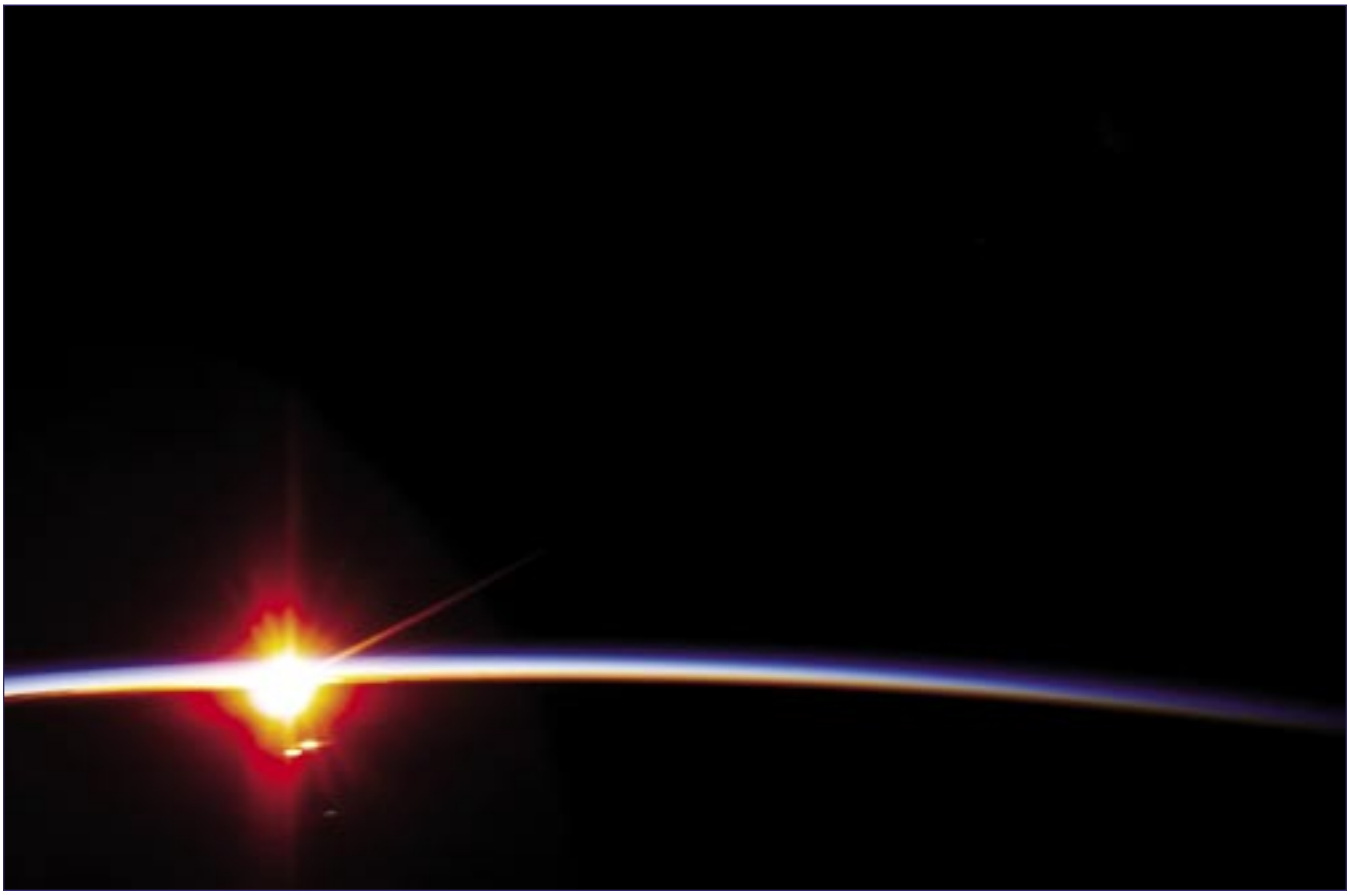
Part Four

Appendices



Sunrise from STS-107 on Flight Day 3

Columbia *being transported to Launch Complex 39-A at the Kennedy Space Center, Florida, in preparation for STS-107.*

Appendix A

The Investigation

A.1 Activation of the Columbia Accident Investigation Board

At 8:59:32 a.m. Eastern Standard Time on Saturday, February 1, 2003, communication with the Shuttle *Columbia* was lost. Shortly after the planned landing time of 9:16 a.m., NASA declared a Shuttle Contingency and executed the Agency Contingency Action Plan for Space Flight Operations that had been established after the Space Shuttle *Challenger* accident in January 1986. As part of that plan, NASA Administrator Sean O'Keefe deployed NASA's Mishap Investigation Team, activated the Headquarters Contingency Action Team, and, at 10:30 a.m., activated the International Space Station and Space Shuttle Mishap Interagency Investigation Board.

