NAAIS

PHILOSOPHY & MANAGEMENT

OF

AIRCRAFT ACCIDENT

INVESTIGATION

JGM
2-12-64

AIRCRAFT ACCIDENT INVESTIGATION

CHECKLIST

STUDENT TRAINING MATERIAL

February, 1964

NATIONAL AIRCRAFT ACCIDENT INVESTIGATION SCHOOL
WILL ROGERS WORLD AIRPORT
OKLAHOMA CITY, OKLAHOMA

(NAAIS Handout #228)

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1. Insures Preservation of Wreckage

2. Establish Headquarters

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   a. For Possible Autopsy

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   b. Provides Appropriate Individual Identification

   c. Manages and/or Participates in, the Conduct of the Investigation

II. Conducting the Investigation

A. Flight Operations

1. Accident

a. Determine

(1) Location

(2) Date

(3) Time

(4) Aircraft Make

(5) Identification Number

(6) Flight Number

(7) Owner

(8) Operator

b. Crew - Crew statements and interview as soon as possible if crew survived and obtain following information

2. Obtain operator's operations manual and related data.

3. History of Flight

a. Determine

(1) Origin

(2) Destination

(3) Scheduled Stops

(4) Type of Flight Plan

(5) Clearance Received

(6) En route Radio Contacts

(7) Local Airport Radio Contacts

4. Passengers

   a. Determine

      (1) Number of Passengers

      (2) Revenue or Non-revenue

      (3) Number of Infants

      (4) Extent of Injuries

      (5) Passengers' Method of Evacuation

5. Communications and Navigation Equipment

   a. Determine

      (1) Number of Radios on Board

      (2) The Frequencies Available

      (3) Make and Model

      (4) Indicator Readings

      (5) Navigation Equipment Available

6. Dispatching

   a. Determine

      (1) Name of Dispatcher Handling Flight

      (2) His Area of Control

      (3) Dispatcher's Qualifications and Statement

      (4) Copy Radio Contacts and Communications

      (5) Pilot and Dispatcher Briefing

7. Aircraft Documents

   a. Obtain Copy of:

      (1) Dispatch Release

      (2) Weight and Balance

      (3) Aircraft Log

      (4) Flight Plan and Trip Log

8. **FAA Air Route Traffic Control and Control Tower Data**

   a. Obtain

      (1) Clearance

      (2) Routing

      (3) IFR or VFR

      (4) Incident Reports

      (5) Controller's Reports

      (6) Tower Controller

      (7) Radar Contacts

      (8) Control Tower Location

      (9) Type of Control

      (10) Number of Frequencies

      (11) Handling of Airport Facilities such as Lights and so Forth

      (12) Emergency Provisions

      (13) Visibility from Twoer

      (14) Location of Various Positions in Tower

9. Airport Data

   A. Obtain

      (1) Visual Layout

      (2) Number of Runways

      (3) Gradient

      (4) Overrun

      (5) Approaches

      (6) Elevation of Field

      (7) Lighting System

      (8) Instrument Approach Systems

(9) Crash and Fire Protection

(10) Navigational Aids

(11) Public Protection

(12) Approach Obstruction

(13) Secure Chart of Field

(14) Name of Airport Manager and Assistant

(15) Method of Snow Removal

(16) Method of Marking Snow-covered Runways

(17) Airport and Field Rules

10. Weather Data

a. Obtain:

(1) Hourly Sequence

(2) Forecast

(3) After-cast

(4) Weather at Time of Accident

(5) Verbal Reports and Cocumentation

II. Supporting Data

a. Obtain copies of the Following:

(1) Approach Plates

(2) Notams

(3) Departure Charts

(4) Arrival Charts

(5) En route Charts

(6) Copy Weather Minimums

(7) Facilities Used

(8) Type of Approach

(9) Flight Recorders

12. Crew History and Qualifications Records

a. Obtain:

(1) Name

(2) Address

(3) Base of Employment

(4) Date of Employment

(5) Date of each Promotion

(6) Total Flying Time

(7) Total Flight Time on Equipment Involved

(8) Total Instrument Time

(9) Flight Time Last 90 Days by Type

(10) Rest Period Prior to Subject Flight

(11) Date and Class of Last Physical Exam by FAA and Company

(12) FAA Certificates and Ratings

(13) Route Qualifications

(14) Date of Last Line Check by Company Check Pilot

(15) Date of Last Line Check by FAA Agent

(16) Last Six Months' Instrument Check and by Whom

13. Company Operations Records

a. Obtain:

(1) Trip Clearance with Attached Weather

(2) Weight Manifest and Loading Schedule

(3) Last - - - Pilot Flight Reports (Squawk Sheets)

(4) Last Pre-flight Inspection Form

(5) Trip Plan and Log

(6) Last Refueling Record

(7) Summary on Aircraft Including Total Time on Aircraft, Engines and Propellers and TSO

(8) Passenger Manifest and Seating Diagram

(9) Copy of Airline Radio Station Log Pertaining to Subject Flight

14. Investigation at Scene

a. Determine:

(1) Instrument Readings

(2) Flight Control Settings

(3) Power Plant Control Settings

(4) Communication and Navigation Settings

(5) Crew Positions and Flight Circumstances

II. Conducting the Investigation Continued

B. Structures Phase Surface and Air Accidents

1. Determine Mode Sequence and Nature of Failure

a. Analyze Individual Breaks and Separations

(1) Fatigue

(a) Stress

(b) Material

(c) Fabrication

(d) Stress Raisers

(2) Loading

(a) Type

1 Tension

2 Shear

3 Compression

4 Bending

(b) Direction

(c) Source

1 Impact

2 Aerodynamic

3 Service

4 Explosion

(3) Determine Need for Laboratory Study

2. Determine Aircraft Flight Configuration at Impact

a. Determine Position and Control Settings of

(1) Flaps - (L.E. and T.E.

(2) Landing Gears

(3) Tabs

(4) Primary

(5) Spoilers

(6) Stabilizer

(7) Other

b. Analyze Individual System Components Positions and Condition

3. Prepare Wreckage Distribution Chart

a. Determine Appropriate Plotting Method

(1) Grid

(2) Center Line

(3) Polar

b. Establish Location

(1) Longitude - Latitude

(2) Elevation

(3) Gradient

(4) Profile

c. Determine Directions and Distances

d. Obtain Maps and Charts

e. Obtain Aerial Photographs

f. Determine Need for Surveyor

g. Record Plot

h. Code and/or Identify Parts and Pieces

(1) Prepare Legend

i. Identify and Label Pieces

(1) Cross Reference Part Numbers

4. Determine Impact Attitude and Velocity

a. Identify Impact Points

(1) Directions

(2) Angles

(3) A/C Part(s) Making Contact

b, Analyze Propeller Slashes

c. Analyze Wreckage Scatter and Position

NOTE: Above Applicable to A/C Collision

5. Construct Wreckage Mock-up

a. Identify and Label Pieces/Parts

(1) Part Numbers

(2) Identify Material

(3) Type of Material

(4) Dimension

(5) Color

(6) Marks

(7) Shape

b. Determine Extent of Mock-up Required

(1) Partial or Complete

(2) 3 "D" or Plan

c. Construct Mock-up

(1) Draw Plan

(2) Determine Materials and Skills

(3) Determination Location and Space

(4) Supervise Construction

6. Analyze Fire Pattern

a. Determine What Burned

b. Determine Source of Ignition

c. Determine When Started

d. Determine Laboratory Study Needs

C. POWERPLANT

1. Examine Powerplant for Failure and Malfunction

A. Check Oil System for

(1) Contamination

(2) Supply

(3) Pumps Condition

b. Check Fuel System for

(1) Contamination

(2) Supply

(3) Pumps Condition

(4) Function of Pumps

(5) Valve Positions and Description

c. Check Carburetor/Fuel Control for

(1) Screen Condition and Content

(2) Control Positions and Movement

(3) Function

(4) Contamination of Fluid

(5) External and Internal Physical Condition

f. Check Propeller System for

(1) Completeness

(2) Blade Angle at Impact

(3) RPM at Impact

(4) Blade Damage, Including Bends

(5) Function, Normal and Feather

(6) System Condition

(7) Governor Function and Internal Condition

g. Check Engine for

(1) Evidence of External Damage Due to

(a) Impact

(b) Lack of Lubrication

(c) Foreign Material

(d) Part Failure

(e) Over Heat Condition

(f) Interference of Rotating Parts

(g) Failure of Fuel Control

(h) Exceeding Operating Limits

(i) Failure of Air Induction Control

3. Operational Condition

2. Establish Power at Impact

a. Reciprocating/Turbo Prop

(1) Estimate Air Speed

(2) Determine Propeller Pitch

(3) Determine RPM

(a) Observe Propeller Blade Bends

(b) Observe Propeller Slashes

(4) Control Position

b. Turbine Engine

(1) Estimate Rotational Energy at Impact

(2) Control Position

3. Identify and Label Engine Parts

a. Prepare Legend

b. Cross Reference Part Numbers

c. Check Historical and Maintenance Records

4. Construct Engine Wreckage Mock Up

   a. Determine Extent of Mock Up Required

      (1) Partial or Complete

   b. Construct Mock Up

5. Record Findings

   a. Photograph all Pertinent Parts and Separate Units

   b. Obtain Engine Records

   c. Write Notes Concerning all Pertinent Condition

II. Conducting the Investigation Continued

D. Systems Investigation

1. Organize a System Investigation

a. Establish Areas of Responsibility

b. Plan Course of Group or Individual Activities

c. Control Working Notes and Information Releases

d. Co-ordinate with Other Groups

2. Conduct Investigation at Scene

a. Review Crash Site to Study Problems and/or Working Areas

b. Identify Individual Components for Future Study and Establishment on Wreckage Distribution Plot

c. Establish Security Control of Systems Components Selected for Detailed Examination

d. Make an Attempt to Recover all Systems Components

3. Schedule Examination of Components for Special Examination or Study

a. Utilize Industry and Government Facilities

b. Supervise and Record and/or Acquire Recorded Results of Special Examinations

4. Make Detailed Examination

a. Hydraulic Systems

b. Electrical Systems

c. Fire Detection Systems

d. Instruments

e. De-icing and Anti-icing Equipment

f. Air Conditioning and pressurization Components

g. Pneumatic Systems

5. Recognize Flight Records

   a. Brief Other Investigators on Physical Aspects and Location in Aircraft

   b. Remove Recording Medium from Recorder

   c. Expeditiously Forward Recording Medium to those Responsible for Evaluation

   d. Interpret Results of Recorder Readout

6. Understand Applicable Regulations

   a. Federal Air Regulations

   b. Airworthiness Directives

   c. Service Bulletins

7. Write Report of Investigation and, if Required, Make Recommendations to Prevent a Recurrence

E. Aircraft and Engine Records

1. Understand Applicable Regulations

   a. Records Required

   b. How Regulation Requirements Are Met

   c. Rules, Policies and Interpretations Applicable to Records.

2. Obtain the Following Records as Necessary

   a. Records Carried in the Aircraft

   b. Records Maintained at Shops and Repair Stations

   c. Records on File at Aeronautical Center

3. Interpret the Following Maintenance Records

   a. Log Books or Equivalent

   b. FAA Form 337

   c. Maintenance Release

   d. Work Orders

4. Establish Causal Factors

   a. Operational Malfunctions Corrected

   b. Proper Maintenance and Inspections

      (1) Required by Regulations

      (2) AD Compliance

      (3) Manufacturer's Mandatory Bulletins and Inspections

5. Document Maintenance Records

   a. Photography

   b. Copying Machines

   c. Statements from persons Responsible for Maintenance

6. Correlate the Records Phase with the Overall Investigation

7. Prepare a Report of the Maintenance Phase of the Investigation

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II. Conducting the Investigation Continued

F. Witnesses

A. The Investigation will

1. Locate Witnesses

a. Direct Location

b. Telephone

c. News Media

d. Letters of Request

2. Evaluate Witnesses

a. Communicate at Level of Witness

b. Take Statement Without Pre-judgement

c. Establish Final Witness Reliability Chart

3. Allow Witness to Give a Narrative in His Own Words

a. Make Mental Notes

b. Look for Key Areas for Future Development

c. Look for Overlooked Areas; Consider all Details

d. Requisition Witness About Details

4. Take Notes During Interrogation

a. Describe: Distances, angular observations, obstructions to visibility, locations, and prespective as stated by the witness utilizing models and measuring aids

b. Use Recorder as Required

c. Note if input to witness was visual, aural, or other

d. Note Timing and Sequence of Events

5. Secure Accurate Signed Statements

a. Reiterate Witness Testimony

(NAAIS Handout #228)

b. Call Attention to all Details

c. Advise Witness of Need for Signed Statement

6. Co-ordinate with Other Groups

7. Prepare a Witness Report

a. Analyse Notes

b. Prepare Witness Charts

II. Conducting the Investigation Continued

G. Human Factors

A. The investigator will

1. Utilize the talents available to him

a. Normal Human Factors Group complement:
Local Coroner (in charge), pathologist, company medical director, other doctors industry, government and manufacturers' representatives

b. Diplomatically persuade local authorities to cooperate

c. Avoid legal entanglements

d. Organization and assignments

2. Contact local authorities for the accident area (Coroner, Chief Medical Examiner, Sherrif)

a. Explain the situation and your needs regarding the fatalities

b. Offer the assistance of medical personnel

c. Determine his plans

d. Try to solicite definite "will hold" until your arrival

e. Get to scene (morgue) as rapidly as possible

3. Ascertain magnitude

a. Number of persons involved

Crew, jump seat, passengers, and infants
(Many operators do not count unticketed infants in the passenger load.)
Division, by name if possible, between 1st Class and Tourist passengers.

b. Number of fatalities and where they were taken

c. Number of survisors and their disposition
- injured and to what hospitals taken
- non-injured, where examined and contact for after release

4. Keep Investigator in charge advised of all current developments

5. Co-ordinate with the other investigative groups

6. Determine occupant locations in the aircraft at the time of the accident

7. Hospitals - Contact the survivors in the hospitals

8. Morgue

   a. Preliminary determination of the causes of deaths

   b. Take photographs of at least the typical fatal injuries

9. Wreckage

   a. Document cabin and cockpit remains before wreckage removal crashworthiness items, enviornment, restraint devices, damage, etc.

   b. Determine original seat locations in the cabin

   c. Photograph pertinent details (overall wreckage, seats, buffett, cockpit, etc.)

   d. Reconstruct portions of the aircraft, as necessary

   e. Relate wreckage to causes of deaths, passengers' locations, and injuries

10. Fire Fighting & Rescue

   a. Get copies of local emergency plans and procedures from airport and local authorities

   b. Interview those who responded to the emergency alarm

   c. Get copies of the official report of those who responded fire companies, other emergency vehicles, ambulances, etc.
   - Understand what the equipment was that responded and its capabilities.

11. Determine medical background of flight crew, both physiological and psychoiogical:

   - FAA Records

- Company medical records

- Individuals' family or personal physicians

12. Contact Witnesses, as necessary, to diplomatically determine and document:

    - crew member activity during the period before the flight

    - Personnel involved with dispatching the flight for general appearances.

    - other flight crew members who have recently flown with this crew for normal habits

    - friends and relatives, only if necessary.

13. Review training records and extent of experience both generally and in this type aircraft for flight crew members and emergency procedures for the cabin attendants

14. A. Review published operating procedures of the Company and manufacturers

    B. Review published cabin emergency procedures of the Company

15. Study the cockpit configuration of a sister ship relative to design and human engineering

16. Prepare a Human Factors Report and necessary illustration exhibits

17. When accident was survivable and it is advisable, prepare a Crash - Injury Study.

III. Processing Recommendations for Corrective Action

A. CAB Personnel

1. Recognize need for corrective action

2. Inform Washington Office of need

(a) Furnish substantiating information and/or material

3. Formal Recommendation by CAB

(a) To FAA

(b) By appropriate division, Washington Office

B. FAA Personnel

IV. Investigation Analysis

1. Maintain open-mind to seek truth and avoid making pre-mature conclusions.

2. Survey and review all available facts.

3. Determine interelations of all available finding (facts).

4. Determine validity of findings as required.

5. Determine additional information requirements.

6. Establish possible cause areas.

7. Analyse and test all possible causes.

8. Use logical reasoning in making conclusions regarding findings.

9. Decide on probable causes and select most probable. (one or more) or decide if cause is undeterminable with information available.

10. Write analysis approach and conclusions in logical sequence.

11. Prepare final report of analysis.

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V. Reporting the Investigation

A. Prepare accident report and exhibits

1. Format

2. Facts, opinions and evidence

3. Subreports

4. Supporting documents

5. Photographs

B. Process aircraft accident report

1. Assemble

2. Classify

3. Distribute

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VI. Public Hearing and Deposition

A. Prepare for hearing and deposition

1. Makes recommendation regarding need for hearing or deposition

2. Co-ordinates with hearing officer to determine

(a) Investigation areas to be covered

(b) Location and data of hearing

(c) Selection of witnesses

(d) Method of notification of witness

(1) Issue subpoena

(e) Selection of exhibits

3. Obtain and prepare necessary exhibits

4. Assists in assembling documentation

5. Plan order of procedure for hearing

6. Examine witness

(a) Attitude

(b) Method of interrogation

B. Participates in hearing

1. Testifies at hearing

2. Interrogate witness

(a) Plans and asks questions to obtain desired information

VII. Releasing Information and Materials

A. Release information to

1. News Media

(a) Kinds of information which can be released

(b) Authority to release

2. Interested parties

(a) Kinds of information which can be released

(b) Authority to release

(c) Responsibility for cost

B. Release wreckage and parts

1. Determine when parts can be released

2. Authority for release

(a) To whom

3. Process release of wreckage and parts

CIVIL AERONAUTICS BOARD
BUREAU OF SAFETY

March 1, 1963

TO : ALL PERSONNEL, SAFETY INVESTIGATION DIVISION

FROM : Chief, Safety Investigation Division

SUBJECT: Implementation of Revised Part 320, April 1, 1963

A. PURPOSE

This instruction outlines the general policy and procedures to be followed in connection with the implementation, on April 1, 1963, of PART 320 - RULES PERTAINING TO AIRCRAFT ACCIDENTS, INFLIGHT HAZARDS, OVERDUE AIRCRAFT AND SAFETY INVESTIGATIONS.

It is important that all Safety Investigation Division personnel become thoroughly familiar with the provisions of Part 320, as revised, and that particular attention be given to the preamble. This preamble expresses the purpose and intent of the revision and highlights the significant differences between the new Part 320 and the previous regulation. Accordingly, it is not deemed necessary to reiterate these points in this instruction.

B. NOTIFICATIONS

1. General:

One of the principle effects of the new regulation will be an increase in the number of notifications to be handled by each field office. This increase will result from the provision that all required notifications are to be directed to CAB field offices, and that notifications are now required for certain additional inflight hazards which did not have to be reported in the past. This means that close coordination must be established with the FAA in setting up local procedures for interchange of notification messages.

