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Proceedings of the International Conference on Aging Airplanes

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Prepared by

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EXECUTIVE SUMMARY
INTERNATIONAL CONFERENCE ON AGING AIRPLANES
JUNE 1-3, 1988

On June 1-3, 1988, the Federal Aviation Administration (FAA) hosted an international conference on older airplanes used in air carrier and commuter operations. Recent events brought to the forefront an FAA concern that the safety of the aging air transportation fleet and the past decade of operation using supplemental inspection documents (SIDs) should be reevaluated.

This conference was held to exchange views and discuss concepts for the future in areas which will be most productive in assuring the airworthiness of this aging fleet. The conference addressed Research and Development (R&D) needs as well as design, maintenance, and inspection. The subject areas addressed by the panels were airframe, inspection (including nondestructive testing), human factors of inspections and engines.

Approximately 400 representatives of airlines, manufacturers, and airworthiness authority organizations from more than twelve countries participated in the conference.

After a plenary session, the conference divided into the four panels: 1) Airframe, 2) Nondestructive Inspection (NDI), 3) Human Factors of Inspections, and 4) Engines. These panels deliberated for two days and panel members presented a number of recommendations on the final day of the conference. Many of the discussions in the individual panel groups paralleled those in other panels. The major conclusions and recommendations of the panel members are listed below.

1. Certain maintenance records should be required to be kept with the airplane for life.

2. Inspectors should be certified to meet minimum qualifications.

3. Airplanes should be certified for a limited lifetime based on the tested lifetime of a representative sample. The lifetime may be limited to one-half or seventy-five percent (75%) of the tested lifetime and it is possible that some means of recertification at the end of this lifetime should be made available at the end of this certification lifetime: supplemental type certificate issue with three countering arguments arising: (a) Multiple site damage cannot be accounted for in a life test; (b) fatigue tests are not appropriate for determining life limit, they are intended to identify critical areas only; and (c) the adequacy of the inspection program is more important than a life limit.

4. New models should not be added to an existing type certificate for older airplane designs unless the manufacturer has shown compliance with current fatigue requirements.

5. The certification rules are not a problem; it's the interpretation of the rule that poses the problem.

6. Corrosion is a bigger problem than fatigue. Only five percent (5%) of maintenance actions is due to fatigue. The other ninety-five percent (95%) is due to corrosion. Supplemental inspection documents do not adequately address corrosion.

7. An FAA national resource specialist in nondestructive inspection (NDI) should be designated. He/she should establish a training program for FAA engineers and

inspectors in NDI and determine NDI research and development objectives. His/her expertise should also be available for nationwide use. He/she should help establish NDI certification requirements for mechanics.

8. Commuter airplanes currently do not have SIDs. These airplanes should be looked at to determine if a SID program is required. Also if these airplanes are being used at or beyond their intended life limits, the question of how to handle the simpler design and construction techniques, i.e., single spar wings, and a less sophisticated maintenance program should be addressed.

9. Currently, FAA inspectors are looking at paperwork, not airplanes. Inspectors should assure that airlines have adequate analysis and inspection programs, but they also need to ensure that the maintenance programs are being followed. This can best be done by looking at airplanes.

10. Communications between the airlines, airplane manufacturers, and the FAA should be improved. Lessors and maintenance organizations are excluded from many issues and their resolutions. Operators should participate in the preparation of airworthiness directives (ADs). Foreign civil airworthiness authorities should also be included in AD preparation. Foreign civil airworthiness authorities have not seen sufficient valid data for some FAA actions. Airlines tend to withhold information from the FAA for fear of possible violations. Perhaps an immunity system should be established for mechanics similar to that established for pilots and controllers (the Aviation Safety Reporting System, ASRS).

11. A task force should be established to continue the work begun in this conference. The task force should include members from airlines, manufacturers, the FAA, and NASA. The task force should be a nongovernment group to avoid conflict with the Advisory Committee Act. The task force should consist of small groups given a definite goal and deadline, then locked away in a room to solve the problem.

12. Several suggestions were made in the area of human factors:

    a. to avoid boredom, the duration of crack inspection should be limited with breaks occurring at established intervals.

    b. Training procedures for A&P mechanics in the area of inspection for cracks should be improved.

    c. Maintenance awareness training should be implemented.

    d. Airplanes should be designed with maintenance in mind.

13. Human errors do occur in the maintenance of airplanes. The cause of these errors is not well understood. Some R&D studies should be conducted to identify the reason for error in the maintenance environment. Factors such as the boredom associated with repetitive inspection rather than a permanent fix, the time spent inspecting for cracks without breaks, and the pressure created by the need to meet flight schedules should be evaluated.

14. FAA inspectors and engineers should visit operators to gain "hands-on" experience in compliance with inspection ADs. They should become aware of the problems through one-on-one discussions with technicians and through actual inspections.

15. In the past, failures have occurred even after an AD had been complied with. These ADs should be reviewed to determine if there was a human factors problem.

16. The provision for alternate means of compliance with ADs and service bulletins (SBs) need improvement. Alternate means should be provided in the AD or SBs if known. The approval of alternate methods suggested by operators and manufacturers should be provided in a more timely manner. For the most part, SBs call out simple methods of compliance which cannot be adapted to the sophisticated equipment owned by large operators. Older ADs which call out antiquated inspection methods should be updated.

17. Engine aging differs from that of airframes in that there are established structured inspection programs, shop visit programs, trend monitoring, life limits on critical parts and part or module change-out requirements. However, nonlife-limited static structures such as cases could become a problem with age. These parts have not shown a correlation between life and operating time or cycles. Perhaps an R&D program to determine a life prediction technique for both repaired and non-repaired engine cases and static structures would be beneficial.

18. In the engine area, NDI equipment operator certification standards are considered adequate and there should be no need for FAA certification of NDI personnel. The engine manufacturers normally provide customer training when new NDI equipment becomes available.

19. The FAA and manufacturers may benefit from seminars to exchange data in a "lessons learned" format with operators of aging engines.

20. There is a need for FAA control of replacement parts distributors and brokers. The lack of repair status of replacement parts is a concern.

21. The propeller issues were not adequately discussed due to lack of representation at this meeting. Perhaps a propeller task force could meet at a later date and discuss this issue.

The approach used to address the issues raised in these discussions will be a task-oriented program predicated on the continued use of the current maintenance and inspection system with more emphasis on diligence and surveillance. This program is intended to emphasize direct FAA maintenance inspection of older airplanes and will involve FAA certification engineers in the human factors aspects of maintenance and inspections.

Both operational objectives and R&D goals were proposed at the conference. For the immediate future, six tasks have been initiated by the FAA in response to the conference discussions:

1. Flight standards inspectors, with support from aircraft certification engineers, will become more involved with "hands-on" at the airlines during their heavy

maintenance checks of high time aircraft to ensure we gain a better understanding of the fatigue and corrosion situation of older aircraft (Airframe).

2. Aircraft certification engineers will make field visits to airline maintenance facilities to become better informed on the human factors aspects of maintenance and inspection, to assist them in taking these factors into account when making aircraft certification judgments in the resolution of service revealed difficulties, e.g., in the drafting of airworthiness directives (Human Factors of Inspections).

3. FAA will establish agency experts in nondestructive testing and inspection technologies for national utilization, and will establish improved training programs for our manufacturing and maintenance inspectors on these technologies (Nondestructive Inspection).