The International Space Station and Space Shuttle Mishap Interagency Investigation Board is designated in Appendix D of the Agency Contingency Action Plan as an external investigating board that works to uncover the "facts, as well as the actual or probable causes of the Shuttle mishap" and to "recommend preventative and other appropriate actions to preclude the recurrence of a similar mishap."[1] The Board is composed of seven members and is chartered with provisions for naming a Chairman and additional members. The seven members take their position on the Board because they occupy specific government posts. At the time of the accident, these individuals included:

- Chief of Safety, U.S. Air Force: Major General Kenneth W. Hess
- Director, Office of Accident Investigation, Federal Aviation Administration: Steven B. Wallace
- Representative, U.S. Air Force Space Command: Brigadier General Duane W. Deal
- Commander, Naval Safety Center: Rear Admiral Stephen A. Turcotte
- Director, Aviation Safety Division, Volpe National Transportation Systems Center, Department of Transportation: Dr. James N. Hallock
- Representative, U.S. Air Force Materiel Command: Major General John L. Barry
- Director, NASA Field Center or NASA Program Associate Administrator (not related to mission): Vacant

Upon activating the Board, Administrator O'Keefe named Admiral Harold W. Gehman Jr., United States Navy (retired), as its Chair, and G. Scott Hubbard, Director of NASA Ames Research Center, as the NASA Field Center Director representative. In addition to these eight voting members, contingency procedures provided for adding two non-voting NASA representatives, who helped establish the Board during the first weeks of activity but then returned to their regular duties. They were Bryan D. O'Connor, NASA Associate Administrator for Safety and Mission Assurance, who served as an ex-officio Member of the Board, and Theron M. Bradley Jr., NASA Chief Engineer, who served as the Board's Executive Secretary. Upon the Board's activation, two NASA officials, David Lengyel and Steven Schmidt, were dispatched to provide for the Board's administrative needs. J. William Sikora, Chief Counsel of the Glenn Research Center in Cleveland, Ohio, was assigned as the counsel to the Board.

By noon on February 1, NASA officials notified most Board members of the mishap and issued tentative orders for the Board to convene the next day at Barksdale Air Force Base in Shreveport, Louisiana, where the NASA Mishap Investigation Team was coordinating the search for debris. At 5:00 p.m., available Board members participated in a teleconference with NASA's Headquarters Contingency Action Team. During that teleconference, Gehman proposed that the International Space Station and Space Shuttle Mishap Interagency Investigation Board be renamed the Columbia Accident Investigation Board. O'Keefe accepted this change and formally chartered the Board on Sunday, February 2, 2003.

On Sunday, Board members flew on government and commercial aircraft to Barksdale Air Force Base, where at 6:50 p.m. Central Standard Time the Board held its first official meeting. The Board initiated its investigation on Monday, February 3, at 8:00 a.m. Central Standard Time. On Tuesday morning, February 4, the Board toured the debris field in and around Nacogdoches, Texas, and observed a moment of silence. On Thursday, February 6, the Board relocated to the Johnson Space Center, eventually settling into its own offices off Center grounds. That evening, the Board formally relieved the NASA Headquarters Contingency Action Team

of its interim responsibilities for initial accident investigation activities. The Board assumed operational control of the debris search and recovery efforts from NASA's Mishap Investigation Team, which functioned under the Board's direction until the completion of the search in early May.

A.2 Board Charter and Organization

During meetings that first week, Chairman Gehman and the Board proposed that its charter be rewritten. The original charter, derived from Appendix D of NASA's Contingency Action Plan, had a number of internal inconsistencies and provisions that the Board believed would impede the execution of its duties. Additionally, the Board was not satisfied that its initial charter adequately ensured independence from NASA. The Board resolved to:

- Have its own administrative and technical staff so that it could independently conduct testing and analysis and establish facts and conclusions
- Secure an adequate and independent budget to be overseen by the Board Chairman
- Establish and maintain records independent from NASA records
- Empower the Board Chairman to appoint new Board Members
- Provide the public with detailed updates on the progress of its investigation through frequent public hearings, press briefings, and by immediately releasing all significant information, with the exception of details relating to the death of the crew members and privileged witness statements taken under the condition of confidentiality
- Simultaneously release its report to Congress, the White House, NASA, the public, and the astronauts' families
- Allow Board members to voice any disagreements with Board conclusions in minority reports