In connection with the above, it should be borne in mind that, although the new regulations require the operator to notify the CAB direct, in many cases notification will probably be initiated by or through FAA Flight Service Facilities and transmitted via FAA communications systems, as in the past.

2. Coordination with FAA - Delivery of Notifications:

The Supervisory Investigator of each field office shall contact the appropriate FAA regional office or offices to coordinate the establishment of procedures to be followed within his area:

a. When the FAA receives first notification of an occurrence:

In such cases, procedures should be established for the immediate delivery to the appropriate CAB field office of notifications received by FAA facilities; except those accidents investigated by the FAA under PN-13. After office hours, all notifications should be telephoned to the CAB duty investigator through the telephone answering service.

b. When the CAB Field Office receives first notification of an occurrence:

In such cases, the CAB duty investigator shall immediately contact the appropriate FAA office and advise them of the occurrence. Agreement shall be reached with the FAA Regional Office regarding the FAA office which is to receive the notification in the event of:

(1) Air carrier accidents or incidents;
(2) General aviation accidents now being investigated by the FAA under PN-13;
(3) General aviation accidents or incidents now being investigated by the CAB.

It is recommended that efforts be made to have all such communications delivered to one central FAA office rather than to the various individual District Offices.

3. Recording Incoming Notifications:

When a notification is received, the details shall be entered on the CAB Aircraft Accident/Incident Notification form (CAB Form 588, revised 2/63). A notation should be made of the time received. In those cases wherein the CAB first receives the initial notification, a notation shall be included on Form 588 to show the time the notification was relayed to the FAA and the name of the FAA representative to whom it was delivered.

Each office shall establish a system for filing all incoming notifications and maintaining a record of the number received

4. Classification of occurrences:

At the time a notification is received by the CAB field office, a preliminary classification should be made based upon the available information. For this purpose, occurrences shall be classified as in the past. That is:

a. Accidents

Occurrences shall be classified as accidents whenever, as a result of the operation of an aircraft:

(1) Any person (occupant or non-occupant) receives fatal or serious injury; or
(2) Any aircraft receives substantial damage.

b. Incidents

Occurrences other than those falling in the category of accidents shall be classified as incidents. These would include:

(1) The inflight hazards described in Section 320.5(c) of Part 320 which require a notification from the operator; and
(2) Other occurrences which involve a potential hazard relating to the safety of flight.

C. COVERAGE AND EXTENT OF INVESTIGATION

1. General.

The adoption of the revised Part 320 does not change present policy or procedures pertaining to the kinds of occurrences which will be investigated by the CAB and the extent of the investigation. The general procedures which have been followed in relation to PN-13 will also be continued. In those cases wherein the CAB will conduct the investigation, arrangements shall be made for the appropriate participation of the FAA as provided for in the Federal Aviation Act.

2. Investigation by the CAB of occurrences classified as Incidents:

When notification of an incident is received by the CAB, a determination shall be made as to the course of action to be taken. If an investigation is to be made, the FAA shall be advised.

As heretofore, the extent of the investigation and the report thereon will, among other considerations, be determined on the basis of the following criteria, in the interest of accident prevention:

a. Significance in respect to design of the aircraft or systems or in relation to operational and maintenance procedures;
b. Potential as a hazard to flight safety;
c. Public interest;
d. Possible relation to other occurrences under investigation;
e. Indication of the development of a trend of unsafe practices, or conditions.

In the above cases, Form 453 or Form 454 will not be requested from the operator unless such report is considered essential to the investigation.

As at present, except in very unusual cases, there should be no need to have the operator hold an aircraft from service pending the arrival of Board personnel, and the appropriate authority (operator, airport manager, etc.) should be advised accordingly.

D. CAB FIELD OFFICE AIRCRAFT ACCIDENT/INCIDENT NOTIFICATIONS (to B-90 Washington)

There will be no change in the manner or procedure of transmitting CAB notification messages to B-90, except that the format of the message has been changed. The appropriate forms are being distributed for your use.

A notification message shall not be sent to B-90 covering any occurrence investigated by the FAA under PN-13.

E. CAB FORM 453, PILOT/OPERATOR AIRCRAFT ACCIDENT REPORT

1. Effective April 1, 1963, concurrently with the implementation of Part 320, as revised, the new CAB Form 453 is to be used by the operator in filing the report required by Section 320.15. It should be noted that the new CAB Form 453 is to be used in reporting occurrences involving fixed-wing aircraft over 12,500 pounds and helicopters. However, the Form 454 shall be accepted when submitted in these cases.

2. This form replaces the FAA Form 2400. However, until such time as the CAB Form 453 receives widespread distribution and is available for the use of aircraft operators, the FAA Form 2400 should be accepted when submitted.

Every effort should be made by each CAB field office to see that distribution of the new CAB Form 453 is made as widespread as possible.

3. Responsibility for preparing Form 453 rests with the operator (the pilot is included within the meaning of term, operator). The investigator should not add any information to the form, other than that called for in the space provided for official use. In those cases wherein the operator fails to file a report, Form 453 may be made up by the investigator for the purpose of supplying the FAA and/or the State authorities with a copy. In doing so, extreme care must be taken to include only factual information which can be supported by evidence contained in the complete report of investigation. In no case shall the cause be stated. In these instances, a statement shall be entered in the space for signature on the back of the form to the effect that the report was prepared by the CAB investigator and that a report was not received from the operator.

4. CAB Form 453 is to be submitted to the FAA by the operator, in the case of accidents investigated by the FAA under PN-13. (Reference Part 320, Section 320.15(c)(2).) There will be no change in the processing of reports by the FAA except that CAB Form 453 will be used in lieu of FAA 2400.

Joseph O. Fluet

MAJOR AIR CARRIER ACCIDENT INVESTIGATION (TEAM CONCEPT)

INVESTIGATOR IN CHARGE (CAB)

FAA COORDINATOR
- Assist IIC
- Liaison
- FAA Reports
- FAA Personnel
- Report FS 27

CAB FIELD ASSISTANT
- Assist IIC
- Liaison
- Security

O P E R A T I O N S

- CAB
- FAA
- Company
- Mfgr.
- ALPA
- FEIA
- ALDA

WITNESS
- CAB
- FAA
- Company
- ALPA
- Mfgr.

ATC
- CAB
- FAA
- ALPA

WEATHER
- CAB
- USWB

E N G I N E E R I N G

POWERPLANTS
- CAB
- FAA
- Company
- Mfgr.
- FEIA
- ALPA

STRUCTURES
- CAB
- FAA
- Company
- Mfgr.

SYSTEMS
- CAB
- FAA
- Company
- ALPA

HUMAN FACTORS
- CAB
- FAA
- AFIP
- Company

FLT. RECORDER
- CAB
- FAA
- Company
- ALPA

MAINTENANCE RECORDS
- CAB
- FAA
- Company

IT SHOULD BE KEPT IN MIND THAT THIS OUTLINE OF INTERESTED PARTY PARTICIPANTS IS FLEXIBLE AND IS CONTINGENT UPON THE MAGNITUDE OF THE ACCIDENT.

HIGHLIGHTS OF THE FEDERAL AVIATION ACT AS IT MOST DIRECTLY PERTAINS TO AIRCRAFT ACCIDENT INVESTIGATION

Section 101 (Contains Definitions). Particularly significant are Air Commerce, Airman, Civil Aircraft of the United States, Federal Airway, Operate Aircraft, Public Aircraft and Supplemental Air Carrier.

Section 102 (Declaration of CAB Policy). The Board shall consider, as being in the public interest .....
"(e) The promotion of safety in air commerce;
(f) The promotion, encouragement, and development of civil aeronautics."

Section 103 (Declaration of FAA Policy). The Administrator shall consider, as being in the public interest .....
"(b) The promotion, encouragement, and development of civil aeronautics."

Section 202(d) (CAB Cooperation with Other Federal Agencies). The Board is authorized to use services of other, consenting civil and military agencies, on a reimbursable, reciprocal basis.

Section 204(a) (CAB Powers). Is empowered to "conduct ... investigations" to carry out statutory duties.

Section 302(k) (FAA Cooperation with Other Agencies). FAA privileges are similar to CAB's.

Section 305 (Fostering Air Commerce). FAA is directed to "encourage and foster" aeronautical development.

Section 313(a) (FAA Powers). Includes authority to conduct investigations to carry out statutory duties.

Section 601(b) (Classification of Standards). Directs that the Administrator perform his duties so as to "reduce or eliminate the possibility of, or recurrence of, accidents in air transportation ....."

Section 701(a) (CAB's Accident Duties). As to civil aircraft, imposes five broad duties on the Board:

(1) Promulgate regulations concerning accident reporting
(2) Investigate, report facts and "probable cause"
(3) Make recommendations to Administrator of FAA
(4) Issue reports of public value
(5) Conduct special studies concerning accident prevention

Section 701(c) (Conduct of CAB Investigations). Establishes investigative powers, including testing, and autopsy prerogatives.

Section 701(d) (Wreckage). Requires the preservation of aircraft wreckage, per CAB regulations.

Section 701(e) (Evidence in Civil Actions). Prohibits use of accident "reports of the Board" as evidence in civil damage litigation.

Section 701(f) (Use of FAA by CAB). Authorizes the FAA "upon the request of the Board" to investigate and report accidents. Board is authorized to use FAA reports in determining probable cause.

Section 701(g) (Participation by FAA). Requires CAB to provide for FAA participation in "any ... (CAB accident) ... investigations", to facilitate FAA discharge of its duties. However, FAA shall not participate in CAB's determination of probable cause.

Section 702 (Military Accidents). Requires CAB to permit military participation in civil-military accidents; requires military to permit FAA participation in solely military accident IF FAA function is involved; and requires military to provide both FAA and CAB with air safety data developed from solely military accidents.

Section 703 (Special Boards). Allows CAB to establish a special inquiry where substantial questions of public safety in air transportation are involved.

Section 901(a) (Civil Penalties). Creates a civil penalty for violation of Title VII (and its resultant regulations) and gives CAB authority to compromise such penalties.

Section 902(g) (Refusal to Testify). Establishes - as a misdemeanor - the refusal to testify in obedience to an FAA or CAB subpoena.

Section 902(o) (Interference with Accident Investigation). Establishes a criminal sanction of one year imprisonment or a fine of $100 to $5000 where one knowingly (but without authorization), at the scene of an accident, "removes, conceals, or withholds any part" of a civil aircraft.

Section 1004 (Taking of Evidence by CAB). Contains comprehensive powers for taking of evidence by Board members and Examiners, including rules on subpoenas, depositions, the production of private records, and self-incrimination.

The Role of the Physician in the Investigation of Aircraft Accidents

Maj Gen Oliver K. Niess, USAF, MC, Col E. C. Lentz, USAF, MC, Col Frank M. Townsend, USAF, MC, Capt W. Harley Davidson, USAF, MC, and Capt Richard M. Chubb, USAF, MC, Washington, D.C.

Experience of physicians, especially those in the armed forces, has demonstrated the important contribution the medical profession can make to aviation safety. Many complex factors are involved in the investigation of an air disaster and careful planning is important for the physician in overcoming obstacles that may be encountered. Collection and correlation of medical data with other factors relating to an accident are of paramount importance. The disciplines of pathology and toxicology play key roles in accident investigation. Only by gathering detailed data from each accident can the responsible safety agencies document their requirements for the materiel and the operational changes needed to make flying safer.

ON SEPT 17, 1908, Lt Thomas Selfridge, of the United States Army, was killed in an aircraft accident while flying with one of the Wright brothers. An autopsy revealed that the sole fatal injury was a fractured skull, and this led to the use of protective helmets.[1] Similarly, the medical investigation of the British Comet disasters was a modern example of the role that physicians can play in improving the safety of flight.[2] In this instance, autopsies indicated that the passengers had been thrown violently upward by the rush of air through a defect in the upper part of the cabin of this early jet transport. The cabin wall was strengthened and no similar incidents have occurred.

It is unfortunate that not all aircraft accidents have been as thoroughly investigated from the medical viewpoint. In 1961 there were 1,581 deaths attributable to aviation accidents in the United States and its armed forces overseas. Nearly half of these deaths occurred in general aviation—the large fleet of nonmilitary, noncommercial aircraft that private citizens in this country use for pleasure and business. In 1961 these aircraft were involved in 437 fatal and 4,128 nonfatal accidents. Medical participation in the investigation of these 4,565 crashes was scanty; it will continue to be so until physicians throughout the country awaken to their responsibility in determining the cause of the deaths and injuries. The number of deaths and injuries will increase greatly in the coming years as the aviation industry continues to expand unless we, as physicians, cooperate with the other interested parties to make flying even safer.

The vast majority of fatalities which result from aircraft accidents are due to injuries so severe that no amount of medical or surgical treatment after the injury will alter the final outcome. Thus, the only feasible method of preventing death in these instances is to prevent the injuries. The participation of the physician in the investigation of the crash is the logical first step in this program. The "clinical history" of these victims includes all of the events leading up to the injury—and no physician should be satisfied until he has completely investigated, recorded, and reported this "clinical history."

The commercial aviation disasters and military crashes almost always are investigated by medical personnel in this country. Military flight surgeons and pathologists, often with the aid of civilian pathologists, carefully examine the human factors involved in each military accident. When there are fatalities in the crash of a commercial airliner, the Civil Aeronautics Board conducts a thorough investigation. This includes study by its Human Factors Group of all possible sources of error by the crew or controller personnel, as well as features of aircraft design or protective passenger restraints that may have contributed to injury. The Human Factors Group always works in close cooperation with the local coroner or medical examiner, who

The Surgeon General, United States Air Force (Maj Gen Niess), Chief, Life Sciences Group, Office of Deputy, the Inspector General, United States Air Force, Norton Air Force Base, Calif. (Col Lentz), and the Armed Forces Institute of Pathology (Col Townsend and Capts Davidson and Chubb).

has the responsibility for determining the cause of death and identifying the victims. In these accidents, a physician called to the scene need be concerned only that any survivors are properly attended and that fatally injured victims and aircraft wreckage remain undisturbed until the investigators arrive.

In general aviation accidents, however, there may be only a single investigator from the Federal Aviation Agency or the Civil Aeronautics Board at the scene. The coroner or medical examiner ordinarily will have full jurisdiction over the deceased victims. With his cooperation, a physician investigating the accident should be able to study the wreckage and bodies as completely as possible to determine the cause of the fatal injuries and, in some cases, the cause of the accident. It is to the physician who is interested in the promotion of flying safety by the careful investigation of general aviation accidents that the following investigative techniques are presented. The addition of a physician will double the size of the investigation team in many instances and should ultimately increase the effectiveness of the investigation and prevent many deaths and injuries.

The Investigation

The first step in the medical investigation is to arrange to be notified as soon as an accident occurs. If a physician waits to be informed by the local newspaper he may arrive at the scene to find the aircraft removed to the salvage yard or the bodies to the cemetery. In either case a proper investigation will be exceedingly difficult. Law-enforcement agencies, firemen, coroners, medical examiners, and Federal Aviation Agency representatives are usually among the first to be informed of a crash—and they should know that the physician wishes to be called and how he may be reached.

As soon as an accident occurs, and any survivors are properly attended, efforts should be made to rope off the area of the wreckage to keep the curious onlookers away. Planning with law-enforcement agencies prior to the accident usually will result in this having been done before the physician arrives. The wreckage of the cockpit and passenger cabin and the bodies of any victims should be carefully examined and photographed before anything is disturbed. This examination should include the seats, shoulder harnesses, lap belts, and any surrounding structures or loose equipment that may have contributed to the injury of the deceased. Photographic film is undoubtedly the least expensive investigative tool available, and good color photographs not only complement the verbal description but also serve as permanent evidence.

Although the victims and wreckage should never be disturbed until carefully examined, ignorance or necessity may result in removal of the bodies prematurely. When it is necessary to remove bodies it will help considerably in the correlation of injuries and injury-producing objects if the persons who remove them will tag each body and leave a similar tag on a stake or other fixed object where the body was found. When bodies have been moved without marking the spot it is necessary to try to have those who moved them remember where they were found.

Any survivors should be interviewed by the physician. He is able to judge their emotional status and the validity of their statements far better than anyone else. Surviving crew members must be carefully interviewed to determine, insofar as possible, their physical and emotional status before and after the accident. Those who had contact with fatally injured crew members prior to the accident must be interviewed in an effort to determine the presence or absence of any abnormal psychophysiologic factors prior to the accident.

All fatally injured crew members and passengers should be autopsied. The procedures to follow have been well outlined and any physician interested should familiarize himself with these techniques.[3-5] Injuries should be described in detail and one should not hesitate to call for assistance from someone with experience in forensic pathology when there is doubt as to the cause of the injury. Foreign objects in wounds should be diligently sought, since they may indicate what aircraft structure produced the wound. In at least one accident fragments of a timing mechanism, apparently from a bomb, were found in a wound. It may be possible to locate foreign objects by exploration of the wound, but postmortem x-rays have proven invaluable in the past in locating radiopaque objects.

External examination of victims who were facing forward when the aircraft was traveling at high speed forward and downward at impact will characteristically reveal severe fractures of the skull and lower extremities, as they have flailed into the structures in front of them. In some cases, however, there may be very little external evidence of injury. Injuries such as intracranial hemorrhage, pulmonary hemorrhage, rupture of the myocardium or aorta from hydraulic pressures at impact, lacerations of abdominal viscera, mesenteric tears, or retroperitoneal hemorrhage will be found only at autopsy. Gross or microscopic evidence of preexisting disease is diligently sought. The condition of the heart, especially the coronary arteries, is particularly important, and if the investigator is inexperienced at examing these it is best to send the entire heart to a pathologist.

Toxicologic studies should be done routinely on crew members and selectively on passengers. Tissues collected for these studies ideally should include approximately 200 gm of gray matter from the brain, one half of a kidney, 200 gm of liver, one half of a lower lobe of a lung, 100 ml of blood,

and all available urine and stomach contents. In some accidents, however, the only tissue available has been skeletal muscle, and toxicologic studies can be performed on small amounts of this if it is in good condition. After collection these tissues should be frozen immediately. If facilities are not available for freezing, the tissues should be kept as cold as possible until such facilities become available. Tissue can be frozen by use of dry ice until it can be shipped in an insulated container by the most rapid means possible to a laboratory that will accomplish the analysis.

In those cases submitted by the military services and the Civil Aeronautics Board, the Armed Forces Institute of Pathology analyzes the tissues from fatally injured victims of aircraft accidents to determine the content of carboxyhemoglobin, alcohol, drugs, and, in central nervous system (CNS) tissue, lactic acid. Tests for a given substance may be done on several different tissues. This may enable the toxicologist to determine by what route the substance entered the body or to estimate the time between ingestion of the substance and death.

In some aircraft accidents the postmortem detection of the existence of antemortem hypoxia is quite important. Experimentally, the postmortem concentration of lactic acid in the brain or spinal cord has been shown to be elevated in animals rendered hypoxic prior to death. Antemortem hyperglycemia will also produce an elevation in lactic acid in the postmortem CNS.[6] The results of tests for lactic acid in the CNS performed at the Armed Forces Institute of Pathology on tissues from victims of aircraft accidents indicate that a concentration of over 200 mg of lactic acid per 100 gm of gray matter is almost always due to hypoxia from low oxygen tension in inspired air, to drowning, or to a short period of survival in a state of shock.

