems and crew effectiveness, and the rescue and fire fighting services effectiveness (post-crash);
- c. To provide data in standard format for study and analysis which, hopefully, will contribute to accident prevention and the saving of lives in future aircraft accidents involving fire.

When using this Manual, and especially when filling out the form in Part II, the investigator is encouraged to expand in detail and not confine himself to filling out the blanks.

2. General.

a. Since fire is frequently involved in aircraft accidents, the investigation for fire usually becomes a necessary part of each accident investigation. A complete fire investigation should determine: (1) whether a fire did exist; (2) the crash/fire sequence; (3) inflight fire damage, if any, and its effect on airborne equipment and the flight progress; (4) effectiveness of fire detection and fire fighting equipment and procedures, both airborne and post-crash.

b. Since fire can be the cause or the result of an aircraft accident, investigators must determine which came first. This problem is complicated by the fact that inflight fire is usually followed by post-crash fire which can obscure or destroy origin evidence. The crash/fire sequence can usually be solved by intelligent, persevering investigation using astute observation and common sense, combined with knowledge of the characteristics of fire and its effect on the aircraft materials.

Part I. Investigator(s) Background Information

100. Organizing the Aircraft Fire Investigation.

101. The aircraft fire investigation is only a part of the total investigation and, therefore, the fire investigator is only a part of the investigation team. When selecting the investigation team, the numbers are usually kept to a minimum for best efficiency consistent with the particular investigation. A typical team for an air transport accident in the USA is usually composed of one or more members of the following organizations: National Transportation Safety Board, Federal Aviation Agency, Air Line Pilots Association, the airline involved, and a representative of the aircraft manufacturer.

102. The aircraft fire investigator may be a member of one of the above organizations, or he may be selected to assist the investigation team. In order that the fire investigation be thorough, the team should include one or more versatile photographers who may or may not double at other duties on the team. If the accident involved post-crash/fire, then a member of the fire department involved should also be on the team. One member of the team should be thoroughly qualified in laboratory procedures and have ready access to field equipment and a fully equipped laboratory.

103. The investigators should make the necessary arrangements for thorough access to the fire scene, provide adequate lighting for the area, provide suitable wearing apparel to protect clothing and hands during the investigation, and to provide the necessary screening tools, such as shovels, sieves and any other equipment that would assist in the investigation.

104. The investigating team should be thoroughly briefed about proceeding carefully and methodically according to a prearranged plan, avoid smoking at the scene or discarding anything at the scene. Each should be cautioned not to touch or move any evidence initially but to call the group together to witness any finding and to photograph and process the evidence. The photographer(s) should be briefed about thorough documentation of everything pertaining to evidence, including all exterior parts of the aircraft, interior features, condition of emergency doors and exits, and especially all areas showing evidence of fire. Photographs should be made in both color and black and white. This provides low cost documentation of all evidence as opposed to possible loss of the evidence or someone else trying to explain verbally what it looked like upon first discovery.

105. Any information obtained during the investigation must not be released to the news media or to any other unauthorized person, except with the permission of the chief of the official investigating team.

200. Obtaining Information

201. One source of information on the accident, especially one involving fire, is witnesses. A burning aircraft immediately attracts attention and can be seen from miles away. Meetings should be established with any known witnesses as soon as possible and their accounts recorded by the Witness Group of the investigating team. In case there are not enough fire investigators to assign one to the Witness Group, the fire investigator should prepare a list of questions to include all points he wants covered. Then the official group will be able to get the necessary information while the fire investigator is free to pursue other facets of the investigation.

202. Each witness should be interviewed separately and privately. He should be put at ease and made to feel important; the interviewer should never try to make himself important. Each witness should be encouraged to tell his own story completely as he saw it, without the interviewer using leading questions since this will often distort the witness' answers. The interviewer should use a model or sketch of the aircraft to assist the witness in his description.

203. A witness' statement in his own writing should be avoided since he tends to rephrase and rewrite until it looks good to him. The use of a tape recorder is the best possible documentation, but if the witness objects, then the use of a secretary or the interviewer making his own written recording is next best. If tape recorder is to be used for any interview which might produce evidence which will be entered into any official record, it is important to have included on the tape permission from the witness to use it for that purpose. Sometimes it is possible for the interviewer to get additional information by stipulating that the interview go "off the record" and exclude that section from the recording.

204. Witnesses should be interviewed immediately after contact. The longer the time passage since the event, the less reliable his statement is. The witness' views will be modified by what he sees, hears, and reads about the event, and he will subconsciously analyze and modify what he thinks he saw.

