

CHAPTER 2
THE NTSB'S ROLE IN AVIATION ACCIDENT INVESTIGATION
AND NTSB'S OPERATIONAL BASELINE

This chapter provides a primer on the NTSB's investigative procedures and describes the baseline data upon which RAND based its analysis. This background information establishes a framework for the findings and recommendations that appear in Chapters 3 through 6 of this report. The description of the accident investigation process is intended to be informative, but not definitive, because the details of this process are discussed in much greater detail in later chapters. For readers not familiar with the history and regulatory authority of the NTSB, RAND has provided a brief background on the agency in Appendix A.

INVESTIGATING A MAJOR COMMERCIAL AVIATION ACCIDENT

Accident or incident investigations are conducted by the NTSB to determine "as accurately and expeditiously as possible what caused the accident so that the necessary steps can be taken to guard against" a similar occurrence (National Transportation Safety Board, April 25, 1980). These investigations are intended to be fact-finding proceedings in which no formal issues are addressed and no adverse parties are involved. They are not subject to the provisions of the Administrative Procedure Act¹ and are not conducted for the purpose of determining the rights or liabilities of any person or company.²

The NTSB investigates both "accidents" and "incidents." An *accident* is defined as "an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, in which any person suffers death or serious injury (hospitalization for more than 48 hours, fracture of a bone, severe hemorrhage, nerve or muscle damage, second or third degree burns), or in which the aircraft receives substantial damage." *Substantial damage* consists of damage or failure which "adversely affects the structural

¹5 USC §504 et seq.

²49 CFR §831.5.

strength, performance, or flight characteristics of the aircraft and which would normally require major repair or replacement of the affected component" (National Transportation Safety Board, April/May 1998a). An *incident* involves an occurrence other than an accident "which affects or could affect the safety of operations."

Every aviation accident or incident investigation falls within one of five categories:

- **Major investigation.** This usually entails an accident involving a commercial airliner or cargo aircraft. The Washington headquarters of the NTSB, through the OAS dispatches a "go-team" of investigators to handle the investigation of such an accident.
- **Major investigation, regional office.** This is a less serious air accident in which significant safety issues have been identified. It is handled by one of the NTSB's six regional offices, at least at the outset. Some nonfatal airline accidents and most small commuter airline accidents fall into this category.
- **Field investigation.** This is an airline accident or incident with no fatalities (such as an incident involving air turbulence) or a GA accident. The investigation is conducted by the nearest regional office and at least one investigator goes to the site of the accident. A small number of field investigations involving GA aircraft are complex and grow to rival headquarters-led investigations.
- **Limited investigation.** A limited investigation, sometimes called a "desk investigation," is conducted subsequent to an event involving GA aircraft. This investigation is carried out by U.S. mail or over the telephone.
- **Delegated investigation.** These investigations are delegated to the FAA. They include accidents involving rotorcraft, amateur-built aircraft, restricted category aircraft, and all fixed-wing aircraft that have a certificated maximum gross takeoff weight of 12,000 pounds or less, *unless* fatalities occurred, the aircraft was operated as an "air taxi," or the accident

involved a midair collision. The FAA is directed to report the facts, conditions, and circumstances of the accident to the NTSB; if necessary, the Safety Board may determine the probable cause.

When a major commercial aviation accident occurs, an NTSB "go-team" led by an IIC is dispatched from the agency's Washington, D.C., headquarters to the accident site, usually within two to three hours of notification of the event. The IIC--a senior air safety investigator with NTSB's OAS--organizes, conducts, and manages the field phase of the investigation, regardless of whether a Board member is also on scene at the accident site.³ The IIC has the responsibility and authority to supervise and coordinate all resources and activities of all field investigators.

Often, an investigator from one of the NTSB regional offices arrives on the scene in advance of the go-team. This individual begins the investigation and coordinates site security and other matters while awaiting the arrival of the go-team. The first job of the IIC is to secure the evidence and conduct an audit to ensure the safety of the area by noting any hazardous cargo, fuel spillage, and fire hazards. Once at the scene, the IIC is responsible for the security and management of the crash site. The IIC and key NTSB personnel usually take a tour of the site and receive an initial briefing from local officials. Until the investigative team is organized, everyone else is restricted from the scene.

The NTSB go-team forms discipline-oriented investigative groups, each led by a "group chair" and overseen by the IIC. The group chairs are senior investigators who are specialists in, among other areas of study, power plants, systems, structures, operations, air traffic control, weather, survival factors, and human performance. An aircraft performance specialist is assigned to most investigations and an NTSB specialist is often assigned to interview witnesses and review maintenance records. All NTSB staff that are assigned to an

³49 CFR §831.8.

investigation work under the direction of the IIC while at the accident scene.

The Party Process

The "party process" allows the NTSB to leverage its limited resources and personnel by bringing into an investigation technical expertise from the aircraft manufacturers or airlines, professional organizations (such as the Air Line Pilots Association [ALPA]), and individuals who were involved in the accident or who might be able to provide specialized knowledge to assist in determining probable cause.

The NTSB maintains the team approach throughout the on-scene phase of the investigation, with teams consisting of staff from both the parties and the NTSB. Shortly after arriving at the accident site, the IIC convenes an organizational meeting, usually at a large hotel or nearby facility where the NTSB command post is established. At that meeting, each party to the investigation--such as the FAA, air carrier, airframe manufacturer, engine manufacturer, the ALPA, and the airport authority--designates a spokesperson or coordinator who is responsible for supervising its specialists on the NTSB team. Each party coordinator is expected to report to and respond to the IIC's directions, and ensure that all personnel from the organization comply with NTSB rules and procedures.