Another important aspect of the autopsy on victims of aircraft accidents is the identification of the victim. Fingerprints or dental records are often available and are sometimes the only means of identification. Personal recognition by friends or members of the family is often undesirable or impossible. Mistakes have been made in the past due to confusion in matching fingerprints or dental records and it is always desirable to confirm such identifications. An autopsy may reveal a unique feature, such as an old fracture, a congenital anomaly, a scar or tattoo, a missing organ known to have been removed surgically, or evidence of a known pre-existing disease. Body build, hair length and color, eye color, and skin color should be matched with known characteristics of the individual whenever possible.

Reporting

At this point the physician may well feel that his task is finished, but the primary purpose of all this work is yet to be accomplished. He must now take steps to prevent any similar future accidents. All of the data from the investigation must be carefully recorded and reported to the appropriate agency. This report is incomplete unless the physician analyzes his findings and makes thoughtful recommendations for changes that will prevent a similar accident or decrease the possibility of injury if such an accident should occur. Omitting this final part of the investigation would be analogous to completing the physical examination, history, x-ray studies, and laboratory studies of a patient and then omitting the final diagnosis and recommendations for treatment.

In addition to the recommendations that the physician or other investigators may make as the result of a single investigation, there will possibly be further recommendations that can be made only after studying the reports of a number of investigations.

The United States Army Board for Aviation Accident Research, the United States Naval Aviation Safety Center, the United States Air Force Deputy Inspector General for Safety, the Federal Aviation Agency, and the Bureau of Safety of the Civil Aeronautics Board are conducting a continuing analysis of the results of aircraft accident investigations throughout the United States in a manner that allows for a logical advance in flight safety.

Statistics kept on all accidents are studied to bring to the attention of the agency any trend that may provide a clue to factors that are not obvious in a single accident. Many changes have been made from these analyses in the past and will continue to be made in the future. It would be impossible to list all the changes made in aircraft structures and operational regulations as a result of these investigations, but some examples may be cited in order to present to you, as physicians, a better undersanding of the key role you may play in furthering flight safety.

Report of Cases

CASE 1.—A supersonic Air Force bomber crashed while manned by a civilian crew. Consultants from the Aerospace Medical Laboratory, at Wright-Patterson Air Force Base, Ohio, and the Armed Forces Institute of Pathology were called upon to assist in the investigation. It was found that the aircraft left light cloud formations at 42,000 ft and was suddenly confronted by a huge thunderhead directly ahead with tops at 50,000 ft rather than the forecasted 40,000 to 45,000 ft. Due to the very high speed it was impossible to turn or climb in time to avoid penetrating this storm cloud, and the bomber was probably damaged by extreme turbulence or hailstones in such a way as to render it uncontrollable. It was estimated that the three crew members ejected between the altitudes of 26,000 and 16,000 ft while the aircraft was in a roll to the left in a steep dive at supersonic speed. The parachutes were all observed to descend normally, but the crew members were found dead. The aircraft made an impact crater 30 ft deep and 60 ft wide and was completely demolished, leaving only the three bodies, their personal equipment and seats, and the pattern of the wreckage distribution for clues. All crew

members showed unusual marks on the surface of the skin covering most of the body. These wounds were up to 1 cm in depth and diameter and consisted of macerated pit marks with hemorrhage into the subcutaneous tissue. The helmets, arm and leg restraints, and clothing were ripped from the bodies. X-ray examinations showed multiple fractures and dislocations of the long bones. The head rest of the pilot's seat showed multiple marks on each side that were identical to those made by rivets that held the sun visor of his helmet in place.

After a complete study of the condition of the ejection equipment and the pathologic reports on the crew it was concluded that these individuals ejected from the aircraft into a hailstorm and that the macerated pit marks were the result of hailstones striking the body at extremely high speed. The rivet marks on the head rest of the seat indicated that the high wind blast had buffeted the pilot's head from side to side at very high speed, causing severe brain damage. The failure of the restraining straps caused the dislocations of the extremities and there was evidence that the pilot's boots had struck the head rest of the seat.

From a study of this and other cases of high-speed ejection, and a review of the research that had been done at the United States Air Force Aeromedical Field Laboratory by Col John Paul Stapp, it was felt that a new device was imperative for protection of crew members from the effects of wind blast.[7] With the accumulated data work was immediately begun on the design of a capsule for this type of aircraft. It is gratifying to note that these aircraft are at present being retrofitted with the new ejecion capsule.

CASE 2.—An Air Force interceptor aircraft was being test-flown to check equipment performance. A diving maneuver was required for this test and, during the maneuver, control of the aircraft was lost, causing the pilot to eject. An autopsy revealed unusual lesions on the posterior aspect of his thighs and multiple fractures throughout the body. The flight surgeon visited the crash scene, examined both the pilot and the aircraft, and cooperated with the engineering personnel on the investigating board. The vertical stabilizer showed unusual damage. Examination of the tail surface revealed fragments of striated muscle. In addition, fragments of the ejection seat were found in the tail section of the aircraft.

In this case the investigator came to the conclusion that during the ejection sequence the pilot struck the tail of the aircraft while still in his seat. It was concluded that the explosive charge in the ejection seat was not powerful enough, and it was recommended by the investigating board that all such aircraft have more powerful explosive charges in the ejection seats. This was concurred in by the responsible Air Force agencies and this modification was made.

Aside from these instances, the safety agencies of the Air Force, the Navy, the Army, and the civilian aircraft industry are constantly reviewing data, publishing the results of their analyses, and forwarding their recommendations for changes to those responsible for making appropriate modifications in equipment or procedures.

Summary

Information has been presented to help prepare the physician for the important contribution he can make to air safety. We have outlined the manner in which accident statistics are gathered and changes are made to improve flying safety in the military services and in civilian aviation. Although the physician hopes that an aircraft accident will never occur in his immediate locale, he must be prepared to assume the medical investigator's role and must be thorough in his examination to obtain the most useful information possible. If this is done the physician's findings and recommendations will afford the responsible agencies of the government the information necessary to substantiate their requirements for changes to make flying safer.

Armed Forces Institute of Pathology, Washington 25, D.C. (Col Townsend).

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3. *Autopsy Guide for Aircraft Accident Fatalities*, Washington, D.C.: Joint Committee on Aviation Pathology Publication, Armed Forces Institute of Pathology, 1957.

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7. Stapp, J. P.: Effects of Mechanical Force on Living Tissues, *J Aviation Med* **26**:268-288 (Aug) 1955.

THE MECHANISM OF TOOTH DECAY.—The evidence which has now accumulated for the acid theory of caries is very considerable, but, as much of it is circumstantial, it falls short of conclusive proof. It must be admitted that methods of preventing caries based on the acid theory (such as alkaline dentifrices) have had very limited success. There are many possible reasons for this failure, the most obvious being the difficulty of getting the active substance into the usually inaccessible part of a carious plaque at the time decalcification is occurring. Nevertheless, it is legitimate to question the validity of the acid theory, and that is what the proteolysis-chelation theory of Schatz and his colleagues does. Briefly, this theory suggests that the decalcification in caries is brought about by the action of substances which can dissolve calcium phosphate by forming tightly-bound complexes even in alkaline conditions.—Jenkins, G. N.: A Critique of the Proteolysis-Chelation Theory of Caries, *Brit Dent J*, Nov 7, 1961.

AIR SAFETY INVESTIGATOR'S BASIC EQUIPMENT

1. Federal Aviation Act of 1958.
2. Copy CAB SIR Part 320 4-1-63

   *CAB Only: Investigation Division Memorandum Mar. 1, 1963: Implementation of Part 320.
3. Copy Accident Investigation Manual FAA-FS-P-8020.1A OA-P-8020.2A

   CAB - Investigation Division Manual
4. Copy of Supervisors Accident Investigation Policies and Procedures.
5. Travel Requests
6. Access to Aircraft Requests.
7. Form 44 Book
8. Copies of all forms relative to Accident Investigation, i.e.

   CAB 528, 266, 267, 537, 457, 485, 453, 454

   FAA 2401, 2401.4, 2819, 2820, 3018, 2843, 2844
9. Appropriate Credentials
10. Investigator's Arm Brassard
11. Shipping and Identification Tags
12. Writing equipment. i.e., notebook, envelopes, graph paper, carbon paper, pencils, ballpoint, grease pencils, draftsman scale, protractor.
13. Non-Metallic Tape.
14. Flashlight
15. Magnifying Glass - 4 to 8 power.
16. Magnetic Compass
17. Abney Level.
18. Jack knife.
19 Small metal or plastic cased mirror.

20. AFIP and fluid sample container.

21. Strong light line.

22. First aid kit, i.e. snake bite kit, insect repellent.

23. Set of hand tools - removal of radio equipment, smallparts, etc.

24. Camera Equipment and Accessories.

25. Gloves, heavy leather

26. Galoshes

27. Plastic rain coat (compact)

28. Appropriate gear to insure investigators comfort despite temperature or terrain obstacles.

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ACCIDENT INVESTIGATION IN AVIATION HISTORY

1500	Early sketches of flying machines made by Leonardo da Vinci. He also studied the effect of air pressure on flat surfaces and realized air would support the moving surface.
1800's	George Cayley studied effect of air pressure on a moving surface and related dihedral and stability.
1850's	Stringfellow built and flew a small steam-powered model.
	Wenham built the first wind tunnel.
1894	Sir Hiram Maxim built a 360 hp flying machine with 4000 sq. ft. of wing surface. It failed to fly.
1891-1896	Lilienthal made 2000 gliding flights.
1895	Percy Pilcher was killed in a glider experiment, as was Lilienthal at a later date.
1896-1903	Octave Chanute built numerous successful gliders.
1903-12/8	First manned aircraft accident, Dr. Samuel P. Langley's Aerodrome. Attempted launch from barge in Potomac River, nine days prior to Wright's manned flight.
12/17	Wright brothers' manned flight
1908-7/17	World's First Aviation Legislation Kissimmee, Florida Regulation of aircraft within city limits, i.e., limits of flight, licensing, etc.
1908-9/17	First Aviation Fatality Fort Myer, Virginia. Orville Wright, pilot - serious injury; Lt. Thomas E. Selfridge, passenger, fatal. (Training flight)
	*1903-08 Safest five years in history of aviation
1912	President Taft attempted to establish National Aeronautical Laboratory. (Failed politically.)
1912 April	Connecticut First state to pass legislation regulating civil aviation pilots and aircraft
1914	U.S. aviation developed through efforts of host of amateurs. U.S. far behind Europe at World War I.

1914	France	1400 Planes
	Germany	1000 Planes
	Russia	800 Planes
	England	400 Planes
	U.S.A.	23 Planes

1914-1/1 First regular U.S. domestic air passenger service initiated from St. Petersburg, Florida, to Tampa, Florida.

1915-3/3 NACA National Advisory Commission for Aeronautics created.

1918 World's first regular airmail service New York, Philadelphia, Washington, D.C.

1918-1923 World War I had detrimental effect on U.S. commercial aviation due to war surplus planes selling at extremely low prices.

1918-1928 European transport aircraft maintained pre-war leadership over United States.

1919 First U.S. Municipal Airport dedicated at Atlantic City, New Jersey.

1919-8/25 IATA International Air Traffic Association. Predecessor of International Air Transport Association.

1920-11/15 First Regular U.S. Carrier international commercial air passenger service (Aeromarine West Indies Airways)

1924 First around-the-world flight

1925 Morrow Board appointed by President Coolidge to recommend a U.S. air policy ended in political failure. Morrow Report, however, influenced drafting of Air Commerce Act of 1926.

1926-5/20 Air Commerce Act passed by Congress providing only for safety in the regulation of air commerce.

1927-5/20-21 First non-commercial transatlantic nonstop solo flight, Charles Lindbergh flying a single engine Ryan monoplane.

1928-May Three Man Board created to review aircraft accidents: under jurisdiction of the Aeronautics Branch of the Department of Commerce.

1929-10/12 Warsaw Convention was signed establishing rules and limits of carrier liability in international air transportation with regard to passengers and property: limit, $8300.00 per passenger.

1930	McNary-Watres Act Air mail contracts exchanged for route certificates and basis for compensation changed from poundage to a space mile basis, thus opening the door to subsidizing passenger operation.
1931-7/27	(ALPA) Airline Pilot's Association organized.
1933-March	World's first modern airliner, (Boeing 247) all-metal twin engine, entered commercial service.
1934	Black-McKellar Bill: Federal Aviation Commission created to study air transport industry and recommend broad government relationship policy.
1934	Congress adopted an amendment to the Air Commerce Act authorizing the Secretary of Commerce to investigate and if he deems it in the public interest, make a public statement regarding major and fatal civil aircraft accidents in the United States.
1938-6/23	Civil Aeronautics Act of 1938 (McCarran-Lea Bell) created the Civil Aeronautics Authority, a single independent agency to regulate civil aviation. The authority was composed of 5 members and a 3-man Air Safety Board.
1939-2/25	Civil Aeronautics Authority issued its first certificate of public convenience and necessity to Delta Air Corp. (Delta Airlines).
1940-3/26	No fatal commercial airline accident during the preceding year.
1940-6/30	CAA supplanted by two separate agencies, the Civil Aeronautics Board and the Civil Aeronautics Authority.
1940-8/31	Pennsylvania Central Airlines; worst crash to date in airlines history, Lovettsville, Virginia, DC-3, 25 fatalities.
1944	Aircraft manufacturers permitted to make prototype aircraft for postwar civilian markets.
1946	Federal Airport Act passed. $500 million for airport construction.
1952	Newark Airport temporarily closed as a result of three fatal airline crashes in the Elizabeth, Newark area within a two-month period.
1952	Airport Commission created to study airport congestion problem; James H. Doolittle headed Commission.

1953-2/11	Domestic certificated airlines rounded out a full year of operation without a fatality.
1954-7/15	Prototype of Boeing 707 flown.
1956-6/30	Worst crash to date in U.S. Airline history, TWA L1049A and UAL DC-7 collided over the Grand Canyon.
1958-6/15	Superskyways created under absolute ground control and separation: altitudes between 17,000' and 22,000' on 3 transcontinental corridors.
1958-8/23	Federal Aviation Act replaced the Civil Aeronautics Act of 1938 and the Federal Aviation Agency was created.
1960-12/16	Worst crash to date in U.S. Airline history; TWA L1049A and a UAL DC-8 collided over Staten Island: 134 fatalities.

AIR SAFETY BOARD

REPORT

TO THE CIVIL AERONAUTICS AUTHORITY

AS A RESULT OF AN INVESTIGATION OF AN ACCIDENT INVOLVING AIRCRAFT

Accident involving aircraft NC 13735 of Eastern Air Lines, in the vicinity of Montgomery, Alabama, on October 18, 1938.

Accident involving aircraft of United States Registry, NC 13735, while operating as Flight 2 of October 18, 1938, of Eastern Air Lines, having occurred in the vicinity of Montgomery, Alabama, on the eighteenth day of October, 1938, at approximately 10:44 o'clock P.M. of said date; such accident having been investigated, and the Air Safety Board having considered the evidence adduced therefrom, reports the following facts, conditions, and circumstances relating to the said accident, its findings, and its conclusions as to the probable cause thereof:

FACTS, CONDITIONS, AND CIRCUMSTANCES:

AIR CARRIER:

Eastern Air Lines, a corporation, as authorized by currently effective Air carrier Operating Certificate issued by the Civil Aeronautics Authority, operates as an air carrier via certain named intermediate points between the terminal points of Newark, New Jersey and San Antonio, Texas. Application has been filed consistent with the provisions of the Civil Aeronautics Act of 1938 with the Civil Aeronautics Authority for Certificates of Convenience and Necessity over certain routes, including the route above named.

Eastern Air Lines Flight 2 of October 18, 1938, scheduled to operate between San Antonio, Texas and Newark, New Jersey, with scheduled intermediate stops at Houston, Texas; New Orleans, Louisiana; Mobile, Alabama; Montgomery, Alabama; Atlanta, Georgia; Spartanburg, South Carolina; Charlotte, North Carolina; Greenboro, North Carolina; Richmond, Virginia; Washington, D. C.; Baltimore, Maryland, and Camden, New Jersey; arrived in Montgomery, Alabama at approximately the scheduled time. The aircraft had functioned normally during the entire trip prior to this time.

AIRCRAFT:

Aircraft NC 13735, operated on the flight, was a Douglas Model DC-2, manufactured by the Douglas Aircraft Corporation of Santa Monica, California. This model is approved by the Civil Aeronautics Authority, for air carrier operation over the route flown by Eastern Air Lines with an approved gross weight of 18,560 pounds. It was powered with two Wright Cyclone engines, model GR 1820 F 2B., and Hamilton Constant Speed propellers, hub models 3E-50, and blade models 6111-6. The left engine had a total time of 6929 hours and 45 minutes, and had operated 98 hours and 50 minutes since last overhaul, while the right engine had a total time of 6863 hours and 18 minutes, and had operated 499 hours and 13 minutes since last overhaul. Overhaul period on this type engine, approved in the currently effective Air Carrier Operating Certificate issued to Eastern Air Lines by the Civil Aeronautics Authority, is 600 hours.

AIRMEN:

The crew consisted of Captain J. D. Hissong, First Officer C. R. Russell, and Flight Steward Frank Gibbs. Captain Hissong had accumulated a total of approximately 8,000 hours flying time, of which 2,546 were in Douglas aircraft, while First Officer Russell had accumulated a total of 1400 hours flying time, of which 1092 hours were in Douglas aircraft. Both airmen were possessed of required ratings and Certificates of Competency for the flight and equipment involved.

The trip was cleared from Mobile, Alabama to Atlanta, Georgia via Montgomery and was subsequently dispatched from Montgomery to Atlanta in a manner consistent with company procedure, departing Montgomery at 10:40 P.M.

WEATHER:

Weather conditions at the time of departure from Montgomery were: Clear, ceiling unlimited, visibility 12 miles, temperature 65°, dew point 57°, wind west 2 MPH, barometer 30.09.

At the time of departure from Montgomery the gross weight of the aircraft was approximately 17,156 pounds, including mail, cargo, approximately 230 gallons of gasoline and 30 quarts of oil, and the following passengers:

John H. Sotham, address given as 315-4th Ave. New York City
Joseph V. Connally, address given as 235 East 45th St. New York City
Z. Livenson, address given as 261-5th Ave. New York City
J. H. Bonck, address given as 356 Fairway Drive, New Orleans, La.
D. Drucker, address given as 10 East 40th Street, New York City
Dr. J. T. Nix, address given as 2140 S. Carrolton, New Orleans, La.
R. B. Kahle, address given as 630-th Ave. New York City
E. D. Rivers, Jr., address given as Atlanta, Georgia
George Stuart, address given as Atlanta, Georgia
W. O. Fotte, Jr. address given as Montgomery, Alabama
F. F. Vonnegut, address given as New Orleans, La.