4. The aircraft certification flight standards, and research and development organizations of FAA will jointly develop the specifics of a research and development program toward gaining and sharing knowledge that will promote the continued safety of older aircraft and engines (R&D).

5. Flight standards will develop a "lessons learned" document on engine maintenance that will summarize the important maintenance shortfalls discovered during FAA evaluation of 22 engine repair stations in the United States (Engines).

6. Aircraft certification will promote and work with industry toward their development of supplemental structural inspection documents for aircraft typically used in commuter service (Commuters).

During the conference, the industry and association participants were charged to initiate actions, including specialist workshops, to help develop those programs needed to improve safety of aging airplanes. The FAA will participate with these organizations in these initiatives.

INTRODUCTION

The purpose of this report is to provide a complete overview of the Federal Aviation Administration International Conference on Aging Airplanes held in Arlington, Virginia, on June 1-3, 1988.

The conference was attended by approximately 400 representatives of airlines, manufacturers, aviation industry groups, and civil airworthiness authorities of other countries, and the general public.

The conference was held to exchange views and hold listening sessions and brainstorming panels to explore ideas and suggestions that will contribute to the safety of the aging fleet. After the plenary session, the conference broke up into four panels: (1) Airframe, (2) Nondestructive Inspection, (3) Human Factors of Inspections, and (4) Engines.

This report is a consolidation of all of the presentations given by keynote speakers, a narrative summary of the four panel discussions, and remarks made at the closing session. This report does not include any final conclusions or recommendations of the Federal Aviation Administration.

CONFERENCE SCHEDULE OF EVENTS

Wednesday, June 1

8:30 a.m. PLENARY SESSION - Clarion Ballroom

Speakers: FAA Administrator the Honorable
T. Allan McArtor
The Honorable Jim Oberstar
The Honorable Dave McCurdy
The Honorable Dan Glickman
The Honorable Tom Lewis

1:00 p.m. DISCUSSION SESSIONS

Airframe - Auditorium

NDI - Washington Room

Human Factors of Inspections - Clarion East Room

Engines - Federal Hall

Thursday, June 2

8:30 a.m. - 12:00 Noon and 1:30 - 5:00 p.m. DISCUSSION SESSIONS

Airframe - Auditorium

NDI - Washington

Human Factors of Inspections - Clarion East Room

Engines - Federal Hall

Friday, June 3

8:30 - 12:00 CLOSING SESSION - Clarion Ballroom

CHAPTER 1. PLENARY SESSION

A. INTRODUCTION

At the Plenary Session, the Administrator of the Federal Aviation Administration spoke on the need to improve the safety of the aging fleet. Also on the program were four members of Congress who expressed their views and charged the assembled experts to develop ideas with regard to how improvements can be made.

B. OPENING STATEMENT OF THOMAS McSWEENY, MANAGER, AIRCRAFT ENGINEERING DIVISION, FEDERAL AVIATION ADMINISTRATION

Good morning. Welcome to the (International) Conference on Aging Airplanes. My name is Tom McSweeny. I am the manager of the Aircraft Engineering Division of the FAA's Office of Airworthiness, and I am pleased to have the honor of being the master of ceremonies for this morning's session. The theme for this conference is "Safety Begins with Safe Aircraft." We are fortunate to have with us today a very distinguished panel of speakers, who will elaborate on how safe aircraft affect all of us and express their views on the subject of aging airplanes.

The first speaker is Mr. T. Allan McArtor, Administrator of the FAA. Administrator McArtor will deliver the opening comments and will introduce the rest of the speakers.

Mr. McArtor.

The following are talking points for Administrator McArtor.

C. TALKING POINTS OF THE HONORABLE T. ALAN McARTOR, FEDERAL AVIATION ADMINISTRATOR

- As early as 1968 the FAA formed an advisory panel on the airworthiness of pressurized, older aircraft.

- The advisory committee consisted of members from the airplane manufacturers, the operators, the Air Force, and NASA.

- The committee report was issued in 1970 and acted upon by the FAA.

- In October 1978, the FAA adopted new damage tolerance rules and advisory material. This damage tolerance technology became the basis of the analysis that developed the supplemental inspection documents.

- After many years of discussion in ICAO, the Airworthiness Committee adopted the concept of supplementary inspection documents in 1979.

- The Supplement Inspection Program for Large Transport Category Airplanes was implemented by an Advisory Circular on May 6, 1981.

- To date supplemental inspection documents (SIDs) have been issued for the Boeing 707, 720, 727, 737 and 747, the Douglas DC-8 and DC-9, and the Lockheed L-188.

- These SIDs were made mandatory by FAA airworthiness directives.

- At least eight other SIDs are expected to be approved in the next two years.

- The FAA and industry have been addressing the aging airplane issue for at least twenty years.

- Recent events have caused us to reevaluate our efforts to see if new technology is available or can be stimulated through research.

- Airplanes in commuter operations were not addressed by the early supplemental inspection programs and need to be addressed in the present activity.

- The FAA sees the aging airplane issue as an international one and is seeking cooperation from all manufacturers, international operators, and international airworthiness authorities.

- I would like to challenge you to be freethinkers during the next two days on things we all might do to improve the safety of aging airplanes.

- I look forward to the reports on Friday of the highlights of the discussions in the four sessions.

D. REMARKS OF THE HONORABLE JIM OBERSTAR, MEMBER OF CONGRESS
CHAIRMAN, SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
HOUSE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

FAA Administrator Allan McArtor deserves high praise and congratulations for acting decisively and quickly in calling this conference to address the critically urgent problem of aging aircraft. This action is characteristic of Administrator McArtor's determination to keep the FAA in the forefront of aviation safety, aggressively exercising its role as the watchdog of aviation safety; not content merely to react, as has happened all too often in the past.

This conference reflects a clear recognition that the U.S. civil aviation fleet is growing older, and that aging aircraft represent one of the most serious challenges to the civil aviation community and the FAA in recent years. The convening of this group of international experts to exchange ideas and information over a three-day period is a positive, constructive step that will produce beneficial results far into the future.

This conference is both a recognition that government and industry need to work together on this problem, and a commitment to do so vigorously. The international nature of the conference reflects the reality that air travel has shrunk the world, diminished the meaning of international boundaries, and drawn all mankind, with its opportunities and problems, closer together.

There is reason to be optimistic over developments in aviation safety. The FAA is beginning to build back the levels of safety intended by the basic Federal Aviation Act of 1958 and which were in place before deregulation. There was a time however, when, as Chairman of the Subcommittee on Investigations and Oversight, I could not make that statement. I am beginning to feel encouraged by various marks of progress that are

significant precursors to this conference and indicators that this gathering may, in its turn, be successful.

At a hearing of my Subcommittee on April 9, 1987, the FAA, for the first time, defined the term "runway incursion." We will now be able to gather credible statistics on such incidents and use that information objectively as one of several measurements of the safety of our air traffic control system.

In response to Subcommittee hearings, the FAA has greatly improved and standardized the reporting of near mid-air collisions, providing also a more accurate, timely, and public accounting of near mid-airs.

The FAA is in the process of developing a system of safety indicators, a composite which will include, among other factors: near mid-airs, operational errors, pilot deviations, and runway incursions, providing the most comprehensive yardstick to date for measuring system safety.