The party process is a fundamental component of the NTSB investigative process (this is discussed further in Chapter 4). Except for the FAA, which by statute is allowed to participate in every investigation, party status is a "privilege" and not a "right."⁴ The IIC has the discretion to designate which parties are allowed to participate in the proceeding. No members of the news media, lawyers, or insurance personnel are permitted to participate in any phase of the investigation, including any meetings. Claimants or litigants (victims or family members) are also specifically prohibited from serving as party members.

According to NTSB procedures, the IIC works with selected insurance representatives, in conjunction with the aircraft owner, for the purpose

⁴49 USC §1132.

of retrieval, movement, and release of the wreckage. The IIC or the on-scene Board member also holds occasional press conferences to report the status of the investigation to the media.

The specialists assigned by any party to an NTSB investigation must be employees of the party and must possess the expertise required to assist the NTSB in its investigation. The NTSB regulations state, in part, that "parties to the field phase shall be limited to those persons, government agencies, companies, and associations whose employees, functions, activities, or products were involved in the accident or incident, and *who can provide suitable qualified technical personnel to actively assist in the field investigation* [emphasis added]." ⁵

Every participant in the Safety Board's investigation must be in a position to contribute specific factual information or skills that would not otherwise be available to the Safety Board. A *Guidance for Party Coordinators*, published by the NTSB's OAS, further warns that no participating organization is permitted to be represented by a person whose interests lie beyond the safety objective of the accident investigation (National Transportation Safety Board, March 1994a).

Specialists assigned to investigative groups are required to work under the direction of the appropriate NTSB group chair at all times. Party status provides representatives access to daily progress meetings that are not open to the public or to the victims, their families, or their lawyers. As a result of providing the Safety Board with technical assistance, parties are given numerous opportunities to learn exactly what happened during an incident and to assist in directing the search for answers.

The transmission of information by private parties back to their corporate headquarters is to take place only with the consent of the IIC when the information is necessary for accident prevention purposes. The information is not to be used in litigation or for public relations purposes. Sanctions for failing to abide by the NTSB rules and procedures include the dismissal of individuals and the parties they

⁵49 CFR 831.11(a).

represent from the investigation team. Party representatives sign a written statement indicating that they are familiar with the NTSB rules and that they agree to abide by the regulations.

The Team Approach

As investigative groups are formed during the organizational meeting, each party, or its accredited representative, is permitted to assign its experts to the respective groups to assist in the investigation. For example, the air carrier typically assigns a training pilot who is type-rated in the kind of airplane involved in the accident to the Operations Group. Similarly, the aircraft manufacturer would assign a test pilot to the Operations Group and systems or structural engineers to the Structures, Systems, or Powerplants Groups.

If the aircraft is equipped with a cockpit voice recorder (CVR) and flight data recorder (FDR), special groups led by NTSB specialists are formed in Washington, D.C., to process the recorder readouts. Membership in the FDR and CVR groups is strictly limited and tightly controlled because of the sensitive nature of the data obtained. Party status to an NTSB investigation does not automatically allow the assignment of personnel to all of the investigative groups.

The on-scene phase of the investigation may last from 7 to 21 days. Each person assigned to the NTSB team comes prepared for extended work schedules, often under extremely stressful conditions that are both physically and mentally taxing. To maintain continuity and maximize the utility of the team concept, substitution of any individuals in a group is highly discouraged, and no "independent" investigations by parties or group members are permitted.

As the on-scene phase of the investigation comes to a close, each group chair prepares "field notes" that contain the factual findings and other data collected by the group. Group notes contain entries such as interview summaries, wreckage diagrams, cockpit documentation lists, damaged component descriptions, photographs, video or audio tapes, and other such materials.

The field notes are the only official representation of conditions immediately following an accident. They are very important because a

witness's memory of events can change with time and the wreckage itself can be altered shortly after the on-scene phase of the investigation is completed. Each group member has an opportunity to review and comment on the field notes and receives a copy of the notes before the group disbands. Factual discrepancies are resolved, corrected, or annotated as dissenting opinions. Each party coordinator receives a copy of all the field notes before the team leaves the site. The parties' group members and coordinators are obligated to remain with the team until the close of the field phase of the investigation, or until they are released from their duties by the NTSB group chair or the IIC.

After the on-scene phase concludes, each of the NTSB group chairs completes a final factual report covering his or her area of responsibility. All factual material is sent to the party coordinators and is placed on the public docket. At that point, a technical review meeting is convened to allow the parties one final opportunity to comment on the quality and scope of the factual record.

PUBLIC HEARINGS AND ACCIDENT REPORT PREPARATION

Following the on-scene phase of the investigation, the investigators begin a rather lengthy period of further fact gathering, often involving one or more public hearings, and a final analysis of the facts that have been collected. This process eventually results in a publicly available printed report that, barring reconsideration at a later date, is the NTSB's final product from an investigation. The Final Report (or "Blue Book") includes a list of factual findings pertaining to the accident, an analysis of those findings, recommendations to prevent a repetition of the accident, and a probable cause statement.⁶

Shortly after the investigation team returns to NTSB headquarters from the accident site, a tentative schedule of follow-on events is established by the IIC. Theoretically, these events should occur over a period of six months, but no time limit exists on NTSB investigative activity. Safety Board procedures call for a targeted publication date of the Final Report to be within one year from the date of the accident,

⁶The terms "Final Report" and "Blue Book" are used interchangeably throughout this report.

but recent major commercial aviation accident investigations have taken as little time as four months and as much as four-and-a-half years (National Transportation Safety Board, October 9, 1998).