The aircraft started the take- off to the southeast, from the northwest corner of the field, at approximately 10:40 P.M., after the motors had been run up and instruments checked, in accordance with normal procedures; and, in a slow normal climb, crossed the boundary lights on the south edge of the field. Immediately after the gear had been pumped to a completely retracted position a slight vibration was felt, which increased noticeably when the motors were throttled from take-off power at an approximate altitude of 1,000 feet to 28 inches manifold and 1950 RPM. After discovery that the right motor was the source of the vibration, this engine was throttled to about 20 inches manifold pressure, and additional power applied to the left motor. On continuation of vibration from the right engine, it was completely throttled, and the aircraft banked in a right gliding turn toward the Montgomery airport, with landing gear lowered.

The cockpit immediately filled with smoke, and flames appeared around the right engine. Immediate closing of the fuel supply to the right engine, and use of the fire extinguisher in the engine nacelle, served to only momentarily check the flames, and fire continued to burn around this engine and along the right wing. The supporting structure of this engine mount was burned away by the flames, and the engine dropped free from the aircraft.

The aircraft thereupon lurched violently, the right wing went up in a vertical position and was brought back to a normal position through the combined efforts of both pilots. When an altitude of approximately 400 feet was reached the landing gear retracting valve was placed in the "up" position and the aircraft nosed down in a glide, with the left engine throttled. Just before reaching the ground the right wing struck a tree, and was sheared from the aircraft. This impact resulted in the rotation of the aircraft to the left, and it struck the ground after an approximately 180° rotation in a tail-first attitude. The ship skidded over uneven ground and came to rest in an upright position.

All passengers and the flight steward left the aircraft through the door, while Captain Hissong and First Officer Russell escaped through the cockpit hatch. No injuries were suffered by either the passengers or crew, with the exception of minor burns sustained by Captain Hissong. The aircraft was destroyed by the fire.

Fxamination and inspection of the aircraft and engines subsequent to the accident, indicated that three front holddown nuts on the No. 6 cylinder flange of the right engine had been loose prior to failure of studs, and that the holddown studs on this cylinder failed progressively, resulting in the cylinder being forced outward because of pressure exerted by power impulse, thus permitting the bottom oil ring to leave the cylinder when the piston was near bottom center of the stroke. Failure of the oil sump, exhaust manifold and No. 6 connecting rod, occurred in rapid succession. Oil flowing from the cracked oil sumps is believed to have become ignited by the flame emitting from a broken exhaust manifold, and, because of the forward speed of the aircraft, the resultant fire progressed through the engine cowling and the diaphragm separating the power section from the accessory compartment, where, intensified by the burning away of fuel, oil and hydraulic lines, it continued around or through the fire wall, into the wheel well and center section, igniting the fuel tanks, and eventually progressing into the cabin.

FINDINGS

1. Aircraft NC 13735 was certificated as airworthy by the Civil Aeronautics Authority, and had been inspected and maintained in accordance with approved maintenance procedure of Eastern Air Lines.

2. Both airmen held required ratings and Certificates of Competency for the flight and equipment involved.

3. Eastern Air Lines Flight 2 of October 18, 1938, was properly dispatched and subsequently cleared to Mobile, Alabama, Montgomery, Alabama, and Atlanta, Georgia, in accordance with approved company procedure and Air Carrier Operating Certificate issued to Eastern Air Lines by the Civil Aeronautics Authority.

4. Weather conditions at Montgomery, Alabama at the time of take-off were: Clear, ceiling unlimited, visibility 12 miles, temperature 65°, dew point 57°, wind 2 MPH, barometer 30.09.

5. The take-off and climb were normal until shortly after the gear was raised when vibration set in from the right engine, of such intensity as to result in the engine being throttled.

6. Hold down studs on No. 6 cylinder of the right engine failed, resulting in progressive failure of other component parts of the engine.

7. Fire resulted from ignition of escaping oil or gasoline, or both, coming in contact with heated parts of the engine.

8. The fire burned either through or around the engine fire wall, and progressed into the center section and the cockpit, destroying the aircraft after an emergency landing had been effected.

9. The Captain and crew displayed exceptional skill and courage, in meeting the emergency and in bringing the aircraft to a landing in a manner as to prevent loss of life.

PROBABLE CAUSE:

Fire in the right engine nacelle, resulting from progressive failure of engine parts, which increased in area and intensity to such an extent as to make it impossible to continue the aircraft in flight.

RECOMMENDATIONS:

Such recommendations as, in the opinion of the Air Safety Board, will tend to prevent similar accidents in the future, will be transmitted in due course.

***

PROCEEDINGS OF THE AERONAUTICAL BOARD OF THE SIGNAL CORPS WHICH CONVENED AT FORT MYER AT 10:15 a.m., SEPTEMBER 18, 1908, FOR THE PURPOSE OF INVESTIGATING AND REPORTING UPON THE CAUSE OF THE ACCIDENT TO THE WRIGHT AEROPLANE WHICH RESULTED IN THE DEATH OF FIRST LIEUTENANT THOMAS E. SELFRIDGE, FIRST FIELD ARTILLERY.

Present: Major C. McK. Saltzman, Captain Charles S. Wallace and Lieutenant F. P. Lahm.

Absent: Major George O. Squier and Lieutenant Benjamin D. Foulois.

There were also present Lieutenant George C. Sweet, U. S. N., and Lieutenant Richard B. Creecy, U. S. M. C., officers officially detailed for the purpose of observing and reporting upon aeronautical work of the Signal Corps.

With the exception of Lieutenant Foulois, all members of the Board and Lieutenants Sweet and Creecy were present at the time of the accident.

The Board visited the scene of the accident, questioned witnesses very carefully and examined the machine.

Mr. Octave Chanute and Professor Albert F. Zahm were present by courtesy during the entire investigation and were consulted by the Board.

Mr. Wright's condition was such as to prohibit the Board consulting or questioning him relative to the accident.

After due deliberation, from the best evidence obtainable from all available sources, the Board finds --

That the accident which occurred in an unofficial flight made at Fort Myer, Va., at about 5:18 p. m., on September 17, 1908, was due to the accidental breaking of a propeller blade and a consequent unavoidable loss of control which resulted in the machine falling to the ground from a height of about seventy-five (75) feet.

The Board finds that First Lieutenant Thomas E. Selfredge, First Field Artillery, (attached to the Signal Corps by War Department orders and assigned to aeronautical duty,) accompanied Mr. Wright, by authority, on the aeroplane, for the purpose of officially receiving instruction, and received injuries by the falling of the machine which resulted in his death.

(Signed) C. McK. Saltzman
Major, Signal Corps, U. S. A.,
President

(Signed) Charles S. Wallace
Captain, Signal Corps, U. S. A.,
Member

(Signed) Frank P. Lahm
1st Lieut, Signal Corps, U. S. A.,
Recorder

APPROVED:
(Signed) George O. Squier
Major, Signal Corps, U. S. Army,
Acting Chief Signal Officer

(NAAIS Handout #225)

W A R D E P A R T M E N T

OFFICE OF THE CHIEF SIGNAL OFFICER,

WASHINGTON

AERONAUTICAL DIVISION

February 19, 1909

The Chief Signal Office, U. S. Army.

Sir:

I have the honor to submit the following detailed report of the accident to the Wright Aeroplane at Ft. Myer, Virginia, on September 17, 1908.

1st The Aeronautical Board of the Signal Corps, composed of Major C. Mck. Saltzman, S. C., Captain Chas. S. Wallace, S. C., and Lieut. Frank P. Lahm, S. C., assisted by Lieut. Sweet, of the Navy, and Lieut. Creecy, of the Marine Corps, also Mr. Octave Chanute and Professor Albert Zahm, made a thorough examination on the morning of September 18th, the day after the accident, of the aeroplane and the ground, and carefully examined witnesses of the accident. The following is their report:

"That the accident which occurred in an unofficial flight made at Ft. Myer, Va., at about 5:18 p. m., on September 17th, 1908, was due to the accidental breaking of a propeller blade and a consequent unavoidable loss of control which resulted in the machine falling to the ground from a height of about seventy-five (75) feet.

The Board finds that First Lieutenant Thomas E. Selfridge, First Field Artillery (attached to the Signal Corps by War Department orders and assigned to aeronautical duty), accompanied Mr. Wright, by authority, on the aeroplane, for the purpose of officially receiving instruction, and received injuries by the falling of the machine which resulted in his death."

2d The detailed examination of witnesses referred to in the above paragraph is given herewith.

Sergeant Daley, Battery "D", 3d Field Artillery, was on the artillery guard house porch at the time of the accident and testified that he saw the rear rudder collapse and fall to the front and to the right, then after the machine had advanced about 60 feet, the broken propeller blade fell to the ground. Sergeant Daley gave the impression of being a reliable witness.

Private Allen, Troop "F", 13th Cavalry, was the mounted sentinel stationed in front of the lower cemetery gate. He was about 30 yards from where the aeroplane struck the ground. He testified that he heard a loud noise, saw the propeller blade fly, and saw the machine start down, then saw it drop rapidly head first. While the machine was falling, he was occupied trying to get out of the way with his horse. He said the men in the machine tried to talk while falling; that when he went up to the machine after it was on the ground, Mr. Wright's head was hanging down between two wires which cross on his chest. His

right arm was extended under Lieutenant Selfridge as through to hold him up. He exclaimed, "Oh, my arm." He said that the front ends of the skids struck the ground first.

Corporal Forrester, Battery "D", 3d Field Artillery, was the non-commissioned officer of the guard on duty around the field. He was mounted and was just in the rear of the aeroplane shed. He heard the propeller snap, then saw nothing until the machine was on the ground.Corporal Forrester and Private Allen demonstrated to the Board the position in which Lieut. Selfridge and Mr. Wright were found.

Private Mincey, Battery "D", 3d Field Artillery, was stationed as a mounted sentinel in front of the south end of Battery "E"'s gun shed. He testified that he heard a pop, looked up and saw the machine advance a certain distance, then drop straight down.

Mr. Chanute was 15 feet south of the press tent and 560 feet west of the point where the machine struck, that is on the opposite side of the aeroplane shed. Mr. Chanute testified that the machine was perhaps 60 feet up and circling the field to the left. He went 40 or 50 feet to the south so as not to be behind the tents between himself and the aeroplane shed. When the machine was 300 feet from him, the propeller flaked off or snapped, and the piece fluttered down to the ground; the aeroplane maintained its level for 60 or 100 feet, then oscillated and pitched down with the left side depressed and disappeared from his view behind the bushes. He did not see it strike. When he examined the broken propeller blade, Mr. Chanute testified that the wood was brittle and over seasoned, or kiln dried. A few days later Mr. Chanute informed me that he thought the propeller blade had struck the upper guy wire of the rear rudder and had torn the end of the wire from its attachment to the rudder.

Dr. George A. Spratt, of Dayton, Ohio, a friend of Mr. Wright's was at the upper end of the field near the starting point at the time of the accident. His written statement of his observations of the accident is attached hereto marked "A".

Sergeant Sweeney, post ordnance Sergeant at Ft. Myer, was at the battery guard house at the time of the accident. Mr. Charles Taylor, a mechanician employed by Mr. Wright, was also examined. Their testimony was not particularly pertinent.

3d On October 31, 1908, I talked with Mr. Wright at the hospital at Ft. Myer, and learned from him the following facts:

He said he heard a clicking behind him about the time he crossed the aeroplane shed: He decided to land at once but as there was scarcely time to do it before reaching the cemetery wall, he decided to complete the turn and head toward the upper end of the field. He thought he was about 100 feet high at the time the propeller broke and that he descended more or less gradually about 40 feet, then the machine dropped vertically. He shut off the engine almost as soon as the clicking began, then corrected a tendency to turn which the machine seemed to have. All this time the machine was coming down pretty rapidly. He pulled the lever governing the front rudder as hard as possible, but the machine still

tipped down in front, so he pushed the lever forward and pulled it back again hard, thinking it might have caught or stuck. At the time of our conversation, October 31st, he said he thought that the rear rudder had fallen sideways and the upward pressure of the air on it probably threw the rear of the machine up and the front down, and that this accounted for its failure to respond more readily to the front rudder. He stated that at a height of about 60 feet, the front end of the machine turned nearly straight down and then it fell. About 15 feet from the ground it again seemed to respond to the front rudder and the front end came up somewhat, so that it struck the ground at an angle of about 45 degrees.

4th The following is a list of witnesses in addition to those whose testimony is given above:

Mr. Magoon, Superintendent of Arlington Cemetery, was half way between the two gates of the cemetery and just inside the wall.

The following reporters were at the balloon tent:

Mr. Heiss, of the New York World,
Mr. Dugan, of the United Press,
Mr. Smith, of the Baltimore Sun,
Mr. McMahan, of the Washington Herald

The following witnesses were near the new artillery stable, west of the point where the accident occurred:

Mr. Robert F. Crowley, Arlington. Va.,
Mr. H. C. Ball, Clarendon, Va.,
Mr. E. B. Speer, Ballston, Va.,
Mr. R. Tall, Ballston, Va.

5th I examined most of the witnesses whose testimony is given above, immediately after the accident, on the field, I was present when the Aeronautical Board made it's examination on the following day, September 18th, and talked at various times with Mr. Wright, Mr. Chanute, Professor Zahm, and others relative to the accident. At the time of the accident I was holding my horse and watching the machine from the upper end of the field near the starting point. When the machine struck, I galloped at once to the spot.

On September 17th, Mr. Wright was almost ready to begin his official trials so he put on a set of new and longer propellers that day for the purpose of tuning up the speed of his machine preparatory to making his official speed trial. These propellers were probably 9 feet in diameter; the ones in use up to that time were probably 8 feet 8 inches in diameter.

Lt. Selfridge was to leave for Saint Joseph, Missouri, for duty in connection with Dirigible No. 1, on September 19th, and was very anxious to make a flight before leaving, so Mr. Wright, at my suggestion, had said a few days before that he would take him up at the first opportunity. On September 15th and 16th, high winds prevented his making a flight. On September 17th, the instruments at the aeroplane shed recorded a northeast wind of four miles an hour. At 4:46 p. m. the aeroplane was taken from the shed, moved to the upper end of the field and set on the starting track. Mr. Wright and Lieut. Selfridge took their places in the machine, and it started at 5:14, circling the field to the

left as usual. It had been in the air four minutes and 18 seconds, had circled the field 4 ½ times and had just crossed the aeroplane shed at the lower end of the field when I heard a report then saw a section of the propeller blade flutter to the ground. I judge the machine at the time was at a height of about 150 feet. It appeared to glide down for perhaps 75 feet, advancing in the meantime about 200 feet. At this point it seemed to me to stop, turn so as to head up the field toward the hospital, rock like a ship in rough water, then drop straight to the ground the remaining 75 feet. I had measurements taken and located the position where the machine struck, 304 feet from the lower cemetery gate and 462 feet from the northeast corner of the aeroplane shed. The piece of propeller blade was picked up at a point 200 feet west of where the aeroplane struck. It was 2½ feet long, was a part of the right propeller, and from the marks on it had apparently come in contact with the upper guy wire running to the rear rudder. This wire, when examined afterward, had marks of aluminum point on it such as covered the propeller. The left propeller had a large dent, and the broken piece of the right propeller had a smaller dent indicating that the broken piece flew across and struck the other propeller. The upper right half guy wire of the rear rudder was torn out of the metal eye which connected it to the rear rudder. I am of the opinion that due to excessive vibration in the machine, this guy wire and the right hand propeller came in contact. The clicking which Mr. Wright referred to being due to the propeller blade striking the wire lightly several times, then the vibrations increasing, it struck it hard enough to pull it out of its socket and at the same time to break the propeller. The rear rudder then fell to the side and the air striking this from beneath, as the machine started to glide down, gave an upward tendency to the rear of the machine, which increased until the equilibrium was entirely lost. Then the aeroplane pitched forward and fell straight down, the left wings striking before the right. It landed on the front end of the skids, and they as well as the front rudder were crushed. Both Mr. Wright and Lieut. Selfridge were in their seats when the machine struck the ground, held there by wire braces which cross immediately in front of the two seats. It is probable that their feet struck the ground first, and as the machine dropped nearly head first, they were supported by these wire braces across their bodies. When I reached the machine, the mounted sentinels at the lower end of the field were entering at the left hand end between the two main surfaces, which were now standing on their front edges. I found Mr. Wright lying across the wires mentioned above, trying to raise himself, but unable to do so. He was conscious and able to speak, but appeared very badly dazed. He was cut about the head where he had struck the wires, and possibly the ground. Lieut. Selfridge was lying stretched out on the wires, face downward, with his head supported by one of these wires. He died at 8:10 that evening of a fracture of the skull over the eye, which was undoubtedly caused by his head striking one of the wooden supports or possibly one of the wires. He was not conscious at any time. With the assistance of a couple of enlisted men I removed Mr. Wright from the machine and placed him on the ground where he was immediately taken charge of by Army surgeons, among them Major Ireland, who were among the spectators at the time of the accident. Lieut. Selfridge was carried out immediately afterward and similarly cared for. At least two civilian surgeons among the spectators, whose names are not known, assisted in caring for both of them. Within ten minutes they were carried to the post hospital on litters by hospital corps men and were placed on the operating table. Captain Bailey, Medical Corps, U. S. Army, was in charge of the hospital at the time. He was assisted in the operating room by the surgeons mentioned above. In the meantime the mounted sentinels had been placed around the aeroplane to keep back the crowd, a very

difficult matter at that time. Mr. Wright was found to have two or three ribs broken, a cut over the eye, also on the lip, and the left thigh broken between the hip and knee. He was in the hospital at Ft. Myer for six weeks under the care of Major Francis A. Winter, and at the end of that time went to his home at Dayton, Ohio. Lieut. Selfridge was buried with full military honors at Arlington Cemetery, on September 25th.

The wings on the right side of the machine were not badly damaged, those on the left side which struck the ground first were crushed and broken. Apparently the front rudder, skids, and left wings received most of the force of the fall. The rear rudder as shown in the accompanying photographs, exhibits "C", "D", and "E", was thrown down on the rear end of the skids and on the main body of the machine, probably due to the shock on striking the ground. The gasoline tank was damaged sufficiently to allow the gasoline to leak out. The water cooler of the engine was somewhat twisted; the engine itself was not badly damaged, and could probably be very easily put in running order again. I had the aeroplane taken to pieces and removed to the aeroplane shed the evening of the accident. It was afterward shipped to Dayton, Ohio, by Mr. Wright's direction.

Very Respectfully,

(Signed) Frank P. Lahm
1st Lieut. Signal Corps.

Gentlemen:

The machine was completing the last quarter of the turn when the portion of the blade was thrown off. It was apparently the blade toward the center of the circle being described by the course of the machine, that was broken. The machine completed the circle and was headed toward the starting derrick, the engine running and the flight apparently undisturbed. It proceeded about 200 feet and started to descent assuming a negative angle (i.e. the chord of the surfaces became directed toward the earth).