With the full cooperation of Administrator O'Keefe, the Board's charter was rewritten to incorporate these principles. The new charter, which underwent three drafts, was signed and ratified by O'Keefe on February 18, 2003. In re-chartering the Board, O'Keefe waived the requirements specified in the Contingency Action Plan that the Board use standard NASA mishap investigation procedures and instead authorized the Board to pursue "whatever avenue you deem appropriate" to conduct the investigation.[2]

Additional Board Members

To manage its burgeoning investigative responsibilities, the Board added additional members, each of whom brought to the Board a needed area of expertise. On February 6, the Board appointed Roger E. Tetrault, retired Chairman and Chief Executive Officer of McDermott International. On February 15, the Board appointed Sheila E. Widnall, Ph.D., Institute Professor and Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology and former Secretary of the Air Force. On March 5, the Board appointed Douglas D. Osheroff, Ph.D., Nobel Laureate in Physics and Chair of the Stanford Physics Department; Sally K. Ride, Ph.D., Professor of Space Science at the University of California at San Diego and the nation's first woman in space; and John M. Logsdon, Ph.D., Director of the Space Policy Institute at George Washington University. This brought the total number of Board members to 13, coincidentally the same number as the Presidential Commission on the Space Shuttle *Challenger* Accident.

Board Organization

In the first week, the Board divided into four groups, each of which addressed separate areas of the investigation. Group I, consisting of General Barry, General Deal, and Admiral Turcotte, examined NASA management and treatment of materials, including Shuttle maintenance safety and mission assurance. Group II, consisting of General Hess, Mr. Wallace, and later Dr. Ride, scrutinized NASA training, operations, and the in-flight performance of ground crews and the Shuttle crew. Group III, consisting of Dr. Hallock, Mr. Hubbard, and later Mr. Tetrault, Dr. Widnall, and Dr. Osheroff, focused on engineering and technical analysis of the accident and resulting debris. Group IV, consisting of Dr. Logsdon, Dr. Ride, and Mr. Hubbard, examined how NASA history, budget, and institutional culture affected the operation of the Space Shuttle Program. Each group, with the approval of the Chairman, hired investigators and support staff and collaborated extensively with one another.

The Board also organized an internal staff of technical experts called the Independent Assessment Team. Under the leadership of James Mosquera, a senior nuclear engineer with the U. S. Navy, the Independent Assessment Team advised the Board when and where NASA analysis should be independently verified and, when needed, conducted fully independent tests on the Board's behalf.

A.3 Investigation Process and Scope

Decision to Pursue a Safety Investigation

During the first week of its investigation, the Board reviewed the structure and methodology of the Presidential Commission on the Space Shuttle *Challenger* Accident, the International Civil Aviation Organization standards used by the National Transportation Safety Board and the Federal Aviation Administration, and the accident investigation models under which the U.S. Air Force and Navy Safety Centers operate. Rather than assign formal blame or determine legal liability for the cause of the accident, the Board affirmed its charge to pursue both an accident investigation and a safety investigation, the primary aim of which would be to identify and correct threats to the safe operation of the Space Shuttle.

The Use of Privileged Witness Statements

With a principal focus on identifying and correcting threats to safe operations, safety investigations place a premium on obtaining full and complete disclosure about every aspect of an accident, even if that information may prove damaging or embarrassing to particular individuals or organizations. However, individuals who have made mistakes, know of negligence by others, or suspect potential flaws in their organizations are often afraid of being fired or even prosecuted

if they speak out. To allay these fears, which can prevent the emergence of information that could save lives in the future, many safety investigations, including those by NASA and by the Air Force and Navy Safety Centers, grant witnesses complete confidentiality, as do internal affairs investigations by agency Inspector Generals. This confidentiality, which courts recognize as "privileged communication," allows witnesses to volunteer information that they would not otherwise provide and to speculate more openly about their organizations' flaws than they would in a public forum.

Given the stakes of the *Columbia* accident investigation, the most important being the lives of future astronauts, the Board decided to extend witnesses confidentiality, even though this confidentiality would necessitate that investigators redact some witness information before releasing it to the public.