Follow-Up Activities

The report-writing process begins with a work planning meeting. This is an internal meeting of the Safety Board group chairs and senior staff, chaired by the IIC. During this meeting, the staff determines which investigative activities remain, including testing, follow-up interviews with witnesses or survivors, and so on. The need for interim and/or urgent safety recommendations is also discussed.

A Factual Report due date is set during the work planning meeting to target the completion time of the final factual reports by the group chairs. Often, a professional writer is assigned to assist with assembling the factual reports and turning them into the Safety Board's Final Report. Non-NTSB investigative group members have an opportunity to review and comment on the draft factual reports prior to the target date. When completed, the factual reports are mailed to all the parties to the investigation.

If it is decided that the investigation warrants a public hearing, parties to the hearing attend a pre-hearing conference. At this meeting, ground rules for proper conduct and questioning are outlined and the areas for questioning are discussed. This is the last formal opportunity for parties to request that certain subject areas be explored, specific witnesses interviewed, or any new exhibits be included in the record.

A public hearing is another step in the Safety Board's fact-gathering process. Major commercial aviation accidents that involve significant loss of life and raise important safety issues, thereby warranting public and media attention, usually call for a public hearing. However, the decision to hold a hearing is discretionary and is not subject to review.

A public hearing is a proceeding during which witnesses are questioned under oath by the IIC and the NTSB group chairs. The witness list can include FAA regulators, surviving crew members or passengers, air traffic controllers, fire and rescue personnel, manufacturers'

design engineers, and others. The hearing is usually held in a city near where the accident occurred, and is directed by an NTSB Board member who is designated as the presiding officer. Each party coordinator may query the witnesses after their initial questioning by the NTSB technical staff, although no party may be directly represented by anyone who "occupies a legal position." Any individual who appears in person to testify at a public hearing has the right to be represented or advised by counsel, but no party may be represented by anyone who also represents claimants or insurers.

On the first day of the hearing, all factual reports generated to that date, including the CVR transcript, are entered into the public docket for the accident. The public docket is the formal collection of documents relating to the investigation, and is open and available for public review. Because the factual reports are publicly released at this time, parties are permitted to communicate with the media about the accident.

Testimony and statements during the hearing, which can take up to three or four days, are transcribed by a court reporter and transcripts become available to the public within a few weeks. Such hearings are fact-finding proceedings with no formal issues being addressed and no adversary parties participating, and the hearings are not subject to the provisions of the Administrative Procedure Act.⁷

The next milestone in the accident investigation process is the preparation of factual reports in which each group chair summarizes the facts that have been gathered concerning his or her area of expertise. Parties may contribute to these reports via their continued interaction with the NTSB group chairs and the IIC, but parties are not allowed to formally review, edit, or comment on the factual reports themselves. Party coordinators may, however, be invited to attend a technical review meeting with the IIC, the group chairs, and NTSB supervisors to review aspects of a factual report prior to its completion.

Parties to the investigation can provide input on the Safety Board's overall analytical process through what are called "party

⁷See 49 CFR §845.1-845.29.

submissions." All parties are encouraged to submit to the Safety Board written observations and findings and recommend conclusions based on the evidence produced during the investigation. These party submissions become part of the public docket of the investigation.

The IIC is nominally responsible for integrating the factual reports into a Final Report that includes a summary, a set of conclusions, and a set of recommendations. The IIC distributes an internal first draft of the Final Report to the group chairs and NTSB supervisors to solicit their feedback. The internal draft is then distributed to the directors of the OAS, the Office of Safety Recommendations, the Office of Research and Engineering (ORE), the general counsel, and the NTSB managing director for comments and any necessary corrections. After this review of the draft is complete, the NTSB directors schedule a closed meeting to discuss the report's content and organization.

Notation Draft and Board Meeting

The draft produced by the directors becomes the *notation draft*-- the final version of the report that is presented to the five members of the NTSB Board of Directors. Board members have a limited time to review the draft in preparation for a final vote on the finding and recommendations. Written submissions from parties to the investigation are not accepted after the Board receives the notation draft. However, personal contact with individual board members is permissible.

Following review of the report by the Board, a public meeting, sometimes referred to as the "Sunshine Meeting," is held in Washington, D.C. The NTSB staff, including the IIC and the group chairs, present the Final Report and comment on it before the Board. Party representatives may attend this meeting but are not permitted to comment or make presentations. At this public meeting, board members may elect to do any of the following:

- vote to adopt the draft, in its entirety, as the final accident report
- require further investigation or revisions

- adopt the final accident report with changes that are discussed during the meeting.

As soon as possible after the meeting, the NTSB's Office of Public Affairs releases the Safety Board's conclusions, probable cause determination, and safety recommendations. The Final Report, which may be hundreds of pages long, is published approximately three weeks after the Safety Board meeting.

Although the publication of the Final Report is the last step in the investigative process, NTSB investigations are technically never closed. Parties to the investigation can petition the Safety Board to reconsider and modify the findings and probable cause of the accident for either one of two reasons: (1) the party believes the Safety Board's findings are erroneous, and that the Safety Board made a mistake in its analysis during its original assessment of probable cause; or (2) the party discovers new evidence. The NTSB will not consider petitions from parties that have not made submissions during the investigation, or that repeat positions previously advanced. Parties can petition the NTSB to reconsider the findings and probable cause at any time after the Board meeting and adoption of the Final Report. Reconsideration proceedings normally involve written, not oral, presentations.⁸

INTERNATIONAL ACCIDENT INVESTIGATIONS

The NTSB's role in investigating aviation accidents that occur outside the United States is somewhat different from its role in investigating domestic accidents. The NTSB is the government agency charged with the responsibility for assuring compliance with U.S. obligations under Annex 13 to the Convention on International Civil Aviation. This international treaty, signed by 52 nations in December 1944 and commonly known as the "Chicago Convention," established the

⁸49 CFR §845.41 sets forth the rules for petitions for reconsideration or modification. This provision allows for petitions for reconsideration to be filed by "other person[s] having a direct interest in the accident investigation." While this language seems to afford nonparties, such as family representatives, the right to file for reconsideration, this is not the interpretation generally applied by the NTSB (Campbell, April 1999).