Its elevation was probably 65 feet when the descent began. At about 25 feet above the ground its angle of incidence became positive (i. e. the chord of the surfaces directed skyward). It did not gain sufficient horizontal velocity by the downward and forward pitch for support. It again took a negative angle of incidence and struck the ground. The forward framing struck first the side to the left of the aviators slightly in advance of the side to the right. The angle at which the surfaces struck seemed to be about 40^{o}.

The stability of the machine considered sideways was disturbed and unsteady. The motor was topped during the first pitch forward.

The course of the descent may be shown diagramatically, as it appeared to me, by the following dotted lines. The accompanying straight lines show the angle of incidence at the point in the course at which they are placed. The cross indicates the point of accident to the propeller.

Submitted by,

Geo. A. Spratt

EARLY AIRCRAFT ACCIDENT REPORTS

(Ralph E. Stokes)

23 pages

(NAAIS Handout #187)
1-31-64

DEPARTMENT OF COMMERCE
BUREAU OF AIR COMMERCE
Washington

September 18, 1934

Note to Editors:

Congress, in the closing days of the last session, adopted an amendment to the Air Commerce Act of 1926 authorizing the Secretary of Commerce to investigate, and if he deems it in the public interest, to make public a statement regarding major and fatal civil aircraft accidents in the United States.

The necessary organization and procedure to carry out the terms of the amendment to the Act had just been established in the Bureau of Air Commerce when, on August 31, a major aircraft accident occurred near Oregon, Missouri. Following is the report of this accident which was made today to the Secretary of Commerce by Eugene L. Vidal, Director of the Bureau of Air Commerce. It represents the first report of the probable cause of an aircraft accident to be published by the Department of Commerce, for in the past lack of authority to conduct such investigations with this end in view required these reports to be kept confidential.

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STATEMENT OF PROBABLE CAUSE CONCERNING AN AIRCRAFT ACCIDENT WHICH OCCURRED TO PLANE OF RAPID AIR LINES CORPORATION ON AUGUST 31, 1934, NEAR OREGON, MO

To the Secretary of Commerce:

On August 31, 1934, at about 10:47 p.m., in the neighborhood of Oregon, Mo., an airplane of United States registry, piloted by a licensed airman, while being operated in schedule flight, carrying mail, passengers and express, crashed with the resulting death of all on board and the complete destruction of the airplane. The accident was investigated by two special investigators sent from the Washington office, assisted by two airline inspectors stationed at the Kansas City office of the Bureau of Air Commerce.

This accident was one where the airplane collided in full flight with objects other than aircraft. The point of impact was on the east side of the Holt County A Highway, four and one-half miles east and two and one-half miles north of the town of Oregon, Holt County, Mo. The terrain in and about this vicinity, which lies to the northward of a sharp bend in the Missouri River, is rolling hill country. The spot where the ship struck is a high point in the region with an estimated elevation of 1,000 feet above sea level.

The plane, a Stinson, model SM-6000, bearing Department of Commerce license NC-11118, was operated between Kansas City, Mo. and Omaha, Nebr. by Rapid Air Lines Corporation. The pilot, C. M. Bontrager, held a Scheduled Air Transport rating. All of the passengers carried had paid for their passage and were bound for the same destination, Omaha, Nebr. They were: Mrs. Maud Schiffmacher, of Edwardsville, Kans.; Mr. W. A. Truelson, of Omaha, Nebr.; Mr. Frank Mahan, of Dennison, Iowa, and Mr. Dallas Leitch of Omaha, Nebr.

The plane departed from Kansas City, Mo. on scheduled trip No 6 at 6:46 p.m. The first bad weather was encountered between Kansas City and St. Joseph, Mo., causing the pilot to deviate to the west of his course. However, a scheduled stop was made at St. Joseph, Mo. at 7:10 p.m. without mishap.

(NAAIS Handout #187)

The plane was held on the ground at St. Joseph from 7:10 p.m. until 10:27 p.m., pending more favorable weather reports ahead. At 10:15 p.m., after a study of available reports from Omaha and Tarkio, a point approximately midway between Kansas City and Omaha, Pilot Bontrager decided to take off, check conditions along the route and it too unfavorable, return to St. Joseph. The actual take off from St. Joseph was made at about 10:27 p.m. and the accident occurred approximately fourteen minutes later.

Our investigation indicates that Pilot Bontrager was proceeding at a low altitude, doing visual beacon to beacon contact flying. Shortly after passing No. 6 beacon on the Kansas City-Omaha route, he suddenly encountered a torrential downpour of rain and attempted to make a turn to return to S. Joseph. At this point it can be seen where the plane first struck a group of trees and then collided head-on into a road bank while still making the turn. Fire followed immediately. The ground at this point is considerably higher than at St. Joseph and an examination of the wreckage and the adjacent territory suggests strongly that, due to the combination of darkness and blinding rain, the pilot had no idea of his nearness to the ground. Unquestionably, everyone on board was killed by the force of impact and a watch recovered from the wreckage fixed the time of the accident at 10:41 p.m.

The Board finds that the probable causes of this accident were:

1. Dangerous and unusual weather conditions encountered.
2. That the pilot committed an error of judgment in taking off in the face of dangerous and threatening weather, about which he did not have sufficient information.
3. That the ground control of operations was inadequate to meet the emergency created by this unusual weather.

Respectfully submitted,
Eugene L. Vidal,
Director of Air Commerce

8906

(NAAIS Handout #187)

July 1, 1938

STATEMENT OF PROBABLE CAUSE
(Airline Accident)

To the Secretary of Commerce:

Location & date: Near Cochrane, Wisconsin, September 2, 1934, 9:25 P.M., CST

Pilot: Jerome H. Sparboe, Federal transport pilot's license and seheduled air transport rating. Seriously injured.

Co-Pilot: Martin A. Severson, Federal transport pilot's license. Seriously injured.

Aircraft: Ford, model 5-ATD, Federal license number NC-9655, owned and operated by Hanford Tri-State Airlines, Incorporated, Sioux City, Iowa. Aircraft completely demolished.

Passengers: None.

Flight: Scheduled trip No. 2, Minneapolis, Minnesota, to Chicago, Illinois, via St. Paul, Minnesota, and Milwaukee, Wisconsin. This was a mail and express schedule only, no passengers carried.

Circumstances: Weather reports indicated flyable weather along the western portion of the route while the eastern portion looked doubtful. The weather at Milwaukee, Wisconsin, was definitely unfavorable. The ceiling at Minneapolis and St. Paul was over 1,000 feet with a minimum visibility of eight miles. After a careful study of the weather, Pilot Sparboe departed from Minneapolis with plans for advancing the mail as far as Winona, Minnesota, or possibly La Crosse, Wisconsin. This was a customary airline practice at the time.

According to the pilot, a change in the weather was encountered near Alma, Wisconsin, at which time instrument flying was necessary. The airplane was then flying at an altitude of between 1,800 and 2,000 feet (above sea level). On entering a cloud formation at this point, he started to turn and shortly thereafter straightened the airplane on a westerly heading and thereupon permitted it to gradually lose altitude until his altimeter indicated 1,500 to 1,600 feet. From this altitude, he still could not see the Alma beacon light which was in the vicinity and realizing that he was flying in the neighborhood of terrain which rose to an altitude of 1,350 feet above sea level, started to climb for more altitude. Shortly after this, while flying in a southwesterly direction at normal cruising speed and still climbing slightly, the airplane collided with the ground with the result that it was completely demolished.

The airplane came to rest in an inverted position and headed in a direction of approximately 120° from the original line of flight. The undercarriage, right and center engines were torn free which suggests that the airplane was in a slight right turn at the time of contact. The fact that the airplane did

not strike higher trees in the immediate vicinity indicates conclusively that it was in descending flight as it approached the point of impact.

A calibration of the sensitive altimeter recovered from the wreckage showed that it would not return to a correct zero reading. A tear-down inspection of the instrument disclosed that the sensitive hand was loose on its pivot. These cannot, however, be considered as definite indications that the instrument was inaccurate during the flight as the force of impact could easily accound for both.

In reviewing the facts and circumstances surrounding this flight, it appears that, with the weather information at hand, the practicability of attempting to advance the mail beyond Minneapolis and St. Paul was questionable. When bad weather was encountered, the pilot had reason to believe that it would get worse as the trip progressed and should have, therefore, ascended to a safe altitude before turning to return to an area where he knew that good weather existed and a descent could be accomplished without danger of striking the ground or high obstructions. It is evident from the surrounding terrain that the airplane contacted the ground in descending flight, whereas the pilot states that he had started to climb shortly prior to the accident. It is probable that the pilot had made his decision to climb and had started to put this decision in effect at the time of contacting the ground. The absolute accuracy of the sensitive altimeter is not a factor in this accident because its readings, as indicated by the pilot, showed that the airplane had descended below a safe altitude for flying over uneven terrain at night.

The Board wishes to call attention to the fact that at the time this accident occurred, scheduled air line flying was undergoing a transition from contact to instrument flying. Consequently, this pilot did not have the benefit of the accumulated experience of the last few years, or the later improvements in instrument flying aids, both in the aircraft and on the ground.

Opinion: It is the opinion of the Accident Board that the probable cause of this accident was the continuation of the flight into a bad weather area and the descent to a dangerously low altitude while flying on instruments.

Respectefully submitted,

ACCIDENT BOARD

/s/ Jesse W. Lankford
Jesse W. Lankford, (Chairman)
Chief, Accident Analysis Section.

/s/ John Easton
John Easton,
Chief, Aircraft Section.

/s/ H.W. Anderson
H. W. Anderson
Airline Inspector

APPROVED AND FORWARDED:

/s/ George W. Vest
Chief, Regulation & Enforcement Division

/s/ Denis Mulligan
Director of Air Commerce

APPROVED:
/s/ J.M. Johnson
Assistant Secretary of Commerce

FOR IMMEDIATE USE

DEPARTMENT OF COMMERCE
BUREAU OF AIR COMMERCE
WASHINGTON

REPORT OF THE ACCIDENT BOARD
BUREAU OF AIR COMMERCE

Statement of probable cause concerning an aircraft accident which occurred to plane of Delta Air Lines, Incorporated, on August 14, 1935, in the vicinity of Gilmer, Upshur County, Texas

To the Director of Air Commerce:

On August 14, 1935 at about 11:45 p.m. at a point 9 miles west and 3 miles south of the Town of Gilmer, Upshur County, Texas, an aircraft of United States registry, piloted by a licensed airman, while being flown in scheduled interstate operation carrying passengers, mail and express, crashed while trying to effect an emergency landing with resultant death to both crew and passengers and the complete destruction of the aircraft.

The airplane, a Stinson, model A, had been regularly inspected by the Department of Commerce on June 29, 1935 and bore Department of Commerce license number NC-14599. It was owned by the Delta Air Corportaion and was being operated between Dallas, Texas, and Atlanta, Georgia, by that corporation. The pilot, Andrew Dixon, Jr., held the necessary Department of Commerce transport pilot's license and scheduled air transport rating. He had satisfactorily passed a physical examination for the renewal of his license on July 5, 1935. The other member of the crew, Herbert Bulkeley, held a Department of Commerce limited commercial license. The passengers killed were Paul A. Ivey, Birmingham, Alabama, and J. W. Thompson, Atlanta, Georgia.

The following is a summary of the facts, conditions and circumstances relating to the accident, at the end of which appears a statement of the probable cause of the same, as found by the Board which analyzed the record, and a note of corrective measures taken.

This flight, scheduled as Trip 4, was cleared from Dallas for the Dallas-Shreveport portion of the flight to Atlanta at approximately 11:00 p.m. Weather throughout the flight was favorable with an unlimited ceiling and visibility in excess of 12 miles.

Investigation disclosed that the left outboard engine had been torn from the plane as the result of an unbalanced condition caused by the breaking of a propeller blade. The engine was found at a spot about one mile SW of the wreckage and a portion of the propeller blade was found about 300 yards west of the engine. From the appearance of the wreckage and facts available, it is believed that the pilot, while attempting to complete an emergency landing, lost control of the plane due to the absence of the weight of the left outboard engine and the resulting disturbed airflow over the wing.

Attention from the ground was first attracted to the plane by the irregular noise of the engines. Subsequent events indicate that the pilot was then in difficulty and was at that time maneuvering the plane into position for an emergency landing in a cotton patch nearby. At this time it was flying approximately on course in an easterly direction. It held its course for about one and one-half miles when it was seen to make a left turn, head west and make approach to the cotton patch for the landing. No one witnessed the actual landing. However, the engines were heard up to the moment of the contact with the ground. Fire followed immediately.

An examination of the propeller disclosed that one blade had broken off at a point 13 inches from the center of the hub. The failure was of the fatigue type, originating near the leading edge of the blade. No manufacturing defect has been found in the vicinity of the origin of the failure.

A preliminary investigation indicates that the failure occurred, after approximately 215 hours of service, as a result of a resonance condition due to the natural periods of vibration of the propeller blades, the engine and the engine mount coinciding with the engine speeds and propeller pitch settings used in flight operations with this particular type and model aircraft. This difficulty has not been experienced with this model propeller when used on other types and models of aircraft.

It is the opinion of the Accident Board that the probable cause of this accident was a lack of control of the aircraft while attempting to complete an emergency landing after having had the left outboard engine torn free of the plane due to a propeller blade failure.

Corrective measures taken were:

1. The use of this type of propeller on this type and model aircraft was discontinued immediately after the accident until the resonance condition in this propeller installation is corrected.

2. Extensive resonance investigations were started immediately and are now in progress.

ACCIDENT BOARD

Jesse W. Lankford
Secretary

(NAAIS Handout #187)

December 3, 1941

REPORT OF THE CIVIL AERONAUTICS BOARD

of the

Investigation of an Accident Involving
Aircraft in Scheduled Air Carrier Operation

4423-40

A Douglas DC-2 aircraft, NC 13725, owned by Transcontinental and Western Air, Inc., was extensively damaged in an accident which occurred on December 7, 1940, about 8:50 p.m., approximately seven miles north-northwest of the Greensburg Airport, Greensburg, Pennsylvania. The aircraft was equipped with two Wright Cyclone engines, Model SGR-1820 F3. Captain James J. Polizzi, in command of the flight, held an airline transport certificate with A Class 4M Land rating. He had flown approximately 2513 hours, 118.43 of which had been on Douglas DC-2 equipment as captain and 538.42 of which had been on that equipment as co-pilot. He had been employed by TWA since July 17, 1938. First Officer A. V. Dunlop held a commercial pilot certificate with Class 2S Land and Instrument ratings. He had 1225 hours flying time, 475 hours of which had been as co-pilot with TWA. The only other occupants of the plane were B. C. Anderson, a passenger, and the Hostess, Miss Kay. No injuries were sustained by any of the four occupants.

The flight, designated by the carrier as Flight 35, departed LaGuardia Field, New York, on schedule at 4:15 p.m. with mail, passengers, and express. Its destination was Chicago, Illinois, with scheduled intermediate stops at Philadelhia, and Pittsburg, Pennsylvania. The aircraft was loaded within its placarded imits. The flight, properly dispatched by a certificated flight dispatcher, cruised at 4000 feet contact to Philadelphia, where a landing was made at 5:08 p.m. Departure for Pittsburg from Philadelphia was 5:20 p.m. Shortly after taking off, the bank and turn indicator became inoperative and the captain radioed to the company that, due to instrument weather ahead, he would land at Harrisburg, Pennsylvania, for a replacement of this instrument. Accordingly, he landed there, where another instrument was installed and the fuel tanks were filled to capacity. After a six-minute traffic delay the flight was resumed at 7:32 p.m.

The weather conditions over the Pittsburg-Harrisburg airway at 7:35 p.m. were generally good with Buckstown reporting a 600-foot ceiling and visibility 4 miles, light rain and light fog. The entire route was overcast but with ceilings at the other stations - Pittsburg 4600 feet, Cove Valey 1300 feet, and Harrisburg 3500 feet. Visibility was low at Harrisburg, 2 miles, variable, due to light smoke and light fog.

On the 8:35 p.m. weather sequence, the precipitation at Buckstown had changed to rain showers with the ceiling lifting to 1300 feet and visibility to 4 miles. Pittsburg reported 4600 feet and 7 miles; Cove Valey 2000 feet and 7 miles, and Harrisburg 4500 feet and 1-1/2 miles visibility, variable, due to light smoke and light fog; ground temperatures over the course averaged above 35 degrees so that no icing would be expected in the very lower levels.

At 8:16 p.m. when the airplane was at an altitude of 8000 feet flying above the overcast between Cove Valley and Buckstown, Pennsylvania, a small loss of power and a slight roughness in the left engine was noted. Considerable oil came from that engine and difficulty in synchronizing the two engines was experienced. Six minutes later the captain observed that the left engine ring cowling was beginning to spread. The captain throttled the left engine, allowing propellers to remain in high pitch, and applied more power to the right engine. At 8:36 the vibration of the left engine began to increase in rapid intensity and soon reached such proportions that the instrument panel could not be read. At 8:40 the pilot radioed Pittsburg that he was contact at 4000 feet over New Alexandria and coming in to Pittsburg on one engine. About 8:45 the air speed had decreased from 120 miles per hour to 96 miles per hour due to the left engine cowling having spread open and flared out in the back. At this time sufficient power to maintain flying speed was not available and an emergency landing was necessitated. The captain turned off the left ignition switch and the fuel to the left engine and put the right propeller in low pitch. He immediately radioed Pittsburg that he would attempt a landing on the Greensburg, Pennsylvania Airport. An attempt to use the left engine again was fruitless because it was backfiring and fire was coming from the nacelle. The left engine was therefore shut off again. Captain Polizzi realized that he would not be able to reach the Greensburg Airport because of the drag induced by the expanded engine cowling and the severe vibration set up in the failed wngine with its propeller still windmilling. He contemplated landing upon a highway but abandoned the idea when he observed heavy traffic thereon. Heading west, he released a landing flare and began a sprialling descent. As he approached an open field he pulled the aircraft up sharply to avoid a house, but immediately afterwards the left nacelle struck an electric line pole breaking it off about 2 - 1/3 feet from its top. Captain Polizzi cut the master ignition switch and landed the aircraft in a tail-low attitude, with wheels and flaps up, on the side of a ridge. It skidded along about 100 yards on the bottom of the fuselage until the tail wheel locking mechanism failed, whereupon it made an abrupt ground loop of about 90 degrees to the right, up the slope of the hill.

An inspection of the terrain revealed that contact with the ground had been made on an open ridge-side with a slope of about 12 degrees, in such a direction that the skidding had been parallel to the crest of the ridge and was neither up nor down grade. Examination of the left engine revealed that the No. 3 cylinder had come off during the flight, forcing the cowling off of its stops and causing it to open up and flare back, resulting in vibration and drag sufficient to prevent continuation of flight. The cylinder, its piston, and wrist pin were missing, and all of the cylinder hold-down studs were broken off at the cylinder pad. The crank case was cracked between No. 2 and 3 cylinders. It was not determined whether the failure was initiated in the cylinder hold-down studs or in the adjacent portion of the crankcase. Further investigatim disclosed that there had no malfunctioning of the control system, or of the structure prior to impact, and that there had been ample fuel. The aircraft was not equipped with full-feathering propellers.