One of DOT Secretary Jim Burnley's first actions was to accept the recommendations of our Subcommittee and the GAO to establish a more accurate count of the air traffic controller workforce -- "truth-in-reporting." Those who actually control traffic will be counted: FPLs, developmentals, supervisors. Those who don't control traffic: academy trainees and air traffic assistants, will not be included in the count.

Last fall, in response to our Subcommittee hearing on maintenance, (October 20-21) the FAA developed uniform guidelines governing the length of time in which airlines can defer maintenance -- an important revision of the MEL policy.

Under the old system, ambiguity of regulations led to inconsistent interpretation and enforcement within the various

FAA regions. Some airlines were deferring repairs for months at a time, long beyond the period intended by MEL guidelines. The new policy establishes specific time limits for equipment repairs.

The FAA, earlier this year, made a significant and increased commitment to cabin safety during our hearings on overwing exits, by establishing a maximum sixty-foot distance between exits, which ruled out the proposal to close off overwing exits on B-747 aircraft. The FAA has also created a new task force to examine all facets of cabin safety.

I mention all these developments because I think they set the tone for this conference. They reflect a concerted effort by the FAA to stay ahead of the curve on safety.

The purpose of this conference is to apply the combined genius of experts from the three pillars or sectors of modern aviation: the manufacturers, the carriers, and the FAA to resolve yet another vexing question for civil aviation: the problem of aging aircraft.

The basic question that must be asked and, hopefully, answered in the course of this conference is: Do aircraft, with proper maintenance, have an indefinite life span . . . or, can the FAA, the carriers, and the manufacturers agree on a definition of "useful life" for a given type and model of aircraft?

This conference needs to ask, and answer:

- What is the responsibility of the aircraft manufacturers to track the fleet that they build?

- What is the responsibility of the carriers to aggressively maintain that fleet in the safest possible condition?

- What is the responsibility of the FAA -- from approval of design concept to approval of the design itself, and surveillance of maintenance conducted by the airlines?

This conference should identify and define the inspection and detection deficiencies or failures which have eluded our human frailty and which need more refined attention and action.

What worries me most about the aging aircraft dilemma is not that there is no tracking system -- there is.

Not that the system wasn't used -- it was.

What worries me is that all of the right steps were taken, but for Flight Attendant Clarabelle Lansing and the injured and frightened passengers aboard Aloha Flight 243, the system failed -- tragically, for Ms. Lansing.

Boeing should have issued a "Service Directive" to inspect cracks along the #10 stringer above row 4 on certain high cycle B-737 aircraft -- and they did, in August 1987.

The FAA should have issued an airworthiness directive on fuselage rivet line cracks -- and they did, in November 1987. Aloha should have acted on those two warnings -- and they did. But they didn't find the problem on Aircraft N-73711.

Question: Was the "Service Directive" not explicit enough, or early enough? Was it not taken seriously enough by the airline?

Was the airworthiness directive not tough enough? Were Aloha's inspection personnel not sufficiently trained for the task? Did they know what they were looking for, and how to find it? Were they skilled and experienced enough to recognize the problem when they encountered it? Was their inspection as vigorous and meticulous as it should have been to discover the cracks? Is more and better training needed?

In light of the warnings issued to Aloha by Boeing and the FAA months earlier about corrosion problems, does Aloha need to upgrade its maintenance program -- and, by extension, do all airlines need to do the same?

Is aviation technology adequate to detect early warning signs of impending failure of airframes and fuselages? Do we need more advanced detection technology?

Do we need all of the above?

A maturing aircraft fleet highlights the importance of sound, comprehensive, continuing inspection, and maintenance programs. We must develop and implement such programs to assure early detection of problems associated with aging aircraft.

If more FAA inspectors and inspections are needed, Congress, I assure you, will provide the funding, as we have done in the past.

If more innovative detection technologies and strategies are needed, they must be pursued aggressively, and all three sectors must join in the pursuit.

Opportunities for design improvements must also be investigated: we need to inquire whether there are alloys which are more resistant to corrosion and fatigue than those now employed.

We need to know whether design standards can be improved or new ones developed to reduce the likelihood of catastrophic failure of fuselage or airframe, as occurred in the Aloha incident.

In thinking through these issues, let us keep a sobering statistic in mind: NTSB data show that from 1970 through 1985, metal fatigue or corrosion was involved in 77 out of 579 aviation incidents. Reducing that figure to a number approaching zero should be our goal.

When we have answered all those and other questions yet to be asked in the course of this conference, do we not have to face the ultimate question of airline economics: Is there a limit to the life span of an aircraft -- and shouldn't an aircraft be taken out of service before it reaches that threshold? This conference will have failed in its responsibility to the flying public if it does not ask and answer that question.

This year, commercial aviation in the United States will move some 450 million people. In a dozen years or less, that figure will be over 800 million, maybe closer to 900 million. With numbers like that in mind, margins of safety in aviation must do more than keep pace; they must vastly, qualitatively, and quantitatively improve.

Few pieces of legislation contain a message of timeless wisdom. The Federal Aviation Act of 1958, the Agency's basic charter, is one of those rarities. Its opening section lays down the ultimate standard for the entire aviation community: "the

prevention of any deterioration in established safety procedures . . ." and "furtherance of the highest degree of safety in the air transportation and air commerce . . ."

The standard set in that law is not 'whatever safety you can afford'; not safety at the margin; not the bare minimum of safety -- but safety with all its redundancy, backups, fail-safe devices, and all the caution our inventive genius can build into aircraft and the air traffic control system to assure safety, which I have come to define in all of our Committee work as "the relative absence of risk."

Establishing enduring standards of safety for our aging aircraft fleet, as directed by the FAA's basic charter, is your solemn task as you work through these three days of dialogue and mind-stretching. Our Committee joins you in this effort and will walk with you in the days beyond in our common obligation to assure "the highest degree of safety" in aviation.

E. REMARKS OF THE HONORABLE DAVE McCURDY, MEMBER OF CONGRESS, CHAIRMAN, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

1. Introduction

We are delighted to participate in this conference today. We strongly support this effort to bring together all who could contribute to defining and solving the problem of aging aircraft. The people represented here today are a continuing partnership of FAA, NASA, the Congress, aircraft designers, operators, pilots, and independent experts.

2. Aloha

It probably goes without saying that we would not be meeting here today had it not been for the Aloha accident.

We want to again commend the efforts of the pilot and copilot at Aloha, Robert Schornstheimer and Mimi Tompkins. Without their skill and calm in the face of extreme distress, we would not have the opportunity to learn so much from this accident.

We also want to recognize and applaud the several efforts FAA and the industry has taken in the days since the accident. The emergency airworthiness directives and inspections are certainly the first responses to problems of this kind, and have rightly been taken quickly.

3. Historical Precedent

History provides us with many precedents for the timing of our concern today. It is nothing new for national aviation policy to grow out of a single accident. FAA itself was formed

in the wake of the Grand Canyon collision between two sight-seeing airliners in the 1950s. That accident is a good example of what we're trying to do today. We've got to make sure that we discover not only the specific lessons to be learned -- in this case about metal fatigue and inspections -- we've got to focus broadly enough to see the general lessons as well. I know from the charter Allan McArtor has given this conference, that we are here to do just that.

4. Congressional Role

Our role, in the Congress, is to make certain that FAA gets the broad policy direction, the authority, and the resources necessary to do the job. We also can assist in bringing the resources of other federal agencies to bear on the problems at hand.