International Civil Aviation Organization (ICAO), headquartered in Montreal, Canada.

With its 183 member nations, the ICAO provides the governing apparatus for worldwide regulation of civil aviation. The objectives of ICAO are to develop the principles and techniques of international air navigation and foster the planning and development of international air transport. Over the years, the ICAO governing body, the Council, has developed and adopted 18 technical annexes to the Chicago Convention, which deal with such varied fields as aeronautical communications, airworthiness, environmental protection, and security. The standards contained in these annexes are applied universally, and have produced a degree of technical uniformity that has enabled international civil aviation to develop in a safe and efficient manner (McCormick and Papadakis, January 1996).

Standards and recommended practices for aircraft accident investigations were first adopted by the ICAO in 1951, pursuant to Article 57 of the Chicago Convention, and were designated "Annex 13" to the Convention. The annex contains standards for accident prevention and for incident and accident investigation and reporting. Under Annex 13, the sole objective of an investigation is to prevent future accidents or incidents, and not to attach blame or liability.

Specifically, Annex 13 defines an investigation as "a process for the purpose of accident prevention, which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes, and when appropriate, the making of safety recommendations (International Civil Aviation Organization, October 11, 1994)." Annex 13 also defines the rights and responsibilities of states involved in an accident investigation with regard to the notification, investigation, and reporting.

When an international aviation accident occurs, the NTSB appoints an accredited team of U.S. representatives to the investigation and supervises advisors from the U.S. aviation industry, including those from the FAA. The NTSB provides an objective and impartial representative to assist the authorities charged with managing an investigation outside the United States.

The interest the United States has in an international investigation and its need for involvement in the investigation stem from its obligations outlined in Annex 13 and its obligations under other ICAO requirements. The reasons for this interest and need are obvious with accidents involving U.S. registered aircraft and U.S. air carriers. In such cases, the NTSB provides direct assistance to those states conducting the investigation. Depending on the sophistication of its own investigative capabilities, the state where the accident occurred can delegate all or part of its responsibilities to the NTSB.

In addition, NTSB involvement enables U.S. authorities to take necessary accident prevention measures based on the findings of the investigation. However, U.S. interests are less clear in accidents involving non-U.S. airlines operating aircraft manufactured in the United States, or accidents involving non-U.S. airlines operating foreign manufactured aircraft that contain U.S. manufactured components.

The NTSB supplies other types of support to investigations conducted outside the United States. For example, the NTSB offers to provide readouts of CVRs or FDRs and metallurgical analyses of failed parts for other authorities involved in an investigation. The NTSB offers its assistance in accordance with the provisions of Annex 13 in a multitude of other forms, such as providing computerized information about accidents and incidents, or overseeing component testing or teardowns at U.S. manufacturing facilities. The NTSB's responsibilities under ICAO represent a significant, and growing, portion of the agency's total workload (this is discussed further in Chapter 5).

NTSB OPERATIONAL BASELINE

To understand the NTSB's mission and operations, RAND performed an in-depth statistical review using available financial and technical data. This baselining activity was designed to lay the foundation for later qualitative and quantitative analyses. These analyses include RAND researchers' exploration of the numerous issues that influence the party process and their assessment of the Safety Board's ability to meet future technical challenges.

The baselining effort was limited in many areas by a lack of data, and considerable effort was required to build alternative strategies for extracting trend information. RAND sought to the greatest extent possible to capture the entire NTSB history since its inception in 1968. This analysis required extensive integration of disparate information bases.

One should keep in mind that this study of the NTSB investigative process focused primarily on one mode of transportation: aviation.⁹ Other transportation modes received limited analysis. Although many of the trends in air travel described in this and subsequent chapters of this report are similar to trends found in other modes of transportation, RAND believes that extrapolating these findings is likely to generate error.

Operating Budget

Figure 2.1 depicts NTSB budget appropriations for the fiscal years 1980 through 1999, shown in inflation-adjusted dollars. The figure also shows NTSB staffing levels. The NTSB's current beginning-of-year funding is close to \$60 million. However, this initial appropriation does not necessarily represent the total funds available to the Safety Board in any given year. The NTSB can seek supplemental funding when situations require extraordinary investigative efforts or when simultaneous accidents cause an unplanned surge in workload (supplemental funding is not reflected in Figure 2.1).¹⁰

The availability of supplemental funding reveals a very important factor in NTSB operations. Access to supplemental funding provides the NTSB with a financial "surge capability" that enables it to conduct large or multiple investigations. However, the NTSB has no such surge

⁹RAND performed a survey of the NTSB's technical staff. At the request of the NTSB senior staff, and with the cooperation of all office heads, this survey was conducted for all transportation modes. This was done to facilitate later study and analysis by the NTSB.