Consistent with NASA Safety Program policy NPD 8621.1H Para 1.j, statements made to Board investigators under privilege were not made under legal oath. Investigators recorded and then transcribed interviews, with those interviewed affirming by their signatures the accuracy of the transcripts. The Board took extraordinary measures to ensure that privileged witness statements would remain confidential by restricting access to these statements to its 13 members and a small number of authorized support staff. Witness statements and information derived from them are exempt from disclosure under the Freedom of Information Act.

The existence of a safety investigation in which privileged statements are taken does not prevent an accounting of personal responsibility associated with an accident. It merely means that such an accounting must result from a separate investigation. In this instance, that responsibility has been left to the NASA administration and the Congressional committees that oversee the agency. To facilitate this separate investigation, the Board pledged to notify NASA and Congress if evidence of criminal activity or willful negligence is found in privileged statements or elsewhere. Additionally, the Board opened all its files to Congressional representatives, with the exception of privileged witness statements. Limited Congressional access to these statements is governed by a special written agreement between the oversight committees and the Board that preserves the Board's obligation to witnesses who have entrusted them with information on the condition of confidentiality.

Expanded Bounds of Board Investigation

Throughout the investigation, Chairman Gehman consulted regularly with members of Congress and the Administration to ensure that the Board met its responsibilities to provide the public with a full and open accounting of the *Columbia* accident. At the request of Congressional Oversight Committees, the Board significantly expanded the scope of its investigation to include a broad review of the Space Shuttle Program since its inception. In addition to establishing the accident's probable and contributing causes, the Board's report is intended to serve as the basis for an extended public policy debate over the future course of the Space Shuttle Program and the role it will play in the nation's manned space flight program.

A.4 Board Policies and Procedures

Authorizing Investigators

To maintain control over the investigation process, the Chairman established a system of written authorizations specifying individuals who were sanctioned to interview witnesses or perform other functions on behalf of the Board.

Consideration of Federal Advisory Committee Act Statutes

Not long after its activation, and well before adding additional members, the Board considered the applicability of the Federal Advisory Committee Act.[3] This statute requires advisory committees established by the President or a federal agency to provide formal public notice of their meetings as well as public access to their deliberations. In contrast to most committees governed by the Federal Advisory Committee Act, which meet a few times per year, the Board intended from the outset to conduct a full-time, fast-paced investigation, in which Board members themselves were active investigators who would shape the investigation's direction as it developed. The Board concluded that the formalities required by the Federal Advisory Committee Act are not compatible with the kind of investigation it was charged to complete. Nor did the Board find the Federal Advisory Committee Act statutes compatible with exercising operational responsibility for more than a hundred staff and thousands of debris searchers.

Though the Federal Advisory Committee Act did not apply to the Board's activities, the Board resolved to be faithful to the standards of openness the Act embodies. The Board held frequent press briefings and public hearings, released all significant findings immediately, and maintained a telephone hotline and a Web site, where users accessed Web pages more than 40,000,000 times**.** The Board also processed Freedom of Information Act requests according to procedures established in 14 C.F.R. Section 1206.

Board Members as Federal Employees

The possibility of litigation against Board members for their actions while on the Board, especially because the Space Flight Operations Contract would be a subject of investigation, made it necessary to bring Board Members within the protections that the Federal Tort Claims Act affords to federal employees. This and other considerations led the Board Chairman to determine that the Board should consist of full-time federal employees. As the Chairman named new Board members, the NASA Administrator honored the Board's determination and deemed them full-time federal employees.

Oversight of Board Activities

To ensure that the Board acted in an independent and unbiased manner in its investigation, the NASA Inspector General was admitted on request to any Board proceeding, except those involving privileged witness statements. The Board also allowed Congressional access to the Board's databases

and offices in Houston and Washington, D.C., with special restrictions that preserved the integrity and confidentiality of privileged witness statements.

Financial Independence

To ensure the Board's financial independence, NASA established a separate operating budget for the Board's activities. This fund provided for Board operating expenses, including extensive testing and analysis and the acquisition of services by support staff and technical experts. With the exception of Chairman Gehman, whose salary was paid by the Office of Personnel Management, and those Board members who were already federal government or military employees, Board members were compensated by Congressionally appropriated funds administered by NASA.

Board Staffing and Administrative Support

Through a Government Services Administration-supervised bidding process, Valador, Inc., a service-disabled-veteran-owned professional services contractor, was selected to provide the Board's administrative and technical support. Under a Mission Operation and Business Improvement Systems contract, Valador arranged for the Board's support staff, technical experts, and information technology needs, including the Board Web site, http://*www.caib.us*. Valador also supported the Board's public hearings, press conferences, the public-input database, and the publication of the final report.