Most of you know that I chair the subcommittee on Transportation, Aviation, and Materials of the House of Representatives Science, Space, and Technology Committee. Our job is oversight of FAA's Research and Development, and NASA's Aeronautics program.

5. Recent Congressional Actions

These roles have led us to take three actions in the last few weeks:

a. Our authorization for NASA's fiscal year 1989 budget contains direction for NASA to conduct research on improved inspection techniques including better methods for detecting fatigue, corrosion and bonding failures, advanced ultrasonic inspection tools; and improved prediction and repair methods.

b. We have introduced a resolution (H. Res. 450) expressing the sense of Congress that FAA give high priority to research in structural fatigue.

c. We have introduced legislation (H. R. 4686) which would amend the Federal Aviation Act to emphasize two specifics --aircraft safety and human factors -- to FAA's research mission.

We believe the chances of these measures reaching final passage are excellent. There is considerable interest among Members of Congress in Aviation Safety. Many feel strongly that they have a safety mandate from their constituents. By my count, over 30 air safety bills have been introduced in the 100th Congress. Few, however, consider the contribution which research can make to the quality of our future actions.

With respect to the agencies involved, NASA has indicated a willingness to undertake the research in inspection techniques. Hearings on the FAA bill and resolution are scheduled for June 16, with markup scheduled for June 29. FAA has moved to position itself to respond meaningfully at the hearing. This conference is part of their effort to do that.

6. Kinds of Research Anticipated

We want this research to be truly broad based. We aren't calling for basic research into metal fatigue. We already have a pretty good theoretical understanding of what's going on there. Here are some examples of the kinds of research we had in mind. Of course FAA is to select the kinds of programs that will be helpful:

a. What kinds of training are needed to insure that airline mechanics can effectively program inspections?

b. Are airworthiness directives or service bulletins complete enough to be understood by a line mechanic?

c. What incentives are there for mechanics to do the best possible job?

d. Is a paperwork review sufficient in an economically constrained environment?

e. Should there be absolute limits on the number of pressurization cycles beyond which an aircraft should not be flown?

f. What ancillary factors, such as corrosive environments, numbers of patches, available inspection techniques, should affect an aircraft's useful life?

g. What new technologies can result in improved inspection techniques?

h. Should there be more extensive destructive testing of older aircraft?

7. Changes in the Industry

Why have we done this? Why, do we need long-term research when we already know so much about fatigue? When, if everyone had acted according to what we already know, this wouldn't have happened? Well, simply put, everyone didn't do what was necessary to prevent this one, and we need to understand why. That is one aspect of the research we are advocating.

We have seen a continuing, extraordinary record of improvement to aviation safety. Most years, it seems, we are setting new records of safety, no matter what index has been

used. We are truly getting close to our goal of no accidents, especially in the FAR 121 operations of the larger carriers. We must be doing something right!

Well, we truly are. But our approach may need fine-tuning, especially as some of the fundamental underpinnings of our industry are changing:

a. Economic deregulation has taken us from a position where ample monies were available for maintenance, to a situation where efficiencies -- at least we hope they are efficiencies -- are important for improving the bottom line.

b. Tremendous growth has resulted in a field of operations professionals -- both pilots and mechanics -- which are less seasoned than they might have been before.

c. The competitive environment and availability of capital have resulted in carriers operating older aircraft, beyond the lives for which they were originally designed.

These factors are changing the operating environment, and we need to be sure we understand just how.

8. Preventing the Few Accidents We Have

The other problem is the low accident rate itself. There really are very few accidents. We've corrected all of the obvious problems. So unless we are willing to adopt a mentality of "you just can't eliminate some accidents," we've got to look pretty carefully at what's happening. And most people would call that research.

9. Summary

Of course, we do not assume that research itself is enough. But my responsibility, and our contribution to this conference, is to ensure that FAA has the charter needed to do the research. And to be one of those who says, we've got to spend some money to get the job done.

F. REMARKS OF THE HONORABLE DAN GLICKMAN, MEMBER OF CONGRESS

I am glad to appear before you today and would like to commend Mr. McArtor and the FAA for holding this conference.

One of the most serious and potentially volatile problems facing aviation today is the number of older aircraft in the commercial aviation fleet. Nearly half of the U.S. airline fleet was at least 15 years or older in 1986.

While aircraft inspections do take place at certain intervals, there is not a systematic program for testing and conducting "teardown" inspections of older or "geriatric" aircraft.

Without such in-depth and regular testing, we are faced with not knowing when the next tragedy will occur. We can't wait for a wing to fall off a plane to determine that our testing procedures to ensure it is attached correctly are faulty.

We need to validate the nondestructive techniques that are used regularly by following them up with destructive testing, such as complete teardown inspections.

The government should seriously consider purchasing selected aircraft in the geriatric fleet such as old DC9s, 727s, and 737s and run both nondestructive and destructive testing on the aircraft. CURRENTLY, THIS IS DONE ONLY AFTER SOMETHING DRAMATIC HAPPENS.

There's an old saying that goes, "what you don't know, can't hurt you." In the case of old aircraft flying around our skies, what you don't know, can kill you. Somehow, the intensive and routine testing and inspection of older aircraft have fallen through the cracks.

Two years ago, the House Science Subcommittee on Transportation, Aviation and Materials held a hearing entitled "Geriatric Aircraft: Aircraft Maintenance During an Era of Aging Commercial Fleets."

At that time, I expressed my concern about "the apparent inadequacy of the FAA's maintenance inspection system and workforce, particularly now that airlines are operating much older aircraft and devoting less of their operating budgets to maintenance".

Recently, at a hearing before the same subcommittee, I questioned FAA Administrator Allan McArtor about these same concerns and the need for the FAA to give more priority to research and development into the areas of structural fatigue, wear and tear and damage as a result of the age and intensive use of aircraft.

As much as we might hate to admit it, some of us especially, aircraft are much like the human body. As we get older, our bodies begin to experience more fatigue and wear and tear. We cannot continue to fly twenty-year old aircraft as if they are right off the line.

A clear, concise policy regarding the testing and inspection of older aircraft must be a priority of the FAA to avert future and potentially more serious incidents like the one involving Aloha Airlines.

In the last few weeks I have taken several steps that, I believe it would be accurate to say, precipitated the calling of this conference.

First, I successfully offered an amendment to the NASA authorization bill when it was before the full House Science,

Space and Technology Committee to earmark research funds to continue developing state-of-the-art inspection techniques especially useful for geriatric aircraft. This bill is scheduled to come before the full House this week.

Second, I introduced legislation directing the FAA to develop an operational research and development program into structural fatigue, wear and tear and damage to aircraft resulting from age and intensive utilization. Included in that program would be routine testing of several models of older aircraft; through "teardown inspection" procedures.

Third, I co-sponsored legislation along with Mr. Lewis and Mr. McCurdy that establishes a long-term research and development program to study a number of aviation safety issues including aging aircraft, aviation maintenance, fire safety, air traffic control projects, and aviation and weather and medicine projects. A hearing on both of these bills has been scheduled for later this month by the Transportation, Aviation and Materials Subcommittee.

In closing, the fundamental and threshold question that we face is this: How long can airplanes last? Only by doing this research can we answer this question and, in the process, perhaps saves thousands of lives. Thank you.

G. REMARKS OF THE HONORABLE TOM LEWIS, MEMBER OF CONGRESS

This conference was convened to address problems with the hope of delivering immediate solutions.