205. Occasionally an accident occurs where there is very little direct information available. There may be no witnesses or survivors. Information may be obtained from the aircraft maintenance history, weather, or accident history of this type aircraft. This information, together with what evidence is produced in examination of the wreckage, may be used to theorize certain possibilities. In this type of investigation, the investigator must base all such theories on the information available and the evidence documented. He should never form the theory in advance and then look sub-

consciously for the evidence which will only support his theory. The investigator must keep an open mind at all times.

300. Protecting the Evidence

301. One of the first and most important steps that must be taken post-crash is to completely protect the evidence in so far as possible. Restraint of the curious, scavengers, and others who might interfere with the wreckage and the investigative procedures must be assured by those in authority at the scene. The protective procedures should be put in effect by the first cognizant persons to arrive at the scene and will be taken over by governmental authorities when they arrive. The use of plain common sense should prevail; however, all the persons who might be involved in investigation should be familiar with Part III, 1.3, "Guarding," in ICAO Doc 6920-AN/855/4, "Manual of Aircraft Accident Investigation"; FAA Advisory Circular AC 150/5200-12, dated 8/7/69, "Fire Department Responsibility in Protecting Evidence at the Scene of an Aircraft Accident"; and the guidance given in the current issue of "Standard Operating Procedures, Aircraft Rescue and Fire Fighting" (NFA No. 402).

302. It is of utmost importance that all evidence in the wreckage and surrounding area be preserved and that false evidence is not inadvertently introduced. The type of evidence which is significant to the fire investigator is generally not recognized by the untrained and may be very minute and easily destroyed. The location and attitude of a piece of wreckage, the exact position of parts, scratch marks through soot, etc., may be very significant.

303. Rescue of victims of an accident is of primary consideration, even though some damage of evidence may occur. Rescue of injured victims is a time factor element and should be accomplished as rapidly as possible. However, bodies of those fatally injured may be better left in position if conditions for their recovery are not ideal — e.g., (a) after the fire is extinguished and the area cools down; or (b) until daylight. This limits the probability of serious injury to the rescuers and facilitates documentation. The amount of damage or loss of evidence incident to removal of occupants will depend upon circumstances and the care used by personnel doing the work. A well-trained crash crew will be aware of the importance of minimizing damage and will be able to brief the investigator on the details of any damage incurred during rescues.

304. Documentation by photography should begin as soon as possible, including, if possible, the total rescue operation, using motion pictures and still cameras. At this point, the focus should be on areas and objects likely to be affected by the fire and rescue opera-

tion. Subsequently, all evidence should be photographed and documented as found in the wreckage before being removed. (Refer to Part III, Chapter 2.2 of ICAO Doc 6920-AN/855/4 regarding photography.)

305. One problem to be considered in protecting the evidence is the cleanup of fire fighting agents. There is no rapid chemical action between agents in normal usage (foam, dry chemical and carbon dioxide) and the metals in the wreckage; therefore, the removal need not be hurried. Thorough inspection and photography should be accomplished before any removal of agents is attempted. A light air blast will remove most of the dry agents without disturbing evidence. Fine water spray will remove foaming agents, but some loss of sooty evidence may be expected. In both cases great care should be exercised and loss or displacement of evidence duly noted, especially bloodstains, etc.

NOTE: Corrosion can occur from prolonged contact between alkaline metal salts, water and some aircraft construction materials. Where fires are quickly controlled and damage to the aircraft is not severe, it may be well to quickly institute cleanup operations to restrict corrosion damage following photographing desired evidence.

306. Another problem in protecting the evidence occurs when sections of the wreckage must be disassembled for inspection. Such will be the case when sections of the structure are deformed and compressed such that they and entrapped equipment cannot be inspected. Structural disassembly of parts of modern aircraft is very difficult due to increased use of heavier gauge metals and extensive use of stainless steel. Disassembly methods used in such cases involve the use of oxyacetylene and electric arc cutting, which produces soot, metal discoloration, and material damage. Other procedures used in disassembly involve stretching and plain nut-and-bolt removal. Due to unavoidable material damage, the disassembly procedures must be completely controlled when the evidence is of significance from the fire viewpoint. The fire investigator should explain his interests to the chief of the investigating team and arrange to be on the scene during that phase of disassembly. Step-by-step photography must be completed and all affected areas and edges affected marked with a colored grease pencil to so identify the work during reinspection of the wreckage. Care should be taken in the use of the grease pencil so as to not affect any possible evidence.

307. Although Rescue and Fire Fighting personnel may or may not be instructed to remove the so-called "black boxes," which include the voice and flight recorders, these are of utmost importance to the investigation and should be retrieved by a qualified member of the investigating team as soon as practicable. Great care should