The Board was aided by public affairs officers; a budget manager; representatives from the National Transportation Safety Board, Federal Emergency Management Agency, Department of Defense, and the Department of Justice Civil Division, Office of Litigation Support; and Dr. James B. Bagian, an astronaut flight surgeon assigned from the Department of Veterans Affairs who worked with the NASA medical staff, Armed Forces Institute of Pathology, and the local medical examiner. A complete list of staff and consultants appears in Appendix B.2 and B.3.

Public Inputs

The Board established a system for inputs from the public that included a 24-hour hotline, mailing address, and online comment form linked to the Board's Web site. This enabled the submission of photographs, comments, technical papers, and other materials by the public, some of whom made submissions anonymously. Board staff logged every input into a database. To establish the relevance of every phone call, letter, e-mail, or online comment, investigators evaluated their significance and, if appropriate, followed up with the submitters. Of the 3,000 submissions the Board received, more than 750 resulted in actions by one of the Board's four investigative sub-groups, the Independent Assessment Team, or other Board staff.

Office of Governmental Affairs

As inquiries from Congress grew and the need to keep the Executive and Legislative branches updated on the investigation's progress became clear, the Board opened an Office of Governmental Affairs. Based in Washington, D.C., it served as the Board's liaison to the White House, departments within the Executive Branch, Congressional Oversight Committees, and members of Congress and their staffs. The office conducted numerous briefings**,** responded to Congressional inquiries, and ensured that the investigation met the needs of the Congressional Oversight Committees that plan to use the Board's report as the basis for a public policy debate on the future of the Space Shuttle Program.

A.5 Investigation Interface with NASA

NASA mobilized hundreds of personnel to directly support the Board's investigation on a full-time basis. Initially, as part of the Contingency Action Plan activated on February 1, the Mishap Investigation Team went to Barksdale Air Force Base to coordinate the search for debris. NASA then deployed a Mishap Response Team to begin an engineering analysis of the accident. These groups consisted of Space Shuttle Program personnel and outside experts from NASA and contractor facilities.

As prescribed by its charter, the Board coordinated its investigation with NASA through a NASA Task Force Team, later designated the Columbia Task Force. This group was the liaison between the Board and the Mishap Response Team. As the investigation progressed, NASA modified the organizational structure of the Mishap Response Team to more closely align with Board structure and investigative paths, and NASA renamed it the NASA Accident Investigation Team. This team supported the Board's investigation, along with thousands of other NASA and contract personnel who worked in the fault tree teams described in Chapter 4 and on the debris search efforts described in Chapter 2.

Documents and Actions Requested From NASA

The close coordination of the NASA Investigation Team with the Board's sub-groups required a system for tracking documents and actions requested by the investigation. The Board and the Columbia Task Force each appointed representatives to track documents and manage their configuration.

Board investigators submitted more than 600 requests for action or information from NASA. Requests were submitted in writing, on a standardized form,[4] and signed by a Board member. Only Board members were authorized to sign such requests. Each request was given a priority and tracked in a database. Once answered by Columbia Task Force personnel, the Board member who submitted the request either noted by signature that the response was satisfactory or resubmitted the request for further action.

Reassignment of Certain NASA Personnel Involved in STS-107

On February 25, 2003, Chairman Gehman wrote to NASA Administrator O'Keefe, asking that he "reassign the top level Space Shuttle Program management personnel who were involved in the preparation and operation of the flight of STS-107 back to their duties and remove them from di-

rectly managing or supporting the investigation."[5] This letter expressed the Board's desire to prevent actual or perceived conflicts of interest between NASA personnel and the investigation. In response, O'Keefe reassigned several members of NASA's Columbia Task Force and Mishap Investigation Team and reorganized it along the same lines as the Board's groups. Additionally, Bryan O'Connor, an Ex-Officio Member to the Board, and Theron Bradley Jr., the Board's Executive Secretary, returned to their respective duties as Associate Administrator for Safety and Mission Assurance and Chief Engineer, and were not replaced. After O'Connor's departure, Colonel (Selectee) Michael J. Bloomfield, an active Shuttle Commander and the lead training astronaut, joined the Board as a representative from the Astronaut Office.