I would never presume to tell such a group of distinguished experts their business, but I think it would be both appropriate and advantageous if you also took the time to consider the long-term issue of detecting problems BEFORE they become accidents.

I speak with some authority and knowledge on these issues, with more than 17 years in aviation technology and more than 40 as a pilot.

More than anything, that experience taught me that MOST air accidents are preventable. That experience also taught me a lot about metal fatigue. The problem is ... what I know is what you know. Translation: Metal fatigue detection is not state of the art.

The Aloha Airlines accident on April 28 was preventable.

The National Transportation Safety Board will issue a factual report on that accident in the near future. I am convinced it will show extensive cracks, corrosion, and even evidence of deterioration that began several years ago.

I say this because I firmly believe neither our inspection nor maintenance practices can detect more than surface problems.

Last week, I introduced research legislation, H.R. 4686, to begin an aggressive, **LONG-RANGE** program to address these issues and much, much more.

I designed the bill to help find and correct problems - **BEFORE** they become accidents.

The legislation **mandates** studies of technologies to detect cracks and other maintenance problems.

The best way to detect a crack or leak today is to find cigarette tar stains on the outside of the fuselage. I would be surprised if this is not the case with the damaged Aloha Airlines 737, because the cracks are so old.

Unfortunately, problems like this have too often been corrected by what I call "graveyard actions" - often effective changes, but **AFTER** serious accidents or lives are lost.

This conference is a good example of what I'm talking about. It should have been convened a year ago, or even earlier.

My legislation also is aimed at developing a fire-resistant aircraft interior. Improvements in this area are long overdue and much too slow in development.

My dream is that one day there will be no lives lost in **ANY** survivable accidents, much like occurred on the 16-year old 727 that ran off the runway in Costa Rica last week and all passengers escaped 5 minutes before fire consumed the airplane.

In a related area, I think it is imperative that the FAA have only one goal, one responsibility: **SAFETY!!**

I introduced another bill, H.R. 4685, to repeal the FAA's responsibility to promote air commerce. We don't need the fox guarding the henhouse.

Before I leave I want to ask a few questions I urge you to address during this important conference:

a. What research should be conducted to detect maintenance problems in aging airplanes - before they become accidents?

b. What research should be conducted in the area of human factors so we have effective maintenance procedures?

And, in general, what long-term research should the FAA conduct that it is not presently doing?

Please contact me if you have ideas and suggestions along these lines.

We have the know-how, the resources, and the obligation. All that's missing is the commitment. I don't know about you, but my attitude is **LET'S DO IT!**

H. CLOSING REMARKS OF THOMAS McSWEENY

As I said earlier, the theme of this conference is "safety begins with safe aircraft." All of us here today have a role in making this a reality. In scheduling this conference, the FAA had some objectives in mind. We tried to include participants from every part of the aviation community -- both nationally and internationally so that we can hear what the rest of the world has to say on the subject of aging airplanes. The FAA certainly does not pretend to have all the answers. I am not sure we even have all of the questions. We are here to listen and to learn, to probe the issues, and to stimulate freethinking and new ideas on what might be done to improve the safety of aging airplanes.

As Administrator McArtor indicated, much has been done over the last 20 years to ensure the safety of the aging fleet, but in light of recent events, I believe it is appropriate to revisit what has been done to see if today's technology offers the opportunity to do even more. The FAA does not expect to resolve all of the issues in the next 2 days. We are looking for an opportunity to bring the issues pertaining to aging airplanes to light and to thoroughly discuss these issues with participation from all segments of the aviation industry. Looking at the size of the audience here today and the countries represented, I think we have the opportunity to learn a lot from each other about the safety of aging airplanes.

In the afternoon discussion sessions, participants should focus on both the FAR 121 and FAR 135 operations. The last time major emphasis was placed on aging airplanes, the commuter-type airplanes and operations were unique problems for both the airplane designers and the continued airworthiness of these type of airplanes. Hopefully, these issues will be thoroughly aired in the next 2 days.

We hope that this conference will only be the beginning of discussions on aging airplanes. I am sure there will be suggestions in the discussion panels that further technical meetings be held to explore the issues raised here. We will be glad to support any such meetings, but the FAA should not be the sole organizer of these meetings. The certification and operation of airplanes is an international reality. There is no such thing as a U.S. airplane since many of the parts and major assemblies of U.S.-manufactured airplanes are designed, manufactured, and approved outside of the United States. Many times, these airplanes are jointly certified by airworthiness authorities through bilateral airworthiness and other agreements. Thus, the responsibility for the safe design, certification, and operation of aging airplanes is a responsibility that all of us share. We hope that future meetings can be planned recognizing this shared responsibility.

I would like to establish some ground rules that will hopefully lead to more productive discussion sessions. The conference and all of its sessions is open to anyone who wishes to attend, and there is no fee for attendance. Members of the press are welcome to attend the individual discussion sessions but with pad and pencil only! These sessions are closed to radios, television cameras, and tape recordings. Please make certain too that you pick up a press kit. They are available in the press room. The FAA will have two people taking notes during the sessions to capture the general content and views of the participants. These general notes will be used to prepare a summary of the conference to assist the FAA in determining any further actions.

There will be four sessions this afternoon--airframe, nondestructive inspection (NDI), human factors of inspection, and engines. Some of the items raised may be the same in each

session, but the chairman will try to stay close to the subject of the session. All of the sessions are self-explanatory, except for the human factors session. The goal of the human factors session is to achieve a better understanding of which inspections can and cannot be accomplished. Topics of discussion will include: are there boredom factors that enter into the inspections, do the designers of the inspection programs understand the human factors involved, etc.

Each discussion room will have two head tables. The chairman and cochairman will be at one, and a panel of FAA experts from the engineering, manufacturing, maintenance, and operations elements of the FAA will be at the other one. The chairman will facilitate the discussion session to ensure that the discussions continue to flow and that everyone is given an opportunity to comment. To ensure that all of the participants can hear the commenter and that only one person speaks at a time, those wishing to comment must be recognized by the chairman and will be handed a microphone. Please do not attempt to speak without being recognized by the chair. Before speaking, we ask that you identify the segment of industry that you represent -- such as manufacturer, pilot, airline representative, airworthiness authority, the media, the public, and the like. This will help everyone to better understand and categorize the comment. We do not need to know your name and company affiliation. So that we can hear from as many of the participants as possible during these sessions, please keep your questions or comments brief and to the point. Although we know that all of you are just as proud of the companies that you represent as we are of the FAA, we would also like to request that you refrain from using the floor to advertise your services or products.

Comments by the members of the FAA technical panel should not be taken as the FAA's final position on any subject but merely the technical opinion of the individual. The panel will attempt to draw out the technical content of the discussions to ensure that all aspects are fully pursued. They will also ask questions of the general audience to raise issues that the FAA believes should be discussed.

Each discussion session will begin with the questions that the administrator posed in his opening comments. Once those questions are fully discussed, anyone from the audience will be free to raise any issues or ask any questions of the general audience that they wish. Please refrain from introducing a new subject until everyone has had an ample opportunity to speak about the subject at hand.

CHAPTER II. AIRFRAME PANEL DISCUSSIONS

The Airframe panel meetings were attended by over two hundred people in each of the three sessions. The principal speakers were from foreign civil airworthiness authorities, major manufacturers (AIA), foreign manufacturers, FAR 121 operators (ATA), general aviation manufacturers (GAMA), the U.S. military, and U.S. Government agencies (NASA), foreign operators, pilots (ALPA), and learned individuals.