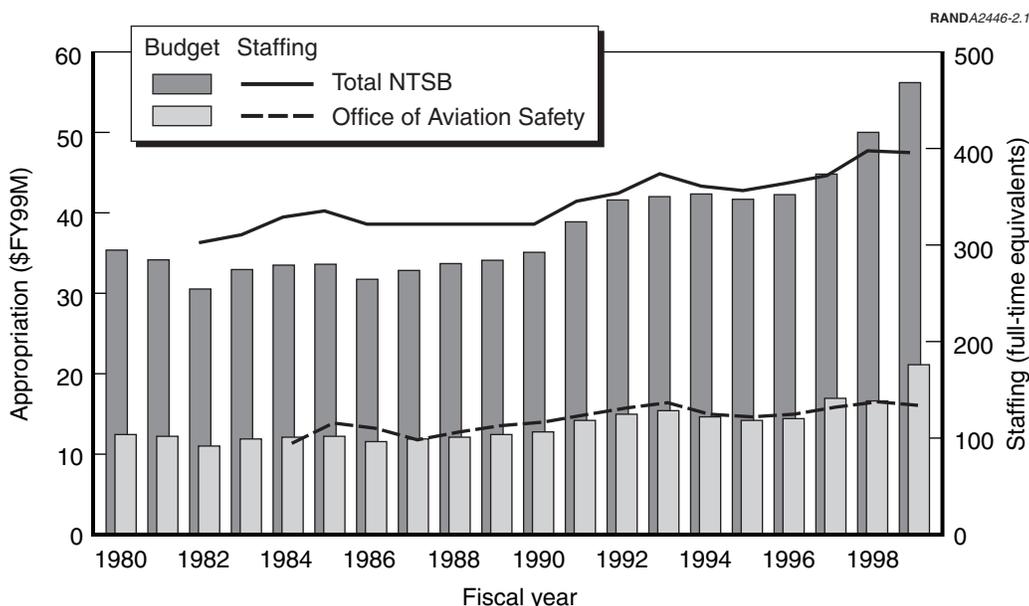
¹⁰In the past, budget supplements have generally been less than \$1 million, but lately they have grown dramatically. In 1997, for example, two supplements were required, mostly to cover the costs of the TWA Flight 800 investigation, which required extensive salvaging and reconstruction, and the USAir 427 accident. The 1997 supplements totaled \$38 million, nearly doubling the NTSB's budget.

capability for staffing. For example, unlike the Department of Defense (DOD) and some other government agencies, the NTSB has not established relationships with technical and engineering support services contractors that could augment the NTSB's workforce in times of heavy workload.

As Chapter 6 discusses, the NTSB maintains few strategic alliances with other federal agencies or with accident investigation agencies in other countries that could assist the NTSB when workload suddenly grows. Because of the stochastic nature of aviation accidents, the Safety Board's only option when several accidents occur in quick succession is to overload staff and stretch work schedules for a period of time.

Another important observation related to spending is the relatively large slice of the fiscal pie dedicated for aviation investigations compared with the portions allocated for investigation efforts for other transportation modes. The NTSB oversees events occurring in rail, highway, marine, and pipeline and hazardous material transportation, in addition to aviation. Yet, as shown in Figure 2.1, the OAS consumes nearly 40 percent of Safety Board's fiscal resources. This skew in spending is largely due to the high visibility aviation accidents have in the media and among the general public and the impact of air safety on the performance of the aviation sector of the economy. It is also surprising to note that field and regional offices consume approximately 50 percent of the fiscal resources dedicated to aviation.¹¹ The majority of this allocation goes to the investigation of small-aircraft accidents. Although the Safety Board is known primarily for investigating major commercial aircraft accidents, responding to events that occur in the GA community consumes an equivalent portion of internal resources and attention.

¹¹The investigation of GA accidents is almost exclusively assigned to the field and regional offices. While these offices are not exclusively dedicated to GA, the majority of the resources provided to field and regional offices are directed to the investigation of small-aircraft accidents.



NOTE: The figure shows initial annual appropriations. On several occasions, supplemental appropriations have been sought to cover extraordinary expenses. For example, the NTSB sought and was awarded supplemental appropriations for the investigation of TWA Flight 800 in the amount of approximately \$38 million, almost doubling the NTSB's FY 1997 budget.

Figure 2.1--NTSB Operating Budget and Staffing

Staff Overview

As shown in Figure 2.1, the NTSB staff consists of nearly 400 full-time equivalents (FTEs).¹² The majority of the staff is dedicated to technical investigations, either directly or in a supporting role. The staff of OAS constitutes approximately one-third of the total, or 130 FTEs. A significant percentage of the ORE staff, however, supports aviation investigations, some of them exclusively. In total, therefore, aviation accident investigations consume about 50 percent of the Safety Board's FTE allocation.

Figure 2.2 depicts the split between the headquarters staff and field and regional office staff for OAS. Currently, 86 field investigators are devoted to aviation accident investigations, mostly

¹²Data on NTSB staffing levels were gathered from internal NTSB personnel records and staff overviews produced at regular intervals in response to inquiries from the House Appropriations Committee, Subcommittee on Transportation.