Handling of Debris and Impounded Materials

To ensure that all material associated with *Columbia*'s mission was preserved as evidence in the investigation, NASA officials impounded data, software, hardware, and facilities at NASA and contractor sites. At the Johnson Space Center in Houston, Texas, the door to the Mission Control Center was locked while flight control personnel created and archived backup copies of all original mission data and took statements from Mission Control personnel. At the Kennedy Space Center in Florida, mission facilities and related hardware, including Launch Pad Complex 39-A, were put under guard or stored in secure warehouses. Similar steps were taken at other key Shuttle facilities, including the Marshall Space Flight Center in Huntsville, Alabama, and the Michoud Assembly Facility near New Orleans, Louisiana. Impounded items and data were released only when the Board Chairman approved a formal request from the NASA Columbia Task Force.

Similarly, any testing performed on Shuttle debris was approved by the Board Chairman only after the Columbia Task Force provided a written request outlining the potential benefits of the testing and addressing any possible degradation of the debris that could affect the investigation. When testing of Shuttle debris or hardware occurred outside the secure debris hanger at the Kennedy Space Center, investigation personnel escorted the debris for the duration of the testing process or otherwise ensured the items' integrity and security.

A.6 Board Documentation System

The Columbia Accident Investigation Board Database Server

The sheer volume of documentation and research generated in the investigation required an electronic repository capable of storing hundreds of thousands of pages of technical information, briefing charts, hearing transcripts, government documents, witness statements, public inputs, and correspondence related to the *Columbia* accident.

For the first few months of its investigation, the Board used the Process-Based Mission Assurance (PBMA) system for many of its documentation needs. This Web-based action tracking and document management system, which is hosted on a server at the NASA Glenn Research Center, was developed and maintained by NASA Ames Research Center. The PBMA system was established as a repository for all data provided by NASA in response to the Board's Action/Request for Information process. It contained all information produced by the Columbia Task Force, as well as reports from NASA and other external groups, presentations to the Board, signed hardware release and test release forms, images, and schedule information.

However, the PBMA system had several critical limitations that eventually compelled the Board to establish its own server and databases. First, NASA owned the Mission Assurance system and was responsible for the documents it produced. The Board, seeking to maintain independence from NASA and the Columbia Task Force, found it unacceptable to keep its documentation on what was ultimately a NASA database. Second, the PBMA system is not full-text searchable, and did not allow investigators to efficiently cross-reference documents.

The Board wanted access to all the documents produced by the Columbia Task Force, while simultaneously maintaining its own secure and independent databases. To accomplish this, the Board secured the assistance of the Department of Justice Civil Division, Office of Litigation Support, which established the Columbia Accident Investigation Board Database Server. This server provided access to four document databases:

- Columbia Task Force Database: all the data in NASA's Process-Based Mission Assurance system, though independent from it.
- Columbia Accident Investigation Board Document Database: all documents gathered or generated by Board members, investigators, and support staff.
- Interview Database: all transcriptions of privileged witness interviews.
- Investigation Meeting Minutes Database: text of approved Board meeting minutes.

Although the Board had access to the Process-Based Mission Assurance system and therefore every document created by the Columbia Task Force, the Task Force did not have access to any of the Board's documents that were independently produced in the Board's four other databases. A security system allowed Board members to access these databases through the Board's Database Server using confidential IDs and passwords. In total, the Columbia Accident Investigation Board Database Server housed more than 450,000 pages that comprised more than 75,000 documents. The bulk of these are from NASA's Columbia Task Force Document Database, which holds over 45,000 documents totaling 270,000 pages.

To ensure that all documents received and generated by individual investigators became part of the permanent Columbia Accident Investigation Board archive, Department of Justice contractors had coordinators in each investigative group who gathered electronic or hard copies of all relevant investigation documents for inclusion in the Columbia Accident Investigation Board Document Database. Every page of hard copy received a unique tracking number, was

imaged, converted to a digital format, and loaded onto the server. Documents submitted electronically were saved in Adobe PDF format and endorsed with a tracking number on each page. Where relevant, these document numbers are referenced in citations found in this report. The Columbia Accident Investigation Board Document database contains more than 30,000 documents comprising 180,000 pages.

Other significant holdings on the Columbia Accident Investigation Board Document Database Server include the Interview Database, which holds 287 documents comprising 6,300 pages, and the Investigative Meeting Minutes Database, which holds 72 documents totaling 598 pages.