Airframe Panel Members

CHAIRMAN: Tom McSweeny, Manager, Aircraft Engineering Division, AWS-100.

COCHAIRMAN: Bob Cook, Accident Investigation Division, ASF-100.

PANEL MEMBERS: Jim Hart, ANM-120S, Bill von Brockdorff, ANM-120L, Tom Swift, NRS, Jim Shiner, AFS-300, Jerry Mack, ACE-115A, George Sedlack, ANM-270S, and Jim Wong, Van Nuys MIDO.

Notetakers: Dayton Curtis, ANM-110, and Mike O'Neil, ANM-120L.

A. RESEARCH AND DEVELOPMENT (R&D)

An operator voiced the suggestion that some work be done to develop a reliable nondestructive test (NDT) method for the detection of corrosion.

Several operators expressed the desire to have R&D work done on coatings to both prevent and protect from corrosion. The operators voiced concern that the knowledge gained over the past 25 years is going to be lost because of conflict between FAA and EPA (Environmental Protection Agency) requirements; especially with the currently used chromate coatings.

With regard to the possibility of funding mentioned by the representatives from Congress, an operator stated that the funding provided for R&D should come without any political strings attached. The operators also expressed concern that no one with an "axe to grind" should do the research, and likewise the research should not necessarily lead to mandatory action.

A representative of a foreign civil airworthiness authority (FCAA) asked that some R&D work be done in establishing an appropriate scatter factor. (Tom Swift, FAA National Resource specialist (NRS) in fracture mechanics and metallurgy responded that scatter factors of 2.0 for redundant structures and 3.0 for single bond path structures had been used historically.) While these factors did not originally correspond to specific reliability values, they roughly correspond to those used for static strength analysis of 90% and 99% probability of survival respectively with 95% confidence. It was suggested by an NDT manufacturer that a study be conducted to determine what NDT research has been accomplished by both the military and NASA and to determine whether the data are applicable to the civil fleet. The manufacturer also posed the question as to just what are the

needs of the civil fleet? There was no specific response to the question.

An operator commented that somebody other than the operators or regulatory bodies should do the research to establish a technical finding. The same operator stated that were the FAA to do the research, the finding may become a mandatory regulation.

B. FATIGUE TESTING

A representative of an FCAA stated that fatigue testing done prior to certification is predicated upon economics rather than safety.

A representative from the U.S. Navy stated that there should be a requirement for a civil aircraft fatigue life and an appropriate scatter factor.

A U.S. Air Force representative stated that fatigue testing is necessary to ensure safety together with damage tolerance criteria.

A foreign manufacturer stated that the purpose of the fatigue test is to verify a relatively crack-free service life and to assist in determining the economic repair life of the article.

An operator proposed that an airplane be fatigue-tested to two lifetimes and then operated to 3/4 of the test lifetime after which the airplane would be discarded.

A representative from the Airline Pilots Association (ALPA) proposed that a service life be established for both airframe and components. For the airframe or component to be operated beyond that time would require the issuance of a supplemental type certificate (STC) which would establish a 'finite' life extension for that component or airframe.

A foreign operator commented that not just the primary structure should be considered. It is the secondary structural parts which fail first. Therefore, secondary parts should be addressed as well.

An operator made the comment that fatigue testing does not give a complete picture. It only represents a small portion of the operators' total maintenance program.

It was stated by a structural consultant that safety depends on finding and fixing fatigue damage. A full-scale fatigue test is very reliable in identifying what is needed for both. The fatigue test must be followed by a rigorous in-service inspection program. This program must be required by FAA.

An Air Force representative stated that, if done properly, a fatigue test of an older airplane could yield valuable data.

It was noted by an FCAA representative that follow-on or derivative aircraft should meet the latest fatigue requirements.

A foreign operator asked how one defined an aging airplane to which an FCAA representative replied 'when it's gone beyond the twinkle in the designer's eye' and that two lifetimes of fatigue testing were necessary to ensure safety.

An FCAA representative stated that there is one commuter airplane whose design life was determined by analysis only.

A structural consultant stated that a fatigue test, in terms of damage tolerance, on an in-service airplane, whose previous loading history is unknown, means nothing. A good load monitoring system is necessary to be able to extend the life of in-service airplanes. Cracks are going to develop on in-service airplanes. Inspection programs are necessary to detect those cracks. The existing fleet of old airplanes were not designed to damage tolerance criteria.

It was stated by both operators and a manufacturer that safety would be assured by the operators continuing maintenance and inspection programs.

The question of whether there should be mandatory fatigue testing was asked by the session chairman to which there was a great deal of discussion with no apparent consensus.

A manufacturer stated that fatigue tests were done to identify critical areas of the structure - not to determine a life for the article.

It was stated by a foreign operator that they would like to see the European authorities who use JAR and FAA get together on the requirements for fatigue testing.

A manufacturer asked that if FAA mandated fatigue testing would FAA also define the test spectrum? The National Resource Specialist (NRS) said no but the FAA should be required to approve the spectrum.

A Navy commander stated that the airplane should be retired when it reaches its demonstrated test life, or a new test program to demonstrate a longer life should be established.

C. MULTIPLE SITE DAMAGE (MSD)

The FAA NRS on Fracture Mechanics and Metallurgy stated that widespread multi-site damage could invalidate the failsafe design features of the current aging fleet. The failsafe philosophy is predicated on an obvious partial failure being detected during normal maintenance inspections.

A structural consultant stated that if the operators can detect small cracks, then safety is accomplished. It becomes a question of economics. When the cost of inspection/repairing the airplane exceeds its income, it is time to retire the airplane.

An operator stated that it is necessary to look at all probable MSD locations, especially if damage is found at one site.

An unknown commander stated that a two lifetime fatigue test was necessary to ensure that no significant MSD would occur in one design lifetime.

An operator commented that residual strength should be reviewed considering the possiblity of multiple flaws.

An operator stated that the issue in MSD is the critical crack length along with the ability to reliably detect multiple cracks.

D. PROOF PRESSURE TEST

The question of accomplishing a proof pressure test on aging fuselages to extend their service lives was raised by the panel.

An FCAA representative stated that there must be a very rigorous inspection both before and after the test. It has been their experience that proof testing had caused more problems than it has solved because of damage caused by the test. The same opinion was voiced by an airline representative based on his past experience with pressure vessel tests. Another operator was in favor of spending the money on NDI research and stated that corrosion was the major problem.

An Air Force representative stated that, based on some quick calculations, a proof test inspection philosophy using a 1.33P proof pressure could be a very viable approach for the aging fleet. He also suggested that much could be learned about multi-site fatigue damage by teardown inspection of old airplanes.

E. CORROSION

It was stated by several operators, both foreign and domestic, that the most critical problem with aging airplanes is not fatigue but corrosion. A foreign operator stated that 95% of his parts removals were for corrosion.

Several operators said that reliable NDI techniques need to be developed, together with better corrosion protection and better coatings being used in the design of the airplanes.

An unknown commentor stated that corrosion is the least mentioned problem in the aging fleet and that the authorities seem more concerned with fatigue testing.

An operator stated that if the corrosion can be detected, they know how to take care of it.

The panel posed a question of the necessity for a mandatory SID program addressing corrosion. Several operators stated that this would be difficult because of the varied climates experienced by the operators.