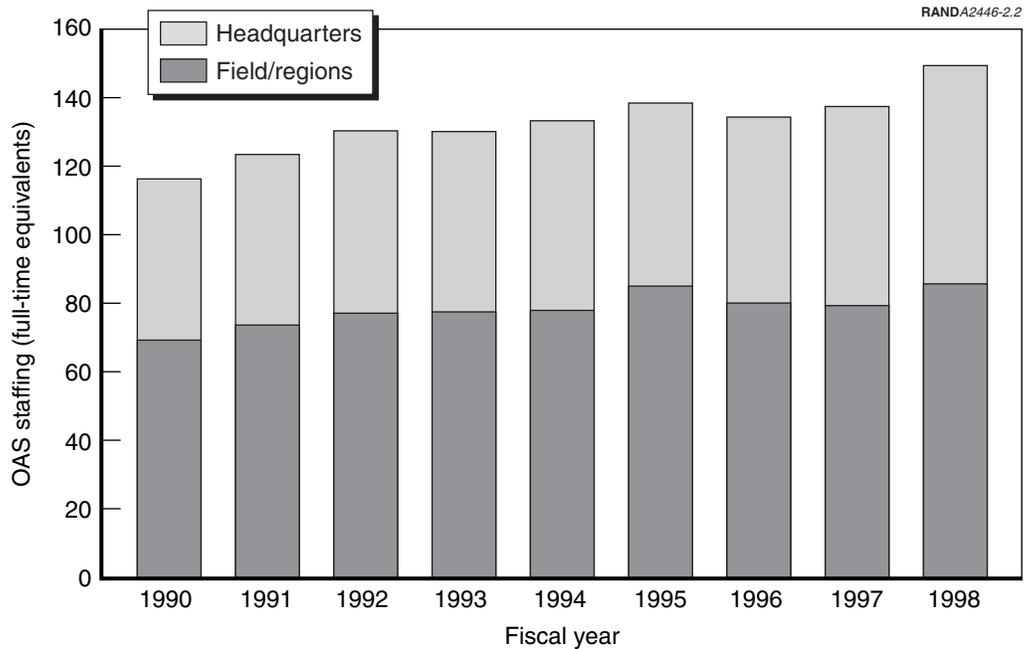


Figure 2.2--OAS Staff Distribution by Location

centered on Parts 91 and 135 unscheduled investigations.¹³ The OAS staff principally consists of accident investigators and technical support professionals, as shown in Figure 2.3.

Accident History

To understand the NTSB's workload and the magnitude of the investigative challenge, RAND needed to gain a historical picture of the

¹³The Federal Aviation Regulations (FARs) classify aircraft operation by type. The following four FAR parts pertain to aviation activities relevant to this report:

- Part 91--primarily GA aircraft, but also including business aircraft and rotorcraft, and experimental aircraft
- Part 121--domestic and flag-carrying transport category aircraft
- Part 129--foreign air carriers and operators of U.S.-registered transport category aircraft
- Part 135--commuter aircraft and air taxi services, and cargo operations

Parts 121, 129, and 135 are also broken down by regularly scheduled service and by unscheduled service. A 1996 change to the FARs reclassified scheduled commuter aircraft with more than 20 seats, and all jet-powered commuter aircraft, from Part 135 to Part 121 operations, thereby subjecting them to stricter safety and operating standards.

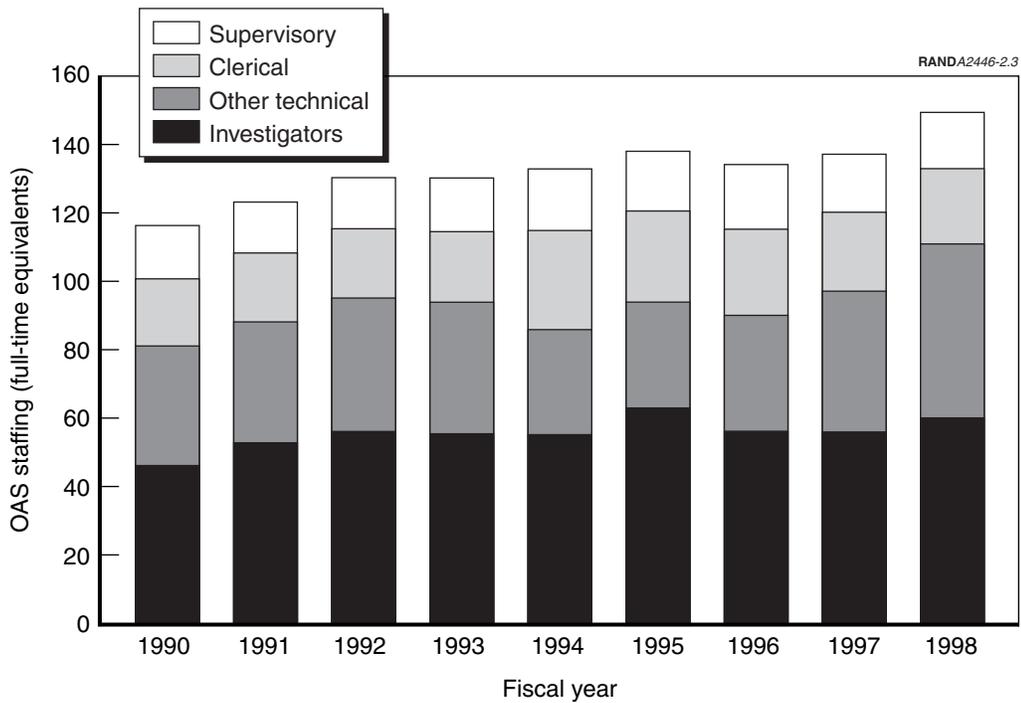


Figure 2.3--OAS Staff Distribution by Type

aviation accident rate. The NTSB maintains computer databases of the accident and incident investigations it performs. These are used primarily for archival purposes and not for historical analysis. RAND integrated several disparate NTSB data systems in order to build an analytical foundation for the study of accident rates and how the NTSB responds to them.¹⁴

RAND acquired information from the NTSB related to accidents in all areas of civil aviation. A 30-year view of the integrated NTSB accident record is shown in Figure 2.4. Typically, a discussion of aviation accidents deals with the relative safety of flying as the passenger demand for air travel increases. The number of accidents per flight hour, the number of fatalities per passenger mile, or some other similar rate measures the number of accidents against the demands placed on the air transportation system. In Figure 2.4, accident data are not