Concordance

Acting on the recommendation of the Department of Justice, the Board selected Concordance as the software to manage all the electronic documents on the Columbia Accident Investigation Board Database Server. Concordance is a full-text, image-enabled document and transcript database accessible to authorized Board members on their office computers. Concordance allowed the Board to quickly search the data provided by the Columbia Task Force, as well as any documents created and stored in the four other databases. The Concordance application was on a server in a secure location in the Board office. Though connected to the Johnson Space Center backbone, it was exclusively managed and administered by the Department of Justice and contract staff from Aspen Systems Corporation. Department of Justice and contract staff trained users to search the database, and performed searches at the request of Board members and investigators. The Department of Justice and contract staff also assisted Congressional representatives in accessing the Columbia Accident Investigation Board Database Server.

Investigation Database Tools

In addition to these databases, several information management tools aided the Board's investigation, deliberation, and report writing.

Group Systems

Group Systems is a collaborative software tool that organizes ideas and information by narrowing in on key issues and possible solutions. It supports academic, government, and commercial organizations worldwide. The Board used Group Systems primarily to brainstorm topics for inclusion in the report outline and to classify information related to the accident.

Investigation Organizer

Investigation Organizer is a Web-based pre-decisional management and modeling tool designed by NASA to support mishap investigation teams. Investigation Organizer provides a central information repository that can be used by investigation teams to store digital products. The Board used Investigation Organizer to connect data from various sources to the outline that guided its investigation. Investigation Organizer was developed, maintained, and hosted by NASA Ames Research Center. Access to Board files on Investigation Organizer was restricted to Board members and authorized staff.

TechDoc

The Board drafted its final report with the assistance of TechDoc, a secure Web-based file management program that allowed the 13 Board members and the editorial staff to comment on report drafts. TechDoc requires two-factor authentication and is certified to store sensitive Shuttle engineering data that is governed by the International Traffic in Arms Reduction Treaty.

Official Photographer

The Board employed an official photographer, who took more than 5,000 digital images. These photographs, many of which have been electronically edited, document Board members and support staff at work in their offices and in the field in Texas, Florida, Alabama, Louisiana, and Washington, D.C.; at Shuttle debris collection, analysis, and testing; and at public hearings, press briefings, and Congressional hearings. Images captured by NASA photographers relevant to the investigation are available through NASA's Public Affairs Office.

National Archives and Records Administration

All appropriate Board documentation and products will be stored for submission to the National Archives and Records Administration, with the exception of documents originating in the Process-Based Mission Assurance system, which will be archived by NASA under standard agency procedures. Representatives of the Board will review all documentation prior to its transfer to the National Archives to safeguard privacy and national security. This preparation will include a review of all documents to ensure compliance with the Freedom of Information Act, the Trade Secrets Act, the Privacy Act, the International Traffic in Arms Reduction Treaty, and Export Administration Regulations. To gain access to the Board's documents, requests can be made to:

National Archives and Records Administration
Customer Services Division (NWCC)
Room 2400
8601 Adelphi Road
College Park, MD 20740-6011

The National Archives and Records Administration can be contacted at 301.837.3130. More information is available at http://www.nara.gov.

A.7 List of Public Hearings

The Board held public hearings to listen to and question expert witnesses. A list of these hearings, and the participating witnesses, follows; transcripts of the hearings are available in Appendix G.

March 6, 2003 Houston, Texas

Review of NASA's Organizational Structure and Recent Space Shuttle History

Lt. Gen. Jefferson D. Howell, Jr., Director, NASA Johnson Space Center
Mr. Ronald D. Dittemore, Manager, Space Shuttle Program
Mr. Keith Y. Chong, Engineer, Boeing Corporation
Dr. Harry McDonald, Professor, University of Tennessee

March 17, 2003, Houston, Texas

***Columbia* Re-entry Telemetry Data, and Debris Dispersion Timeline**

Mr. Paul S. Hill, Space Shuttle and International Space Station Flight Director, NASA Johnson Space Center
Mr. R. Douglas White, Director for Operations Requirements, Orbiter Element Department, United Space Alliance

Prior Orbital Debris Re-entry Data

Dr. William H. Ailor, Director, Center for Orbital and Re-entry Debris Studies, The Aerospace Corporation

March 18, 2003, Houston, Texas

Aero and Thermal Analysis of Columbia Re-entry Data

Mr. Jose M. Caram, Aerospace Engineer, Aeroscience and Flight Mechanics Division, NASA Johnson Space Center
Mr. Steven G. Labbe, Chief, Applied Aeroscience and Computational Fluid Dynamics Branch, NASA Johnson Space Center
Dr. John J. Bertin, Professor of Aerodynamics, United States Air Force Academy
Mr. Christopher B. Madden, Deputy Chief, Thermal Design Branch, NASA Johnson Space Center