The total time on the left engine was 7996.03 hours. The time since last overhaul was 573.16 hours and the total time since last cylinder base stud check was 79.17 hours, both of which were within the prescribed overhaul and inspection periods required by the Civil Aeronautics Administration. Moreover, all phases of the flight were in accordance with the Civil Air Regulations and with the company's procedure.

As a result of similar accidents involving engine failure on multi-engine aircraft, the Civil Air Regulations were amended, effective August 1, 1941, to require that such aircraft when operated as scheduled air carriers be equipped with full-feathering propellers or other means of stopping propeller rotation.

PROBABLE CAUSE:

Structural failure of left engine resulting in a forced landing on unsuitable terrain.

APPROVED:

/s/ Edward Warner

/s/ Harllee Branch
Harllee Branch

/s/ Oswald Ryan
Oswald Ryan

/s/ Josh Lee
Josh Lee

Chairman Pogue did not take part in the decision.

File No. 466-41

REPORT OF THE CIVIL AERONAUTICS BOARD
of the
Investigation of an Accident Involving Aircraft in
Scheduled Air Carrier Operation

A Stinson aircraft (Model SR-10C) was extensively damaged in an accident which occurred at the Bellefonte Airport, Bellefonte, Pennsylvania, about 4:25 p.m. on February 7, 1941. It was owned by All American Aviation, Inc., and was certificated as NC 18499. The pilot, T. Foster Thomas, 2nd, held an airline transport certificate with 1 Land, 2S Land, and Instructor ratings and had logged approximately 3,060 flying hours. He was uninjured, as was the only other occupant of the plane, George Markley, flight mechanic.

The flight departed Williamsport, Pennsylvania for Pittsburg, Pennsylvania, at 3:42 p.m. and made scheduled mail pick-ups at Jersey Shore, Pennsylvania, Lock Haven, Pennsylvania, and Bellefonte, Pennsylvania. During this part of the trip precipitation was general with rain changing to snow and ceilings and visibility slightly above the minimums prescribed by the Civil Air Regulations. After leaving Bellefonte, the pilot encountered weather which was below those minimums. Thomas subsequently stated that, after studying various alternatives and making a radio contact the the Bellefonte operator, he decided to return to Bellefonte and land. He also stated that he made what he considered a normal landing at Bellefonte without using the brakes, but that after the aircraft had rolled about 100 feet it nosed over in the snow.

It was subsequently ascertained that there had been no failure of the control system or of the structure, and no malfunctioning of the engine or brakes. The airport was covered by three or four inches of snow which was not drifted but which was crusted to a depth of about one-half an inch.

PROBABLE CAUSE: Rapid deceleration of aircraft due to crusted snow.

AIR SAFETY BOARD
REPORT

TO THE CIVIL AERONAUTICS AUTHORITY

AS A RESULT OF AN INVESTIGATION OF AN ACCIDENT INVOLVING AIRCRAFT

Accident involving aircraft NC 13727 of Braniff Airways, Inc., near Oklahoma City, Oklahoma, March 26, 1939.

An accident involving aircraft of United States registry, NC 13727, while operating as Trip One of Braniff Airways, Incorporated, of March 25, 1939, having occurred in the vicinity of Oklahoma City, Oklahoma, on the 26th day of March, 1939, with the resultant destruction of the aircraft, fatal injuries to eight persons aboard, and serious injuries to the remaining four occupants, the Air Safety Board of the Civil Aeronautics Authority on the same day, directed that full and complete investigation of the accident, pursuant to the provisions of Section 702(a) (2) of the Civil Aeronautics Act of 1938 (52 Stat. 973, 1013), be immediately begun, and that the facts, conditions and circumstances relating to the accident and the probable cause thereof be determined. It was further ordered that the investigation include such field investigation and research and such public or private hearing or hearings as might be considered necessary.

For the purpose of carrying out the above order, the Air Safety Board designated R. D. Hoyt, Chief of the Investigation Division of the Air Safety Board, as Investigator in charge, and Robert W. Chrisp, Senior Attorney Examiner, Examiners Section of the Air Safety Board, as legal advisor to the investigator in charge during the field investigation and as Examiner empowered to order and conduct such public or private hearing or hearings in connection with the investigation as the Board might direct. It was further ordered that Mr. Hoyt and Mr. Chrisp be assisted and advised by W. S. McDuffee, Executive Officer of the Air Safety Board, Phil C. Salzman and George W. Haskins, Power Plant Engineers, Air Safety Board.

The investigation, research and hearings were carried out under the direct supervision of Thomas O. Hardin, Vice Chairman of the Air Safety Board.

Investigation of the accident was begun on the 26th day of March, 1939, by the above-named personnel and the public hearing in connection therewith was temporarily delayed pending improvement in the physical condition of survivors of the accident.

A public hearing was ordered and held in the City of Dallas, State of Texas, on the 8th and 9th days of June, 1939, and was subsequently reopened by the Hearing Examiner in the City of Washington, District of Columbia, on the 27th day of June, 1939.

That the Civil Aeronautics Authority require all multi-engine aircraft operated by all air carriers in the transportation of passengers in interstate, overseas and/or foreign air commerce, to be equipped with full feathering propellers or other propeller control mechanism which permit the pilot to completely stop the rotation of any propeller in such an attitude as to afford a minimum of resistance. It is further recommended that the Civil Aeronautics Authority require the installation of such propeller control mechanisms on all aircraft above described on the earliest date or dates possible under existent circumstances. (It is, of course, recognized that the installation of full feathering peopellers has already been completed on a number of air carrier aircraft by several air carriers, and that this recommendation as a practical matter will affect only such air carrier aircraft as have not already been so equipped).

(Note: In order to expedite this safeguarding of life and property in air transportation, it is suggested that the Authority in fixing and determining fair and reasonable rates of compensation for the transportation of mail by aircraft, give due consideration to the expense that would be incurred by air carriers in complying with this requirement.

It is of interest to note in connection with this recommendation, that it has long been the established policy of the Federal Government to recognize and accept responsibility for financial burdens imposed upon air carriers in the enforced or recommended adoption of known technical improvements materially increasing the efficiency and safety of commercial aviation--even long prior to the enactment of Section 406 (b) of the Civil Aeronautics Act of 1938 which requires the Civil Aeronautics Authority to consider, as an element in the establishment of fair and reasonable rates for the transportation of mail by aircraft, the amount which, "**together with all other revenue of the air carrier, " would" ** enable such air carrier under honest, economical, and efficient management, to maintain and continue the development of air transportation to the extent and of the character and quality required for the commerce of the United States, the Postal Service, and the national defense." An illustration of this policy was the continued payment by the Post Office Department over a period of approximately four years (1930-1934) of 6 cents per mile compensation to air carriers, in addition to the basic contract rate for the transportation of mail, provided the carriers employed aircraft equipped with two-way radio. That such action by the Federal Government is directly responsible for the adoption and use of costly communication equipment in air carrier aircraft, and that it has been reflected in the amazing advancement of American air transportation's efficiency and safety is beyond question. Because similar results inevitably would attend the installation of full-feathering propellers or similar propeller control mechanisms, the immediate adoption of the above recommendation in this regard cannot be urged too strongly.)

(NAAIS Handout #187)

Having considered the evidence adduced during the investigation, the following facts, conditions, and circumstances relating to the accident and conclusion as to the probable cause thereof are hereby reported, and recommendations, which, in the opinion of the Air Safety Board, will tend to prevent similar accidents in the future, are hereby made to the Civil Aeronautics Authority:

FACTS, CONDITIONS, AND CIRCUMSTANCES

Braniff Airways, Incorporated, a corporation organized and existing under and by virtue of the laws of the State of Oklahoma, having duly filed applications for certificates of convenience and necessity over certain routes in accordance with the pertinent provisions of the Civil Aeronautics Act of 1938 and regulations issued thereunder, was operating at the time of the accident as an air carrier engaged in interstate air transportation. Subsequent to that date, a certificate of public convenience and necessity was issued by the Civil Aeronautics Authority to Braniff Airways, Incorporated, authorizing it, subject to the provisions of such certificate, to engage in air transportation with respect to persons, property and mail via certain named intermediate points between the terminals of Chicago, Illinois, and Dallas, Texas.

Aircraft NC 13727, operated on the flight, was a Douglas Model DC-2, manufactured by the Douglas Aircraft Corporation of Santa Monica, California. This model is approved by the Civil Aeronautics Authority for air carrier operation over the route flown by Braniff Airways, Inc., with an approved gross weight of 18,200 pounds. It was powered with two Wright Cyclone Engines, Model GR 1820 F 2A, and Hamilton Standard Controllable Pitch (two-position) Propellers, hub Models 3E-50, and blade models 6111-6. According to the testimony of Stanley Shatto, Supervisor of Maintenance, Braniff Airways, the left engine had a total time of 5,142 hours and 11 minutes, and had operated 397 hours and 8 minutes since last overhaul. Overhaul period on this type engine, approved in the Maintenance Competency Letter issued to Braniff Airways, Inc., under date of July 11, 1938 by the Bureau of Air Commerce and subsequently adopted by the Civil Aeronautics Authority, is 525 hours.

The crew consisted of Captain Claude H. Seaton, First Officer Malcolm Wallace, and Flight Hostess, Louise Zarr. Captain Seaton had accumulated a total of approximately 9,060 hours flying time of which about 4,500 hours were flown at night, and approximately 1,253 hours in Douglas DC-2 aircraft. First Officer Malcolm Wallace had accumulated a total of 2,244 hours flying time, of which 526 hours were in DC-2 aircraft. Both airmen were possessed of required ratings and Certificates of Competency for the flight and equipment involved. Miss Louise Zarr, 25, of Waco, Texas, was employed by Braniff Airways in March, 1937, and had served as Flight Hostess for approximately two years.

Braniff Airways Trip One of March 25, 1939, scheduled to operate between Chicago, Illinois, and Dallas, Texas, with scheduled intermediate stops at Kansas City, Missouri, Wichita, Kansas, and Oklahoma City, Oklahoma, departed from Chicago, at 9:20 p.m. (CST), after

a twenty-minute delay due to connections. The trip proceeded normally from Chicago to Oklahoma City, making regular scheduled stops at Kansas City, Missouri, and Wichita, Kansas. A short time before the trip arrived at Oklahoma City, Captain Seaton was asked by the Dallas Dispatcher "whether the aircraft was OK to proceed to Brownsville, Texas." In reply to this message the pilot reported, "Ship OK". The maintenance and overhaul shops of Braniff Airways are located at Dallas, Texas, and it is customary to request a report on the condition of all aircraft prior to arrival at that point in order that they may be cleared for further use if desired.

The trip arrived at Oklahoma City at 2:37 a.m., having made up 8 minutes of the 20 minutes lost at Chicago, and departed at 2:42 a.m., after being properly cleared by the Dallas Dispatcher.

* * * * * * * * * *

PROBABLE CAUSE

A stall, induced by a violent yaw, resulting in loss of control from which the pilot was unable to recover.

CONTRIBUTING FACTORS

1. Failure of hold down studs on the No. 6 cylinder of the left engine which resulted in the cylinder being forced off, carrying with it the lower third of the engine ring cowling.

2. Displacement of the remaining portion of the left engine ring cowling, which caused buffeting, as a result of disturbances of the air flow over the tail surfaces, and increased the drag on that side of the aircraft.

3. Severe vibration induced by the continued rotation of the propeller.

4. Lack of individual propeller pitch controls which would have permitted the pilot to increase the pitch of the propeller on the inoperative engine, thereby reducing the speed of rotation and consequently the vibration from the effect of "windmilling".

RECOMMENDATIONS

1. In view of the fact that a known and approved means of eliminating the hazards incident to the continued "wind-milling" and resistance of a propeller on an inoperative engine already exists, and that such mechanisms are presently available for the majority of the types of multi-engine aircraft currently used by air carriers and can be made available for all such types within the reasonably near future, it is believed that the five experiences enumerated in this report--all of which have occurred within the last fourteen months and four of which have occurred since the creation of the Civil Aeronautics Authority and the Air Safety Board--sufficiently indicate the pressing need for immediate adoption by the Civil Aeronautics Authority of the following recommendation:

2. It is recommended that, prior to the installation of propellers of the type hereinabove described, the Civil Aeronautics Authority require the installation of a separate manual control for each propeller in all air carrier aircraft equipped with controllable pitch propellers.

3. A recommendation was made to the Civil Aeronautics Authority by the Air Safety Board under date of October 31, 1938 that the Civil Aeronautics Authority require a substantial reduction in engine power output of air carrier aircraft in all cases where there was reason to believe that safe power limits were being exceeded for take-off, climb or cruising. It is understood that the majority of the air carriers voluntarily made reductions in engine power output during the 1938-1939 winter operations but that no official action was taken in this regard by the Civil Aeronautics Authority. Since, from the point of view of safety, an excessive number of mechanical and structural power plant failures have occurred both before and after October 31, 1938 -- some of them resulting in loss of life and destruction of aircraft -- the desirability of reducing currently approved ratings for power plants used in air carrier aircraft, particularly during take-off and initial climb, is clearly indicated, and it is hereby recommended that the Civil Aeronautics Authority determine the extent of and require such reduction.

4. It is recommended that a study be made by the Civil Aeronautics Authority of methods now used to secure the engine ring cowling on the Douglas DC-2 and other aircraft, with a view to determining the possibility of fastening the cowling in such a manner as to prevent the displacement of remaining portions in the event that any one section or sections is damaged or carried away.

5. It is recommended that the Civil Aeronautics Authority require that all aircraft of United States registry be equipped with safety belts having uniform approved type quick-release devices, which device, when a safety belt is in use, shall be in such position and of such type that it can be quickly and easily released with either hand. It is further recommended that this requirement be made effective on the earliest practicable date.

ALLEN and HARDIN, members of the Board, concur in the above report and recommendations. SMITH, member of the Board, concurs in the report and recommendations with the exceptions below noted:

Exceptions of SMITH, member:-

While I concur in the substance of the findings and conclusion as to probable cause contained in this report, I am not in agreement with certain portions of the recommendations as submitted in the Majority Report of the Air Safety Board.

Recommendation 1 and 2: I concur in those two recommendations, with exceptions below noted, and am of the opinion that the Authority as well as the Industry should give special attention to this particular development which is among the many projects now being studied by both parties.

I concur heartily in the apparent feeling of the other Board Members that every reasonable step should be taken to insure more safety in air transportation but I am unable to concur in the action of the majority of the Board in making certain recommendations with reference to the fixing and determining of fair and reasonable rates of compensation of the transportation of mail by aircraft.

(NAAIS Handout # 187)

The Civil Aeronautics Act of 1938 clearly vests exclusively in the Authority the function of determining air mail rates, and it is further my opinion that the Air Safety Board's function is limited to the recommending of preventive measures and that it would not only be unfair, but that it might even prejudice the case to handicap the Authority in determining the method it shall adopt in bringing about any suggested safety measures, for the Air Safety Board to make non-pertinent and also limited recommendations obviously beyond the scope of Title VII of the Act.

Recommendation 3: I concur in the substance of this recommendation and wish to emphasize the importance of a practical solution thereof.

Recommendations 4 and 5: I concur in these recommendations.

BY DIRECTION OF THE BOARD

_____

Executive Officer

(NAAIS Handout # 187)

APPENDIX "B"

UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON

May 15, 1939

NATIONAL BUREAU OF STANDARDS

Report

on

Examination of

Crankcase and Broken Hold-Down Studs

Submitted by

Air Safety Board

Civil Aeronautics Authority

Washington, D. C.

I. Introduction

At the request of the Air Safety Board, April 8, 1939, examinations were made of crankcase and two cylinder flanges from the left engine of an airplane of the Braniff Airways which had crashed at Oklahoma City on March 26, 1939.

In the request from the Air Safety Board, the following were mentioned as specific items for study:

a. Determine the cylinder hold-down stud, of No. 6 cylinder which was the first to fail.

b. Determine the progression of successive stud failures, previous to the separation of the cylinder from the engine.

c. Does inspection indicate that looseness of one or more of the cylinder hold-down nuts is responsible for failure?

d. Was the No. 8 stud or nut loose previous to failure?

e. Where did failure originate?

f. Was any stud or nut loose previous to failure?

g. Any statement of comparison condition of unfailed studs.

h. Photograph of fractures on studs.

i. Examine for cracks in studs on other cylinders.

j. Report on reasons for flange hole distortion in No. 6 cylinder (Mr. Newton to furnish dimensions and other observations made at Dallas).

k. Examine, microscopically, nut seats on cylinder flanges for lapping and give interpretation of possible causes.

l. Caliper several remaining studs for possible permenent set in undercut section and to establish variation in tolerance in dimension of this section.

Details concerning the circumstances at the scene of the crash; the construction of the engine; and the operation and maintenance of the engine were furnished verbally by representatives of the airline, the engine manufacturer, the Civil Aeronautics Authority and the Air Safety Board, while the examinations were underway at the National Bureau of Standards. Photographs showing the condition of the engine before it was dismantled were also furnished.

According to statements made by these representatives, it had been established that the crash resulted from a failure, in the air, of the left engine; and further, that the complete separation of No. 6 cylinder from the crank case had caused the failure of the engine.

II. Examination of Crankcase and Broken Studs

Only the crankcase and the cylinder flanges from No. 6 and No. 5 cylinders were submitted to the National Bureau of Standards. The appearance of the No. 6 cylinder-flange seat on the crankcase is shown, in the condition as receive, in the photograph, Figure 1, accompanying this report. It was evident that fracture of the 12 hold-down studs had permitted the cylinder to be separated bodily from the crankcase. It was further evident, from the appearance of the fractured surfaces that on each stud a considerable portion of the section had been severed by a fatigue fracture. The characteristic r- markings of fatigue fractures are plainly evident on photographs of the fractured surfaces of the studs at 6 diameters magnification, placed in appropriate positions on the photograph of the flange seat, Figure 1. The location of the origin of the fatigue fracture on each stud, according to the best estimate that could be made from the appearance of the markings, is indicated by arrows on the photographs. It is noteworthy that according to these estimates the fractures on each stud, except No. 10, originated at or near that portion of the circumference of the stud closest to the cylinder sleeve.

III. Details of Broken Studs

It was desired, in order to make more detailed examinations of the fractured studs, to remove them from the crankcase, without damage to the fractured surfaces. This was readily accomplished by sawing into the crankcase to, but not into, the studs. The following data were obtained by visual examination of the portions of the studs thus removed. The studs are designated by number, 1 to 12, in a clockwise direction, starting at the forward side of the crankcase, as shown in Figure 1.

Stud No.	Remarks
1	Fatigue fracture had progressed about halfway across the section. Ten full threads remained in crankcase.