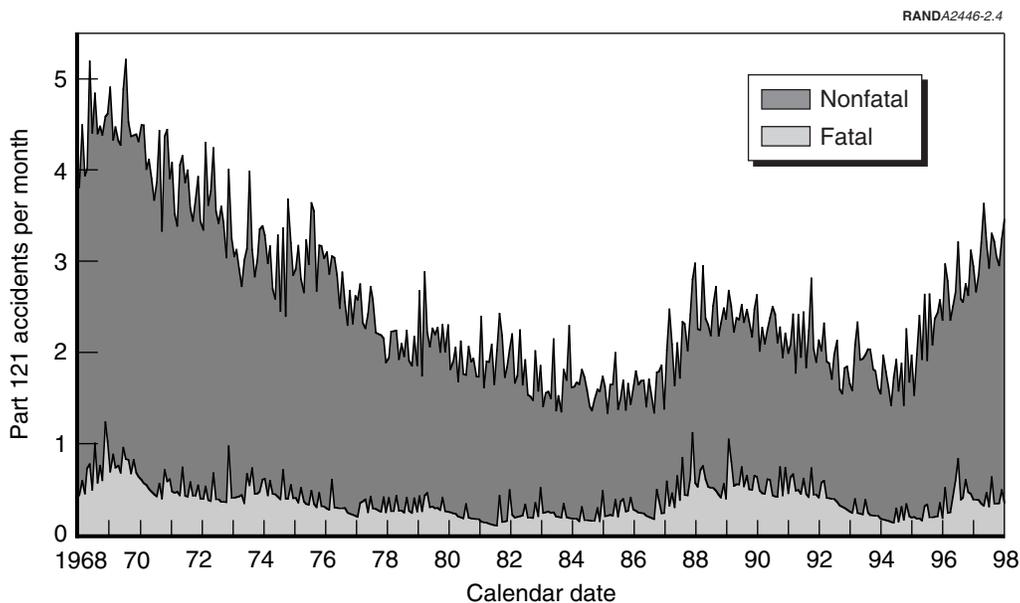
¹⁴This integration was especially complex in that NTSB records are kept on different computer platforms. Many data anomalies were encountered that required additional analysis. A summary of the extent and limitations of the resulting data set can be found in Appendix B of this report.

normalized in this way. Instead, Figure 2.4 shows a six-month moving average (the current month and the five previous months' accident data) of the number of aviation accidents per month.

By ignoring the steady growth in demand for air travel, Figure 2.4 does not reflect the improvements in air safety over the years. However, the figure does provide some insight into the scale and nature of the NTSB's workload. Regardless of whether the aviation industry's safety record is improving, the NTSB must maintain sufficient resources to investigate the actual *number* of accidents that occur each month.

Figure 2.4 also highlights two points that are important to NTSB staffing and workload:

- First, while the number of nonfatal accidents has declined dramatically since the late 1960s, the nonfatal accident rate is now on the rise. While *major* accidents involving domestic transport aircraft are certainly the most labor intensive to investigate, nonfatal accidents nevertheless consume significant staff time. The number of nonfatal accidents per month nearly doubled between 1986 and 1998.



NOTE: The data presented are a six-month moving average extracted from the NTSB's accident database for commercial transport aircraft operating under Federal Aviation Regulations Part 121.

Figure 2.4--Thirty-Year Accident History

- Second, the number of fatal accidents per month has not changed significantly over the 30 years of analyzed data. While safety has improved dramatically, the NTSB still has nearly the same workload, as measured by the number of fatal accidents. Additionally, the NTSB's staffing profile is fixed, at least in the short term; therefore, while the number of accidents can vary greatly, available staff remains the same. RAND examined closely the ability of NTSB management practices to balance workload and accomplish ongoing training and professional development in this stochastic environment.

An additional challenge that investigators face lies hidden within the aviation accident statistics: the growing complexity associated with crashes. The limited data record prevented a rigorous examination of factors associated with crash complexity, but RAND was able to establish a first-order *severity index* to establish a trend line. This index was formed by multiplying the size of the aircraft by a qualitative damage index that was consistently reported in the NTSB data record. The results are shown in Figure 2.5 for Part 121 and Part 129 accidents

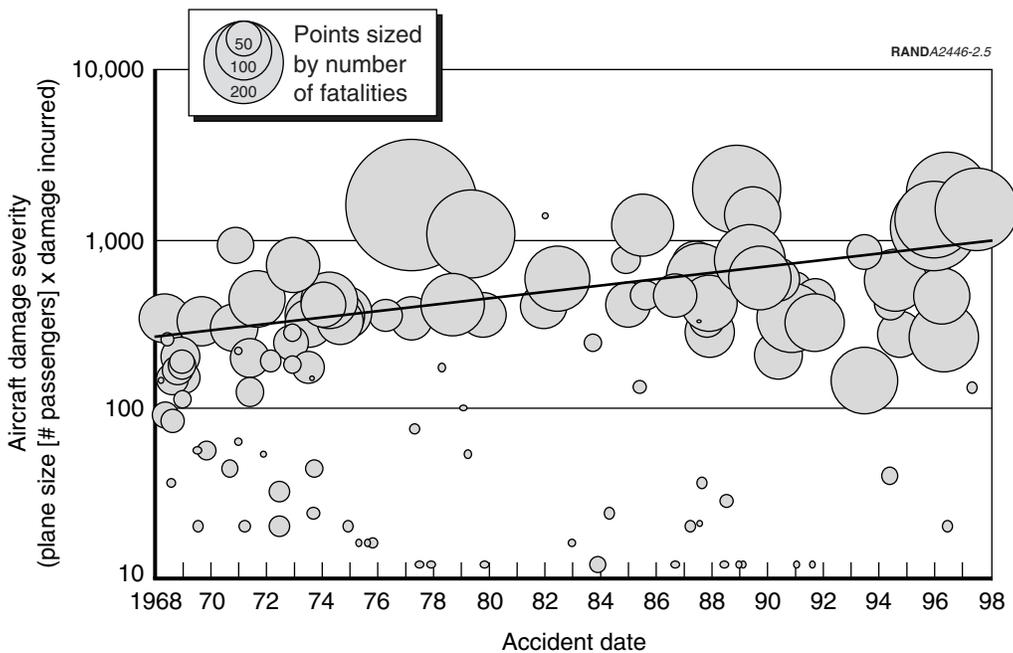


Figure 2.5--Growing Complexity of Transport-Category Aircraft

between 1968 and 1998. This semilog plot shows steady growth in the severity of accidents with which the NTSB must contend.