March 25, 2003, Cape Canaveral, Florida

Launch Safety Considerations

Mr. Roy D. Bridges, Jr., Director, Kennedy Space Center

Role of the Kennedy Space Center in the Shuttle Program

Mr. William S. Higgins, Chief of Shuttle Processing Safety and Mission Assurance Division, Kennedy Space Center
Lt. Gen. Aloysius G. Casey, U.S. Air Force (Retired)

March 26, 2003, Cape Canaveral, Florida

Debris Collection, Layout, and Analysis, including Forensic Metallurgy

Mr. Michael U. Rudolphi, Deputy Director, Stennis Space Center
Mr. Steven J. Altemus, Shuttle Test Director, Kennedy Space Center
Dr. Gregory T. A. Kovacs, Associate Professor of Electronics, Stanford University
Mr. G. Mark Tanner, Vice President and Senior Consulting Engineer, Mechanical & Materials Engineering

April 7, 2003, Houston, Texas

Post-Flight Analysis, Flight Rules, and the Dynamics of Shedding Foam from the External Tank

Col. James D. Halsell, Jr., U.S. Air Force, NASA Astronaut, NASA Johnson Space Center
Mr. Robert E. Castle, Jr., Chief Engineer, Mission Operations Directorate, NASA Johnson Space Center
Mr. J. Scott Sparks, Department Lead, External Tank Issues, NASA Marshall Space Flight Center
Mr. Lee D. Foster, Technical Staff, Vehicle and Systems Development Department, NASA Marshall Space Flight Center

April 8, 2003, Houston, Texas

Shuttle Safety Concerns, Upgrade Issues, and Debris Strikes on the Orbiter

Mr. Richard D. Blomberg, Former Chairman, NASA Aerospace Safety Advisory Panel
Mr. Daniel R. Bell, Thermal Protection System Sub-System Manager for the Boeing Company at Kennedy Space Center
Mr. Gary W. Grant, Systems Engineer in the Thermal Management Group for the Boeing Company at Kennedy Space Center

April 23, 2003, Houston, Texas

Tradeoffs Made During the Shuttle's Initial Design and Development Period

Dr. Milton A. Silveira, Technical Advisor to the Program Director, Missile Defense Agency, Office of the Secretary of Defense
Mr. George W. Jeffs, Retired President of Aerospace and Energy Operations, Rockwell International Corporation
Prof. Aaron Cohen, Professor Emeritus of Mechanical Engineering, Texas A&M University
Mr. Owen G. Morris, Founder, CEO, and Chairman of Eagle Aerospace, Inc.
Mr. Robert F. Thompson, former Vice President of the Space Station Program for McDonnell Douglas

Managing Aging Aircraft

Dr. Jean R. Gebman, Senior Engineer, RAND Corporation
Mr. Robert P. Ernst, Head of the Aging Aircraft Program, Naval Air Systems Command

Risk Assessment and Management in Complex Organizations

Dr. Diane Vaughan, Professor, Department of Sociology at Boston College

May 6, 2003, Houston, Texas

MADS Timeline Update, Ascent Video

Dr. Gregory J. Byrne, Assistant Manager, Human Exploration Science, Astromaterials Research and Exploration Science Office at the Johnson Space Center
Mr. Steven Rickman, Chief of the Thermal Design Branch, Johnson Space Center, NASA
Dr. Brian M. Kent, Air Force Research Laboratory Research Fellow
David W. Whittle, Chairman of the Systems Safety Review Panel and Chairman of the Mishap Investigation Team in the Shuttle Program Office

June 12, 2003, Washington, DC

NASA Budgetary History and Shuttle Program Management

Mr. Allen Li, Director, Acquisition and Sourcing Management, General Accounting Office
Ms. Marcia S. Smith, Specialist in Aerospace and Telecommunications Policy, Congressional Research Service
Mr. Russell D. Turner, Former President and CEO, United Space Alliance
Mr. A. Thomas Young, Retired Aerospace Executive

Endnotes for Appendix A

[1] NASA Agency Contingency Action Plan for Space Flight Operations, January 2003, p. D-2.

[2] Guidelines per NASA Policy Guideline 8621.

[3] 5 U.S.C. App § §1 *et seq*. (1972).

[4] JSC Form 564 (March 24, 2003).

[5] Harold W. Gehman to Sean O'Keefe, February 25, 2003.