Stud No.	Remarks (Cont)
2	Fatigue fracture had progressed more than half-way across the section. Eleven full threads remained in crankcase. There was a crack in the thread groove between the first and second threads below the fractured surface.
3.	Fatigue fracture less than half way across section. Ten full threads remained in crankcase. There was a crack about halfway around the circumference, in the thread groove between the first and second threads below the fractured surface.
4	Fatigue fracture less than halfway across the section. Ten full threads remained in crankcase. No additional cracks.
5	Fatigue fracture about halfway across section. Ten threads in crankcase. No additional cracks.
6.	Fatigue fracture more than halfway across section. Fracture had occurred in nut, between first and second thread beyond reduced section. No additional cracks.
7	Fatigue fracture well over halfway across section. Fracture had occurred in nut, between first and second thread beyond reduced section. No additional cracks.
8	Fatigue fracture over halfway across section. Ten threads remained in crankcase. No additional cracks.
9	Fatigue fracture well over halfway across section. Fracture had occurred in nut, between second and third thread beyond reduced section. No additional cracks.
10	Fatigue fracture had progressed practically entirely across the section. Nine threads remained in crankcase. No additional cracks.
11	Fatigue fracture had progressed over about 90 percent of section. Ten threads remained in crankcase. No additional cracks.
12	Fatigue fracture had progressed over about 90 percent of section. Ten threads remained in crankcase. No additional cracks.

IV. Summary of Data on Broken Studs:

(a) 1 stud fractured between the 9th and 10th threads from bottom of stud.

1 stud fractured between 11th and 12th thread from bottom.

7 studs fractures between 10th and 11th threads from bottom.

3 studs fractured in the nut.

(b) Fatigue fractured had severed:

practically all of the section on stud No. 10;

(b) (Cont.)

nearly all of the section on Nos. 11 and 12;

well over half the section on Nos. 2, 6, 7, 8, and 9;

about half the section on Nos. 1 and 5;

less than half of the section on Nos. 3 and 4.

(c) All of the fractures in the studs had originated in the bottoms of thread grooves at or close to the threads that emerged from either the crankcase or the stud nut. The fracture in each stud therefore occurred in the region of maximum stress, in the stud as a whole, with the added effect of stress concentration due to the thread groove. As fatigue fractures are stress fractures, there were no unusual features in the manner of failure of the studs.

V. Possible Sequence of Failure in Studs

Some importance was attached to the sequence of failure of the studs if this could be determined. As the cylinder flange was intact, except for certain distortions, it was obvious that all 12 studs were broken before the cylinder left the crankcase. It is unlikely, although possible, that fatigue fractures were progressing in all 12 studs simultaneously.

Ordinarily it would be considered that the studs on which the fatigue fractures had progressed farthest across the section were the ones to rail first, and those with the least areas of fatigue fracture were the ones to fail at the end when sudden rupture took place because the unsevered portions of the studs were inadequate to carry the normal load. According to this reasoning, studs Nos. 10, 11 and 12 were the first, or among the first to tail; Nos. 3, 4, 1 and 5 the last, or among the last to fail; while Nos. 2, 6, 7, 8, and 9 were intermediate. According to this sequence, the cylinder would have been loose on the side containing studs 7, 8, 9, 10, 11, and 12 while it was still held to the crankcase on the side with studs 1, 2, 3, 4, 5, and 6. This sequence of failure is a conjecture not subject to positive verification.

VI. Examinations of Unbroken Studs and Microstructure and Hardness of Stud Material

The studs from the remaining 8 cylinders, except for 2 or 3 which had already been removed from No. 2 cylinder seat, were unscrewed from the crankcase with a 10-inch Stillson wrench applied to the projecting portions of the studs, carrying the S. A. E. Threads. These studs were carefully examined, after cleaning free of grease, with a binocular microscope, at moderate magnification, with particular attention to noting whether or not there were any cracks in roots of the threads. No cracks were found. The studs were then etched lightly and again examined, by two observers, with the same result; no cracks were found in any stud.

The most unusual feature about the failure therefore was the fact that all 12 studs on No. 6 cylinder were fractured, while the 96 studs on the remaining 8 cylinders were intact. These circumstances indicate that either the studs on No. 6 cylinder were different from the other studs; that the nuts on the studs of No. 6 cylinder were not drawn up equally with those on the other cylinders; or that

VI. (Cont)

the operating conditions in No. 6 cylinder were different from those in the other 8 cylinders.

The first of these possibilities was investigated. A specimen for metallographic examination and hardness tests was cut from the lower end of each of the failed studs, leaving the fractured surface intact. The representative microstructure on one of these studs is shown in Figure 2. This structure is typical of a quenched and tempered alloy steel. The appearance of the nonmetallic inclusions on the polished but not etched surface of this specimen is shown in Figure 3. The microstructure and appearance with respect to the non-metallic inclusions on the specimens from the remaining 11 broken studs could not be distinguished from those shown in Figures 2 and 3. The same was true for 2 specimens from unbroken studs from cylinders Nos. 5 and 8.

As the specimens were not suitably shaped for determinations of Rockwell numbers, hardness tests were made with a Vickers Hardness Tester, using a 30 Kg load. The Vickers numbers ranged from 326 to 341, with an average of 333. Rockwell C scale numbers equivalent to the Vickers numbers ranged from 33 to 35 with an average of 34. On the two unbroken studs from cylinders 5 and 8 the Vickers numbers were 328 and 330, equivalent to Rockwell C scale numbers 33 and 34. Rockwell tests were made directly on one stud, chosen at random, from each of the 8 groups of unbroken studs. These numbers ranged from 30 to 36, with an average of 32. As there was a chance for error in making the Rockwell tests on the studs, the slightly lower average obtained by the Rockwell tests is not considered to be significant. It was concluded, on the basis of the examinations made, that the broken studs were not different, metallurgically or physically, from the unbroken studs.

Positive evidence indicating that the nuts on cylinder No. 6 had or had not been drawn up the same as those on the other cylinders was not available from examinations of the parts concerned after the failure. There was a definite impression of the cylinder flange on the crank case pad, Figure 1. This impression was more deeply marked in the regions of studs Nos. 7, 8, and 9, and 1, 2, and 3, than in the regions of studs 10, 11, and 12, and 4, 5, and 6. This condition might be considered to indicate that one or more of the nuts on the studs 7, 8, 9, --1, 2, 3 had been less tight than those on the other axis, 10, 11, 12 --4, 5, 6; permitting a rocking of the cylinder that resulted in the deeper markings on the crankcase pad. This condition would also have made the stresses higher in one or more of the studs 10, 11, 12 --4, 5, 6 than in the loose studs, a condition which could be reconciled with the conjecture that studs 10, 11, and 12 might have been among the first to fail. Although it is possible that the impression of the cylinder flange on the crankcase pad was caused, in part at least, by looseness between flange and seat because some of the nuts had been insufficiently tightened, it is equally possible that the battered condition occurred only after some of the studs had been fractured, permitting the flange to batter on the seat.

Likewise, the appearance of the seating of the stud nuts on the top of the cylinder flange did not permit any definite conclusions to be made that any of the nuts had been less tight than others, before the failures occurred.

The distortions observed in the No. 6 cylinder flange were caused, most likely, by the battering of the piston against the cylinder skirt after the cylinder had

VI. (Cont)

been pushed out from the crankcase.

No indications of any different operating conditions in cylinder No. 6 was obtained in the examinations of the parts submitted.

There was therefore no evidence to prove, or even to indicate, that either the nuts on the hold-down studs on the cylinder No. 6 had not been tightened like those on the other cylinder, or that the operating conditions in cylinder No. 6 were different from those in the other cylinders of this engine.

VIII. Summary and Conclusions

1. Failure of the 12 hold-down studs on No. 6 cylinder had permitted the cylinder to be pushed out of the crankcase while the engine was in operation.

2. Failure of the studs resulted from fatigue fractures which, on each stud, had severed a considerable portion of the section before sudden complete rupture took place.

3. In each stud, the fatigue fracture started in the root of a thread groove. In 9 of the studs the thread groove in which the fatigue fracture originated was the first or second groove in the stud, below the surface of the flange seat on the crankcase. In three of the studs, No. 6, 7, and 9, the fatigue fracture started in the nut in the first or second thread groove beyond the reduced section on the stud. In each stud the crack had originated therefore at a point of localized maximum stress.

4. No cracks were found in any of the studs of the other 8 cylinders removed from the crankcase. Metallurgical examination and hardness tests indicated that the material of the broken studs could not be distinguished from that of the intact studs.

5. No positive evidence was obtained that any of the nuts on the broken studs had been tightened differently from those on the unbroken studs, nor that the operating conditions in No. 6 cylinder were different, before the failure, from those in the other cylinder. It is, however, a reasonable assumption that one or both of those conditions existed, in view of the fact that all 12 studs on one of the 9 cylinders failed, whereas no cracks or failures occurred in 96 identical studs in the other 8 cylinders in the same engine.

6. Thread grooves in bolts or studs subjected to repeated or vibratory stresses are known to cause localized stress concentrations resulting in a lowering of the endurance of the bolt from that indicated by fatigue tests on smoothly machined and polished specimens of the bolt material.

7. There are a number of ways in which the damaging effect of thread grooves can be lessened:

(a) By grinding the thread grooves as smooth as possible the damaging effect due to stress concentration is much less than in machine cut threads. The threads on the studs, both broken and unbroken, appeared to be as smooth as could be obtained by any commercially practicable operation of grinding.

VIII. (Cont)

(b) Rolled threads are known to be less damaging than ground or cut threads. It is not believed that rolled threads would be practical on the type of steel used in these studs.

(c) Reducing the unthreaded shank of a bolt or stud to a diameter less than the root diameter of the threads is known to change the stress distribution so as to overcome, to a certain extent at least, the stress concentration effect of the thread grooves. It is known that the maximum stress in the threaded portion of a bolt or stud occurs just inside the point of emergence of the thread from the nut, or member into which the stud is driven. The reduced section on the studs submitted did not extend into the crankcase nor into the nut. A more efficient design would have been obtained by lengthening the reduced section on those studs.

(d) The stress concentrating effect of thread grooves of conventional design, U. S. Standard, S. A. E., or other similar designs, can be lessened possibly by threads of drastically different design. At least one such design has recently been recommended for cylinder hold-down studs.

8. Improvements that might be obtained in the endurance strength (resistance to failure under repeated stresses) of hold-down studs or similar threaded parts, by changes in finish or design of the threads, can be evaluated quantitatively by laboratory tests on the actual threaded parts.

E. C. Crittenden, Acting Director.

Lyman J. Briggs, Director

FAA'S PHILOSOPHY ON AIRCRAFT ACCIDENT INVESTIGATION

PRESENTED BY

ANSELM M. TIBBS
ACCIDENT INVESTIGATION STAFF
FLIGHT STANDARDS SERVICE

APRIL 29, 1964

NATIONAL AIRCRAFT ACCIDENT INVESTIGATION SCHOOL

The Congress of the United States has placed joint statutory responsibilities upon the Civil Aeronautics Board and the Federal Aviation Agency as related to the improvement of safety of flight of air transportation in civil air commerce. This joint responsibility is most evident in the area of aircraft accident investigation.

Because of a lack of full understanding and misinterpretation of the responsibilities of each of our Agencies in this area, aircraft accident investigation has been subjected to a rocky road of public relations, a great deal of which has been aimed at attempts to cause friction between the two Agencies. In the past, unfortunately, this friction has become very real and has been openly discussed on occasions before special committees of Congress. Some of this friction was apparently internally created and, on some occasions, undoubtedly involved people of both Agencies who created such friction with a degree of deliberateness. The press also has contributed its share in unjustifiably "stirring up the pot" with the result of creating doubts and lack of confidence on the part of the public not only in our two Agencies but in some cases this lack of confidence has had adverse affect on the entire aviation industry.

Public relations has been a particularly critical area. The Agency's role in this area must be clearly enunciated: In the wake of a major aircraft accident it is not always possible or desirable for both Agencies to adopt identical approaches to the public relations problem. In each circumstance the two Agencies must jointly and individually examine the manner and propriety of their response to legitimate press inquiries insofar as what can be released and how it should be released, particularly in the early and continuing stages of an investigation. It is, of course, understood that at no time should an approach be taken which would prejudice the Board's investigative proceedings.

When a major accident occurs, the FAA is very seldom permitted the luxury of remaining silent. During the course of an investigation apparent deficiencies may require immediate corrective actions, and the Agency must continually keep industry informed of its activities and its evaluation of the air transportation system in

order to secure its full cooperation in carrying out and developing corrective measures. We also have a responsibility to the public. Public confidence should not be permitted to decline for lack of information. The public must oftentimes be reassured in regard to the adequacy of the air transportation system. We must, however, recognize the position and authority of the Board in this process and, through consultation and coordination with its officials, reflect the appropriate area of our concern in language related to our own authority and interests without jeopardizing the role and responsibility of the Board.

The responsibility of promoting a safe civil air transportation system in this country, and the effect and impact which it has on the American public and the economy of our country, is far too great a responsibility to permit any of us to allow petty misunderstandings or grievances to adversely influence us in the performance of these responsibilities.

The Federal Aviation Act of 1958 makes it abundantly clear that the CAB has the primary duty to investigate aircraft accidents and has the sole responsibility for determining probable cause. The Act is equally clear in setting forth the FAA's broad responsibilities in promoting safety in aviation, and is quite specific about the FAA's role in aircraft accident investigation. These dual areas of interest and responsibility in the Act might impede the attainment of the major objective of promoting a safe aviation transportation system if each Agency views them as independent mandates and overlooks their complementary character, in at least certain aspects.

While the Board must maintain complete freedom to allocate blame wherever it may be deserved, including the FAA, the FAA must be recognized as a coordinating arm of the Government mandated by the Congress to actively participate in accident investigations.

Fully recognizing and respecting the Board's authority and responsibility in the field of aircraft accident investigation, let us examine the Agency's role and responsibilities in this area.

Under the provisions of the Act, the Agency has rather broad responsibilities toward promoting safety of flight; for example: Section 601(a) of the Act establishes that the Administrator is empowered and it shall be his duty to promote safety of flight of civil aircraft in air commerce.

Section 601(b) further states: "The Administrator shall exercise and perform his powers and duties under the Act in such manner as will best tend to reduce or eliminate the possibility of or recurrence of accidents in air transportation." Section 601 further states that the Administrator has the authority to prescribe minimum standards, rules, and regulations with regard to airmen and aircraft.

Under Section 305, the Administrator has the general statutory responsibility of encouraging and fostering civil aeronautics; under Section 307, he has the responsibility to prescribe air traffic rules with emphasis on those rules required to prevent collisions between aircraft.

In the pursuit of these responsibilities, the Administrator must be immediately aware of all problems posed by accidents which may require immediate corrective action, either through regulatory action, certification action, or other corrective actions.

The Congress recognized the Administrator's need to participate in accident investigations in order to fulfill his responsibilities and made provision for this in the language emphasized in Section 701 (g) of the Act, which states:

"In order to assure the proper discharge by the Administrator of his duties and responsibilities, the Board shall provide for the appropriate participation of the Administrator and his representatives in any investigations conducted by the Board under this Title: Provided, that the Administrator or his representatives shall not participate in the determination of probable cause by the Board under this Title."

It is evident that the Agency is involved in accident investigation not by choice but rather by Congressional mandate.

It is the responsibility of each and every one of us to continually strive to effect the best possible working relationship between our two Agencies while observing due regard for their respective statutory responsibilities.

It is our firm conviction that the past 2 years have shown a real improvement of relationship between the two Agencies in the accident investigation area. This improvement has been due in great part to the joint efforts of the Chairman of the Board and the Administrator of the FAA in emphasizing and implementing policies and procedures which bring the two Agencies into closer unison in the performance of their respective duties. This joint Accident Investigation School effort is the most recent tangible evidence of the progress being made in this area.

In addition to providing us with the technical training so necessary in carrying out our responsibilities in accident investigation, this school should result in a major contribution toward a better understanding of our mutual responsibilities, duties, and relationship in the performance of aircraft accident investigation work.

Each of us must continually be cognizant and respectful of the other's role. We must be alert to the avoidance of personality problems, policy misunderstandings, and the pitfalls that might result from lack of preplanning and coordination; for, where serious differences occur, they interfere with the efficient conduct of investigations and defeat the very purposes for which the Board and the Agency were established by the Congress.

In addition to the technical training aspects of this school, we are looking to the school to provide a degree of standardization, and another avenue or means of freely discussing areas of differences between the two Agencies before they become magnified out of proportion. Hopefully, the anticipated type of student interchange of ideas and airing of problem areas will be the basis for changing old or initiating new policy guidelines and procedures in both Agencies as related to accident investigation. We are convinced that many of the previously encountered

difficulties can be avoided and that the two Agencies can look forward to an improved cooperative approach and capability in accident investigation. We are also convinced that we will have a greater flow of safety information between the FAA and the CAB throughout the investigation, which will eliminate any undue time delay in recognizing apparent deficiencies and taking the necessary corrective action to protect our traveling public.

The investigation of accidents and incidents is one of the more important tools the Administrator has available in the discharge of his responsibilities related to the FA Act. In performing his duties the Administrator of the FAA has set forth instructions related to accident investigation in FAA Handbook OA P 8020.2A entitled "Aircraft Accident Procedures and Service Responsibilities", directing the actions of the various segments of the FAA involved in the accident. These instructions establish the Director of Flight Standards Service as the individual who will perform on behalf of the Administrator such investigations of aircraft accidents and prepare such reports as may be required pursuant to the Administrator's responsibility and authority. All FAA participation in accident investigations is funneled through Flight Standards Service.

The Administrator further establishes that the Director of Flight Standards Service in accomplishing these duties will call upon the advice and services of the Director of Air Traffic Service, System Maintenance Service, the Civil Air Surgeon, the General Counsel or any other element of the Agency, together with their headquarters or field personnel to the extent necessary.

The Administrator has further established that an accident coordinator shall be appointed from within Flight Standards to coordinate the Agency's participation in all aircraft accident investigations conducted by the CAB and those military investigations in which the FAA participates. This selection is normally made in accordance with regional directives established by the Regional Chief, Flight Standards Division. This coordination is responsible for the activities of Agency

personnel in the conduct of the accident investigation and completion of the Accident Report. The Accident Coordinator has no small job. There are many other duties and responsibilities associated with the job. The FAA Accident Coordinator has the authority to obtain the assistance of the best technically trained people in the FAA, irrespective of geographical and organizational assignment. The Coordinator will work closely with the CAB, on the military investigation and assist in assigning FAA personnel to the working groups, obtaining records and data as may be required. FAA participants assigned by the coordinator to the investigation shall not leave the investigation without the approval of the coordinator. All FAA Coordinators must recognize their responsibilities and the responsibility of the Agency in promoting Air Safety. These responsibilities involve an understanding and application of the Federal Aviation Regulations, standards and procedures, the quality and performance of the investigation.

The FAA Accident Coordinator or Investigator may be an Operations, Maintenance, or Electronics Inspector from Flight Standards. Some of the specialist areas are represented in this class. It is most important that each specialist be prepared to carry out Agency responsibilities in aircraft accident investigation. The instruction presented by this School is intended to give those designated as Coordinator/Investigator or technical specialist an appreciation and understanding of their functions and responsibilities in the investigation of aircraft accidents.

As I have mentioned, one of the Agency's responsibilities is to promote safety of flight of civil aircraft in air commerce. One of the best criteria for determining the effectiveness with which this function is being administered is to examine the aircraft accident rates.