An operator stated that corrosion control is adequately addressed by MSG-II and MSG-III (Maintenance Steering Group Planning Methods). This comment was followed by a manufacturer's statement that there is a need to ensure that people are doing the right things.

An FCAA stated that corrosion control is necessary but it must be flexible to account for differences in aircraft, environment, operations, etc.

It was mentioned by an FCAA representative that there was to be an international meeting on the subject of corrosion in March 1989 in Scotland.

An operator mentioned that industry does have a committee which is working on corrosion problems.

F. NONDESTRUCTIVE INSPECTION (NDI)

An NDI equipment manufacturer stated that before he can design new equipment or develop new inspection techniques, the where and what is to be detected must be defined.

An operator commented that a good reliable technique to detect the condition of bond lines was needed.

The panel posed the question as to whether it was economically/humanistically possible to detect widespread MSD by NDI. A foreign manufacturer stated that this was dependent on the size of the aircraft.

It was noted by several people that automatic inspection techniques should be developed - techniques which take the human element out of the loop. The comments were made in discussion of detailed inspections of individual fastener holes in splices where tedium and the tremendous number of holes to be checked could affect the accuracy of the inspection.

A foreign manufacturer stated that the NDI techniques were developed and checked out by their structures people and that the skill level of the operator in the field was defined.

A foreign carrier commented that NDI results are dependent upon the skill of the operator and that the results may vary.

An operator stated that the question is really one of continuing vigilance and motivation for the day in/day out operations. He said that additional training may not be the answer. Another operator stated that their training program attempted to educate the inspector with the importance of the inspection and the ramifications of missing existing damage. A different operator went on to say that it was always their 'best'

man who failed to detect a flaw and the less experienced who found it.

It was stated by an operator that some damage tolerance training would be beneficial to the NDI inspector. He also said that damage tolerance training would be beneficial for those people who write up the work cards.

A manufacturer mentioned that some NDI training was being developed by them for use in the SID programs and for service bulletins.

A representative of the U.S.A.F. stated that they are doing work on techniques which do take the man out of the loop, but there has not been sufficient funding nor pressure to bring them into regular commercial use.

A foreign operator who does contract maintenance for others pointed out that they have found defects that must have existed when prior inspections were done.

There appeared to be some consensus among the regulatory authorities that there was a need to improve and standardize training for NDI technicians.

There was dissertation on the benefits of the acoustic emission (AE) technique and on some of the programs in which AE had proven to be beneficial. A statement by a NASA representative indicated that their experience with AE had been such that he didn't believe that it would be useful for a structure as complicated as a complete airplane.

A foreign operator stated that the quality of NDIs performed in a controlled environment such as a hangar were better than those performed in the field.

G. SUPPLEMENTAL INSPECTION DOCUMENT (SID) PROGRAMS

An operator stated that they haven't found the damage that they expected during SID inspections.

A designated airworthiness representative (DAR) stated that the SID did not work for Aloha. A manufacturer responded that Aloha was covered by service bulletin (SB) and airworthiness directive (AD). The manufacturer further questioned whether SID inspections are being conducted properly, and also wondered whether, as written, the SID inspections could be conducted properly.

An operator cautioned to not underestimate the value of the SID programs as they require the opening up of areas of the airplane which are not normally inspected. Another stated that the operators were a party in developing the SID programs.

A DAR commented that the SID programs are sometimes accomplished on paper but not in practice.

A foreign operator noted that the NDI methods being used today are good and can adequately protect the current fleet. He also said that SID programs are good if properly used.

The panel posed a question of whether a SID type program should be required for corrosion. An operator commented that a mandated corrosion program would be difficult because of the varied operating environments found worldwide.

A foreign operator stated that feedback from the operators to the manufacturers is essential to make the SID programs work - especially international feedback. The manufacturers should be responsible for international feedback. Another operator stated that international feedback was very good for the 707 and that it

was U.S. operators who were conspicuously absent. A manufacturer stated that feedback from operators is mandatory and is being accomplished.

A manufacturer commented that although commuter airplanes (FAR 135 operators) are less sophisticated than large transport airplanes, the requirements for a SID program should exist for them also. He also stated that the maintenance programs for commuter operators are likewise less sophisticated.

An FCAA representative stated that most of their commuter fleet is safe-life designed and that components are periodically retired. The retirement criteria for one U.S.-manufactured airplane is two spar lifetimes on a single spar airplane. The spar lifetimes are manufacturers' lives based on analysis and fatigue test.

The panel posed the question of whether the Maintenance Review Board (MRB) met often enough and if the MRB documents were reviewed often enough. An operator responded that the MRB document was the initial inspection document and was subsequently modified by each carrier to meet his particular operating environment. Another operator questioned the necessity for reviewing the MRB document. The panel replied that the MRB was updated to include derivative airplanes and as initial programs for operators new to that type of airplane.

The panel questioned the operators' practice of continually increasing inspection intervals. An operator responded that they are continually reviewing their experience and varying the inspection intervals based on their experience. We must rely on the established system and the individuals in the system to be responsible citizens.

An operator stated that the manufacturer does not operate airplanes and, therefore, cannot be all knowledgeable on the continuing maintenance program. Continuing maintenance is the responsibility of the operator and is a dynamic, continuing program. A manufacturer said that they are an intermediary between operators and a supplier of information for the initial MRB.

An FCAA representative stated that the manufacturer knows the airplane because he designed and built it. Operators may know corrosion better but they don't have the capability to do the analyses required to establish inspection intervals for fatigue cracks as the manufacturer does. The probability of detecting a crack is less than one, therefore, more opportunities to detect flaws are needed.

A manufacturer stated that the operators must evaluate their own maintenance/inspection programs, and that they are the only ones who can do so.

The panel asked if the current sampling philosophies of the SID programs should be revised to 100% inspection. An operator asked for the technical reason to support the change. The panel responded that the reason was the rogue flawed airplane.

A manufacturer stated that rogue flaws are considered in the inspection intervals and that fail-safe design should prevent problems with rogue flaws.

An FCAA representative stated that he has problems accepting sampling programs covering rogue flaws.

Another manufacturer stated that the rogue flaw is a random event and would be detected by normal maintenance or as a feature of the design. The SID programs are designed as a

supplement to the operator's normal maintenance programs. Normal corrective action would follow a SID detected flaw. Sampling is a necessary feature of the SID programs.

It was stated that the question of a rogue flaw should be addressed to the entire fleet, not just older airplanes.

An FCAA representative stated that the rogue flaw is a legitimate fatigue failure and that we had all better do something about it.

An operator stated that they haven't found the damage that they expected during the SID inspections.

H. SERVICE BULLETINS (SBs) AND AIRWORTHINESS DIRECTIVES (ADs)

The question was asked by the panel as to whether all service bulletins were accomplished by all operators.

A foreign operator said that they accomplished all service bulletins and service letters.

A foreign manufacturer said that he thought that all service bulletins were mandatory. He also stated that they have problems getting feedback from operators even if the operators had a resident company representative on site.

An operator stated that each service bulletin is evaluated against their existing maintenance program to determine its impact. Another said they make an economic evaluation to determine the best way to accomplish the bulletin. It was said by another that they review each bulletin and make changes to both their system and the airplanes to ensure safety and reliability.

An owner/lessor recommended getting the lawyers out of the AD writing process in response to a panel comment about the 'CAA Mandatory' stamp which is not in concept with the U.S. rulemaking procedure. ATA stated that the U.S. rulemaking procedure requires the public be allowed to comment on proposed rules.