The complexity of a subsequent investigation is partly linked to the severity of the accident. The more extensive the wreckage, the more complex the job of attempting to isolate and characterize possible causal factors. Victim identification is also more complex. In severe accidents, reconstruction is becoming a more important investigational theme. Locating adequate facilities, building the requisite fixtures, and completing salvage operations take longer and require a more complex management process. The severity of the crash does not, however, get at the issue of system complexity associated with the accident. RAND believes that growing system complexity will be an additional factor that will heavily influence future NTSB accident investigation procedures.

The data record of aviation accident investigations contains both the accident date and the date of the report. From this information, RAND was able to approximate accident investigation time lines.¹⁵ Figure 2.6 depicts the average length of investigations from 1968 through 1998 for Parts 121, 129, and 135 fatal and nonfatal aviation accidents (excluding GA Part 91). The Part 121 average investigation duration is called out separately.¹⁶ The standard deviation, a measure of how consistently the NTSB concludes its investigations, typically increases at times when the average length of an investigation increases.

Throughout the 1990s, the NTSB frequently missed its one-year goal for completion of major investigations. The trend line in recent years is again climbing and, considering current NTSB workloads, it is likely that the 1999 average will remain high. Both an increase in the number of nonfatal accidents and the rising complexity of major fatal accidents are likely to be strong determinants of this trend.

¹⁵Although the precise report date may not always exactly correlate with the completion of the investigation, it is the best available approximation.

¹⁶Note that a gap exists in the database for the period 1983 to 1986. This and other anomalies in the data are described in Appendix B of this report.

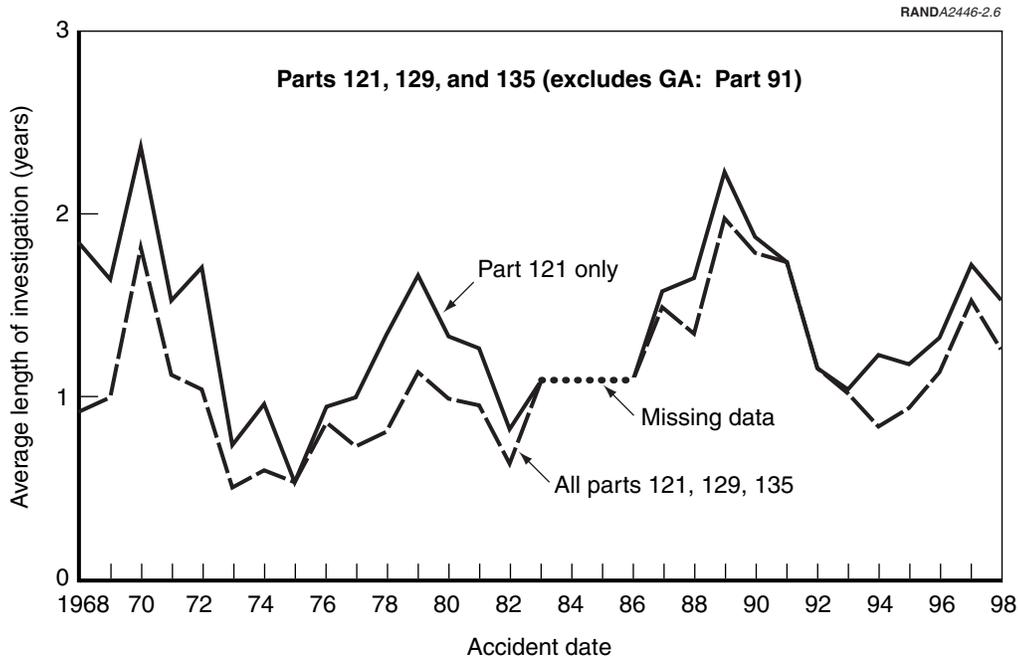


Figure 2.6--Accident Investigation Duration

While the NTSB's goal is the thorough analysis of accidents, in practice it must balance the need for additional investigation and research against its limited resources and the need for a timely resolution. A timely response is needed to ensure ongoing flight safety and to resolve the causal uncertainty associated with the deaths of many individuals.

As Figure 2.6 shows, although its responsiveness is highly variable, the NTSB has struggled to complete investigations in approximately one year. To achieve this goal, the NTSB must make tradeoffs. Safety Board managers face a great challenge in balancing resources across many open investigations. In monitoring its responsiveness, the NTSB ultimately must be the judge of the level of analysis required to determine *probable* cause. No equation exists for calculating probability when reaching a probable cause determination; the decision is subjective and not constant.

Interviews with NTSB managers and staff reveal an agency deeply committed to doing everything possible to resolving the cause of accidents in a timely fashion. However, as future chapters of this report describe, this level of commitment is strained by staff work

overload and insufficient attention to training. These problems are amplified by a lack of certain information that would help managers better balance the workload at all levels of the NTSB organization.