The ultimate safety goal would, of course, be to reduce the aircraft accident rate to zero. A positive and progressive trend toward this end can be achieved through a sound preventive program, such program being based upon remedial actions, effective regulatory measures, and sound policy guidelines, resulting from effective accident investigation and safety programs.

Aircraft Accident/Incident investigations and safety studies are the means of obtaining and developing factual information reflecting areas of deficiencies upon which intelligent corrective actions can be taken. The data to support corrective actions can be no better than the facts presented in each investigative report.

The FAA recognizes aircraft accident investigation as a necessary fundamental element of a safety program and it regards its continued active participation in this area as a necessary tool enabling it to carry out its statutory safety responsibilities under the Act.

* * * * * * * * *

PRESENTATIONS

at the

NATIONAL AIRCRAFT ACCIDENT INVESTIGATION SCHOOL

on

CAB POLICY AND PHILOSOPHY OF AIRCRAFT ACCIDENT INVESTIGATION

by

MR. GEORGE A. VAN EPPS
Supervisory Air Safety Investigator
New York Office, Bureau of Safety, CAB
April 29, 1964

and

MR. JOSEPH O. FLUET
Chief, Safety Investigation Division
Bureau of Safety, CAB, Washington
March 2, 1964

Mr. George A. Van Epps, April 29, 1964 at National Aircraft Accident Investigation School, Oklahoma City, Okla.

CIVIL AERONAUTICS BOARD
BUREAU OF SAFETY

CAB PHILOSOPHY AND POLICY OF AIRCRAFT ACCIDENT INVESTIGATION

Gentlemen:

At the opening of the last class here Mr. Fluet, Chief of the Investigation Division, Civil Aeronautics Board Washington, delivered a most interesting address on CAB philosophy and policy of aircraft accident investigation and I strongly recommend that this document be made available for your reference. During my address I shall, from time to time, refer to pertinent items of Mr. Fluet's speech.

The basic CAB philosophy and policy of aircraft accident investigation has not undergone any change in over 25 years during which the Board has been charged with this responsibility. During that period there have been, of course, many changes and improvements to the Board's procedures in order to provide improved safety in aviation and keep pace with the rapid growth of the industry.

In presenting my message to you, I feel that it is appropriate to relate the Civil Aeronautics Board's position and the current regulations governing aircraft accident investigation activity. To some of you this information may be repetitious; to others it may assist in clarification.

To better acquaint you with all the facts, I now refer to Public Law 87-726, dated August 23, 1958, Federal Aviation Act of 1958, and under title 7, "Aircraft Accident Investigation."

"(a) It shall be the duty of the Board to--

(1) Make rules and regulations governing notification and report of accidents involving civil aircraft;

(2) Investigate such accidents and report the facts, conditions, and circumstances relating to each accident and the probable cause thereof;

(3) Make such recommendations to the Administrator as, in its opinion, will tend to prevent similar accidents in the future;

(4) Make such reports public in such form and manner as may be deemed by it to be in the public interest; and

(5) Ascertain what will best tend to reduce or eliminate the possibility of, or recurrence of, accidents by conducting special studies and investigations on matters pertaining to safety in air navigation and the prevention of accidents."

"(f) Upon the request of the Board, the Administrator is authorized to make investigations with regard to aircraft accidents and to report to the Board the facts, conditions and circumstances thereof, and the Board is authorized to utilize such reports in making its determinations of probable cause under this title."

(REFERENCE PN-13)

"(g) In order to assure the proper discharge by the Administrator of his duties and responsibilities, the Board shall provide for the appropriate participation of the Administrator and his representatives in any investigations conducted by the Board under this title: Provided, That the Administrator or his representatives shall not participate in the determination of probable cause by the Board under this title."

In compliance with the Act, the Civil Aeronautics Board has published a current document entitled "Civil Aeronautics Board, Safety Investigation Regulations," which became effective April 1, 1963. This document supersedes a similar document which was in effect prior to April 1. The Regulation just referred to, SIR (Safety Investigation Regulation) -4, is entitled, "Part 320, Rules Pertaining to Aircraft Accidents, Inflight Hazards, Overdue Aircraft and Safety Investigations."

To carry out the Civil Aeronautics Board's responsibility of determining probable cause and assisting in the adoption of preventive measures, the Board has within its structure the Bureau of Safety. The Bureau has 188 employees, 75 of whom are stationed in field offices strategically located throughout the United States. All of the technical employees amongst these people must be highly qualified in the various aspects of aviation. There are, for instance, employed within the Bureau of Safety, aeronautical

engineers, operations specialists, maintenance specialists, meteorologists, powerplants specialists, and aircraft systems specialists. The majority of these personnel have extensive pilot qualifications.

The important function of the Federal Aviation Agency for promoting safety in aviation, as directed by the Act, must be well known and a way provided for their function to be carried out expeditiously. I would like to point out that relations between the Board and the FAA, and its predecessor the CAA, have always been close, and the liaison between the agencies has been excellent. As a matter of interest, it can be pointed out that the Chiefs of all of the five Divisions comprising the Bureau of Safety are former FAA employees, and that the Assistant Chiefs of two of the Divisions are also former FAA employees. There are also within the FAA, in positions of responsibility, many former Board employees. I am sure that this interchange of personnel has worked to improve the understanding and the working relations between the agencies.

An excellent example of the fine inter-agency relationship is exemplified in the National Aircraft Accident Investigation School you are now attending.

Organization

One of the greatest assets for conducting an aircraft accident investigation is the ability to organize. This is true in all types

of aircraft accident investigations.

Security of wreckage, records, mail and cargo should be such that no one interferes with the evidence and it provides a way for the investigator in charge to organize and prepare for his chore.

Once an organization program is initiated, the rest of the chore falls in line. First, in organizing there must be one, and only one, person who is directing the activity. This person may then lay out his program in a chronological order which will be most productive.

The major reason for keeping people out of an accident scene and providing for the least amount of disturbance is to allow an organized plan for development before too many of the facts are disturbed. Organization further encompasses the chore of knowing what you are looking for before starting the program. Example: The chairman of a systems group must know or request from those assisting him all of the details of a hydraulic system, including plumbing, valves, etc., from the hydraulic supply routed through the aircraft and back to the storage area. When each chore is accomplished in this manner, then and only then can one proceed with an expeditious program.

The investigation of aircraft accidents today incorporates in the organization plan specialists from different organizations and groups to participate and offer their assistance for the

accomplishment of a complete chore. This is true of major catastrophic accidents. Lighter aircraft accident coverage will usually be by CAB, FAA and state officials. Normally, the FAA, operator, ALPA, FEIA, ALDA and others will be a part of this organized effort.

Communication

In the program of prevention the need for expeditious communication is very important. Again, only through an organized program can communications be properly carried out. Information should be directed to the investigator in charge, who in turn would pass it on through the chain of command for use in expeditious action of preventing further occurrences.

One of the first requirements in isolating the immediate cause of the accident is to have personnel in sufficient numbers who by education, training, and experience are capable of uncovering accident cause which must first be isolated before the underlying factors can be pursued. It must be emphasized that it is far easier for a technical man to find a malfunction or failure of an aircraft that is whole and undamaged than to discover the same malfunction or failure in an aircraft which is substantially, or in some cases, almost totally destroyed.

Basically, the philosophy of the Board stated very simply is the thoroughly painstaking investigation of all phases of each accident in order to establish the probable cause. By this action, the first step in the prevention of future accidents can be taken by such thorough and painstaking efforts.

Aircraft accident investigation is one of the fundamental elements of any sound program for the improvement of aviation safety. Conscientious investigation and accurate reporting of aircraft accidents are essential to our statistical recording system and are fundamental to any accident prevention program.

Aircraft accident investigators must analyze each accident to determine cause factors, adequacy of equipment suitability of procedures employed and the need for corrective action. Through the aircraft accident, incident, flight hazard, and ground accident report, the analyses, comments, and recommendations of the investigators are submitted via the chain of command for evaluation to determine steps to be taken to prevent similar occurrences.

The purpose of an accident investigation should be clearly understood in order to yield the greatest benefits. It is not to assess blame, but to gain factual knowledge in order that similar occurrences may be prevented. It is not enough to establish a cause factor. Few accidents result from a single cause. More commonly, a sequence of events occurs, the elimination of any one of which might have prevented the accident. Therefore, to prevent future occurrences, it is imperative that all cause factors be determined. An incomplete investigation resulting in erroneous conclusions nullifies completely the only possible benefit which could be derived from a costly accident.

The investigation of the circumstances surrounding an aircraft accident is a methodical accumulation of small bits of information which eventually

form a pattern. The wreckage itself contains valuable evidence which, if correctly identified and assessed, will provide the factual evidence necessary for the determination of cause factors. All factors, mechanical environmental and human, must be determined and the proper relationship established between the factors involved. Only then can corrective action be formulated.

In order to properly investigate aircraft accidents we need specialists or aircraft accident investigators. The investigator - what kind of a man is he? This individual must be a well qualified airman. He must possess strong character, dedication, trustworthiness, alertness; also, he must be kind and understanding, unbiased, an organizer and fully capable of absorbing criticism. He must be on call for 24 hours a day and plan to work long, hard hours in all kinds of weather. He is expected, after completing a good day's work, to be called up in the middle of the night or to be interrupted during a Sunday dinner to answer the call of duty.

The investigator must be physically fit to enable him to climb mountains, and take long hikes over rough terrain in adverse weather. He must be able to work with people, understand the value and use of large construction equipment, meet and present to the press facts that he is allowed to disclose and be present in ten or more different places at one time.

In addition to the aforementioned qualities, the investigator must have or acquire specialized qualifications such as being imaginative, being capable of speculation, possessing foresight, keeping an open mind, being curious as

well as persistent, employing tact and diplomacy, and being knowledgeable in a variety of subjects.

For all of this an investigator can expect to receive a fair reward in salary, but most of all, this type of an investigator realizes complete satisfaction for his accomplishments in that he has contributed to making a safer place in aviation through his investigation, recommended corrective action and studies in the preventive field.

The investigator - what kind of a man is he? He is an individual striving to obtain the qualities previously discussed and while accomplishing this, he becomes a specialist in his own field as a result of his dedication and sincerity.

I would like to speak for a moment on the subject of accident prevention, which in the final analysis is the prime cause for all accident investigation.

The CAB and the FAA have this as their first responsibility. However, this responsibility is borne by all phases of the industry and it is for this purpose that provisions are made for full participation by industry in major accident investigations. Also responsible in accident prevention are all mechanics and pilots in both air carrier and general aviation and all must assume their share of the responsibility for accident prevention.

Although the record to date is excellent, there is always room for improvement.

in the future and to make public such reports as may be deemed to be of public interest.

Special studies and investigations are also required to ascertain what will tend to reduce and eliminate the possibility of accidents, such as by conducting special studies and investigations on matters pertaining to air safety.

To carry out this large responsibility of determining probable cause and assisting in the adoption of preventive measures, the Board has within its structure the Bureau of Safety. The Bureau has 188 employees, 75 of whom are stationed in field offices stratigically located throughout the United States. All of the technical employees amongst these people must be highly qualified in the various aspects of aviation. There are, for instance, employed within the Bureau of Safety aeronautical engineers, operations specialists, maintenance specialists, meteorologists, powerplants specialists, and aircraft systems specialists. The majority of these personnel have extensive pilot qualifications.

I would like to point out that the first requirement in isolating the immediate cause of the accident is to have personnel in sufficient numbers who by education, training, and experience are capable of uncovering accident cause which must first be isolated before the underlying factors can be pursued. It must be emphasized that it is far easier for a technical man to find a malfunction or failure of an aircraft that is whole and undamaged than to discover the same malfunction or failure in an aircraft which is substantially, or in some cases, almost totally destroyed.

The Act further provides that the Board provide for the appropriate participation of the Administrator of the Federal Aviation Agency in accident investigation in order that he may discharge his duties and responsibilities. It is made clear, however, that the Board retain the sole responsibility for the determination of the probable cause of the accident. It is also provided that the Board may request the Administrator to investigate certain accidents and report to the Board the circumstances involved in order that the Board may determine the probable cause.

I would like to point out that relations between the Board and the FAA, and its predecessor the CAA, have always been close, and the liaison between the agencies has been excellent. As a matter of interest, it can be pointed out that the Chiefs of all of the five Divisions comprising the Bureau of Safety are former FAA employees, and that the Assistant Chiefs of two of the Divisions are also former FAA employees. There are also within the FAA, in positions of responsibility, many former Board employees. I am sure that this interchange of personnel has worked to improve the understanding and the working relations between the agencies.

An excellent example of the fine inter-agency relationship is exemplified in the National Aircraft Accident Investigation School you are now attending.

Basically, the philosophy of the Board stated very simply is the thoroughly painstaking investigation of all phases of each accident in order to establish the probable cause. By this action, the first step in the prevention of future accidents can be taken by such thorough and painstaking efforts.

At this time I would like to bring out that travel by air in this country in scheduled passenger service is in all respects an excellent and publically acceptable means of transportation and that the passenger fatality rate has been excellent over the past years. For instance, during 1963, there was one passenger fatality for 435 million passenger miles flown. But, we cannot be satisfied with this fact, and must strive to further improve safety which will have a direct bearing on even greater public acceptance of travel by air.

Insofar as general aviation is concerned, the major problems as a causal factor lie in the pilots lack of knowledge and/or disregard of the problems associated with flying and weather. Our efforts should be concentrated on increasing the knowledge of general aviation pilots with respect to this problem.

In spite of the record over the last few years, the adverse publicity and dramatic headlines news associated with the catastrophic type of aircraft accidents has a profound effect on public opinion concerning the safety of flight. The effect of this adverse publicity can be exemplified by the fact that in 1960 the adverse publicity which the Electra was receiving and that associated with the New York midair collision, the number of passengers carried in scheduled service increased in 1961 by only 525,000. In 1962, after a relatively "good" year, in scheduled passenger service passengers carried increased by 4 million. In 1963, after another year which could be considered a "good" year, the passengers carried increased by an estimated 8 million.

Recommendations from the establishment of special studies can be made. It is our firm belief that each accident investigated can produce some fact or circumstance which, although apparently isolated, can weave into a fabric which will enhance the safety of civil aviation.

It is the policy of the Board to utilize to the fullest extent all possible industry personnel who can contribute by their technical knowledge and skills to the investigation of an accident. This is of course particularly true in the investigation of catastrophic accidents involving either scheduled or supplemental air carrier operators. Such industry personnel, together with representatives of the FAA, working under the leadership and guidance of Board investigators in the various special fields, such as operations, powerplants, structures, etc., are kept cognizant at all times during the course of the investigation of all facts relating to the investigation.

The procedures used in the actual investigation of the accidents and the causal factors will, of course, be covered fully during your course of study during the next six weeks.

First and foremost in the implementation of the Board policy is the improvement in quality of each accident investigated. This can be accomplished only by improved technical knowledge and skill of the investigators involved. This of course includes both the Board personnel and the FAA personnel assigned to the accident. The utilization of specialized skills and talents is essential at all times.

During the course of any accident investigation there is available to the field investigator the specialized talents of the Washington office staff. It is our policy that these special knowledges and skills be utilized by means of communication in order to secure advice and counsel or by a request for assistance in the field phases of the investigation. The specialized knowledge of the Washington personnel is also available to assist in the analysis of the facts uncovered in the field phase of the accident investigation.

The essence of any particular accident investigation is the thoroughness with which the field phase is carried out. This can only be accomplished by painstaking attention to each detail which could possibly contribute to the probable cause.

The investigator must in all cases remain at the accident site until every possible circumstance involved has been thoroughly explored. It is wasteful of time and money to return to the scene because some facet of the investigation has not been thoroughly covered.

Thoroughness in the original investigation is therefore one of the most essential elements in the successful conclusion of an investigation. As an example of thoroughness in investigation and the use of all possible tools, we can consider the very recent accident involving an Eastern Air Lines DC-8, which crashed in Lake Ponchartrain shortly after taking off from Moisant Airport, New Orleans. Extensive efforts have been made to recover the main wreckage of the aircraft. Upon recovery of this

wreckage the painstaking work of study and reconstruction will commence. However, in many instances such as this the wreckage cannot be found. In these cases, all efforts must be made to uncover all of the facts, conditions, and circumstances of the flight. This involves a study of all records concerning pilot history, aircraft history, maintenance procedures, training programs, and other essential elements of the operation of the air carrier involved and by the operation of this particular type of aircraft by other air carriers. One of our important tools is the flight recorder which if in the above-mentioned case the wreckage is recovered will give us many important clues.

There are areas in which the flight recorder could well be improved. An example of this is the recording of forces on the controls and control movements. Further, thorough investigation must be made in cases such as this of all other aircraft which have been operating in the general area at approximately the time the aircraft was found to be missing. An example of this is the fact that a Delta Air Lines aircraft took off from Moisant Airport approximately two minutes after the ill fated DC-8. The flight recorder from this aircraft has been obtained, and is being studied in order to make a determination of any G forces or other flight aspects which could possible be contributing causes to the Eastern Air Lines accident.

Routinely, of course, pilot statements must be obtained from all pilots operating in the area, as well as any possible eye or ear witne

Further study must be made of all other accidents with any similarity to the accident at New Orleans, particularly with the same type of aircraft. In this instance the same aircraft was involved in an accident involving extreme turbulence, at Dulles Airport on August 20, and another Eastern Air Lines DC-8 was recently involved in a turbulence accident, on November 9, 1963, near Houston, Texas. Clues must be sought by comparing the latter two accidents which did not involve fatalities with the catastrophic New Orleans accident.

The Bureau of Safety has made every attempt to instill in its investigators the necessary qualities essential to the investigating in order that he may successfully complete an investigation. The most important ingredient, of course, is an interest in the job to be done, an open mind, and perseverance in the carrying through of each investigation to its logical conclusion. In this effort, the investigator must contain his efforts solely to the establishment of factual information. He must never be misled or sidetracked by rumor or suggestion. In order to analyze properly the causes leading to an accident, only facts can lead to cause and contributing factors. Conjectures and guesswork, and lack of thoroughness can only result in an unsubstantiated or incorrect finding of cause. Reliance on facts established is therefore the foundation of all accident investigation.

Finally, I would like to speak on the subject of accident prevention, which in the final analysis is the prime cause for all accident investigation.

The CAB and the FAA have this as their first responsibility. However, this responsibility is borne by all phases of the industry and it is for this purpose that provisions are made for full participation by industry in major accident investigations. Also responsible in accident prevention are all mechanics and pilots in both air carrier and general aviation and all must assume their share of the responsibility for accident prevention.

Although the record to date is excellent, there is always room for improvement.

The Board's philosophy and policy may therefore be summed up succinctly by saying that it is our desire to:

1. Assure that all investigators are properly trained and have the perseverance and dedication which are prime requisites to successful completion of an investigation.
2. That all available skills and facilities of both government and industry are used in each case to determine the facts and the underlying causes involved in each accident.
3. That objectivity be maintained at all times, and that each investigation be conducted with the thoroughness which is essential.

/s/ Joseph O. Fluet

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