I. AIA/ATA RECOMMENDATIONS (See Appendix 1)

The following is a summary of comments heard on the AIA/ATA recommendations. The complete list of recommendations is included as Appendix 1.

Recommendation 1

ALPA representatives reiterated their desire to see a service life established for both airframes and components with operation beyond those times supported by an STC which defines a new retirement time based on new testing.

A manufacturer said that they don't feel an STC should be required because enough information is currently available.

An operator stated that inspection intervals for corrosion are dependent upon the operating environment of the airplane.

A U.S.A.F. representative stated that the current inspection system did not catch the Aloha problem - need a sense of urgency to account for this.

An FCAA representative stated that the current system is OK if we know where to look, how to look, and when to look. We clearly do not know that now. An unknown person stated that these statements lead to recommendation number 3.

A manufacturer referred to the second sentence in the recommendation. They are going to look for the problem with the Aloha inspection.

Recommendation 2

A manufacturer stated that good NDI methods were needed to assess the condition of bond lines as no such methods exist at this time.

Recommendation 3

A lessor/owner said that the concept of 'oldest' airplane must be kept in context and that too much faith should not be put in a teardown inspection because of the great variety of operating conditions which exist.

A foreign manufacturer stated that a teardown inspection is a very time-consuming and complex procedure which is very labor-intensive and expensive. Another manufacturer said that they were aware of the time and cost but teardowns are a way of life for them - they just spend the time, money, and manpower.

The panel questioned whether this test would be of a complete airframe or limited to a specific portion such as the wing or fuselage to which no comments were received. The FAA NRS for damage tolerance stated that he applauds the position of full-scale fatigue testing of old airplanes and will support the proposal as he is able.

A manufacturer said that they had purchased a high time airframe and tested it to about five originally estimated life-times. He also supports testing of all models of old airplanes.

The panel chairman said that the rules state 'the applicant must demonstrate...' and asked whose job is it to prove the airplane airworthy and questioned aircraft manufactured outside the United States.

AIA/ATA commented that there were provisions in pending legislation which would charge FAA with this task.

An operator stated that the money should be taken from the aviation trust fund.

An FCAA representative asked if this testing were in addition to a certification fatigue test and at what age should older aircraft be tested.

A NASA representative questioned the pedigree of the test article and having one test apply to several different type designs. An FCAA representative replied that each model would have to have its own fatigue test.

A U.S.A.F. representative stated that civil aircraft in storage at Davis Maritime AFB might be viable candidates for testing.

An unknown person said that testing of the old airplanes was all well and good but not to forget the testing of new airplanes.

A manufacturer stated that we've caught all the hot spots, so far, except for Aloha. The system works pretty well.

The panel stated that airplanes are currently able to withstand large damage, and that the thing to be concerned about is widespread multi-site damage.

A manufacturer questioned whether widespread damage could be detected and corrected.

An FCAA representative questioned why another airplane should be taken out of service when it is the manufacturer's responsibility to show the life of the airplane.

A foreign operator suggested that a thorough inspection be accomplished at a defined life. Based on the results of that inspection, the life of the airplane could be extended by a finite amount.

ALPA reiterated their proposal for an STC to extend life-times with an additional suggestion of charging for the STC and using the proceeds to defray the cost of the testing.

An ex-Navy pilot defied anyone to find a 'typical' airplane. In his experience, the units with the best aircraft were those with the best corrosion inspection programs.

A foreign operator asked that if there are airplanes operating beyond their design life, how valuable was the original fatigue test. A panel member responded that not all of the existing fleet had been fatigue tested.

It was stated by a manufacturer that a fatigue test by itself does not assure safety - failsafe/damage-tolerant design does.

An unknown person made the statement that checking just one airplane doesn't give you a fleet life. He regards the AIA/ATA proposal as proactive and the comments he has heard as passive.

ALPA suggested that a scatter factor of two be used together with 60,000 hours. He considers his proposal to be proactive.

An FCAA representative suggested that the proposal to test be amended to be applicable only to those airplanes which had not been tested during certification.

A foreign manufacturer stated that fatigue testing an aging airplane might not create multi-site damage.

A GAMA representative reminded those assembled that there is a level of confidence in the certification program that has been conducted on the airplanes. Don't lose sight of the approved maintenance programs for the airplanes.

A representative of the panel stated that we've given the airplanes ultimate strength, failsafe, and damage tolerance design but there is a time when failsafe structure may be subject to widespread multi-site damage which may degrade the failsafe capability of the structure.

The panel chairman asked how it would be decided which service bulletins were to be accomplished. A manufacturer responded that a panel should decide on those bulletins to be accomplished. As to how the test would affect the fleet, the manufacturer responded that if the operators wanted to take advantage of the test results, they would have to incorporate these bulletins.

Another manufacturer commented that knowing which service bulletins were to be installed and the previous history of the airplane should not be a deciding factor in doing the test.

The panel chairman asked if there were any proposals relative to foreign manufactured airplanes and who should pay for it.

An FCAA representative stated that the authorities who sponsor the Joint Airworthiness Requirements (JARs) would hopefully incorporate the requirements.

A foreign operator asked what was going to happen while all these tests are in progress. He has the oldest DC-9 fleet. They updated the structure of their entire fleet ten years ago and are going through the same type of review program with the

manufacturer at the current time. Inspection and repair, as necessary, is the best accident prevention when it is done correctly.

An operator seconded the previous comment. He stated that the enemy in this battle was the second law of thermodynamics and that the operators are the ones in the trenches. The FAA must ensure that the operators are doing the inspections that they should. FAA inspectors should put on overalls and ensure that the approval programs are being accomplished on the airplanes and not just check the paper.

A structures consultant said that a fatigue test would give information for that model only, not all models. To get data on the 'zipper' effect, hundreds of panels should be tested.

The panel chairman stated that recommendation 3 is not a Boeing proposal, but rather a consolidated position presented by a representative from Boeing.

Recommendation 4

There was no discussion.

Recommendation 5

An operator stated that this should include international knowledge.

A foreign manufacturer stated that they will be contributing to the conference on corrosion in Scotland in March 1989, and that proposals are due by the end of July. The subject of the meeting is general aircraft and corrosion.

A foreign manufacturer said that NDI techniques should be more automated.

An FCAA representative said that the Advisory Group for Aerospace Research and Development (AGARD) has R&D work on NDI.

Recommendation 6

A panel member stated that NDI inspectors should be certified.

Recommendation 7

A manufacturer/airline group representative said that in recommendations 7 and 8 they were primarily concerned with feedback, including international and lessor/owner feedback. An FCAA representative said that maintenance organizations should also be included.

An operator stated that on the recent 737 telegraphic ADs there was FAA/manufacturer coordination but there was none with the operators.

An ALPA representative said not to treat human error as negligence.

An FCAA representative stated that they depend entirely on FAA and the manufacturers for information. It is important to trust them with the whole story. They need the information and will not release it to the press.

A GAMA representative said that communication goes beyond just the normal and routine - it has to include sensitive information.

Recommendation 8

AIA/ATA stated that they were looking at task forces like Administrator McArtor's on flight crew performance. AIA offered to host that kind of activity. They did not have specific task groups in mind but those groups must be small and locked in a room with a goal and a deadline. They also offered that SAE-type committees had too much bureaucracy involved to be effective.

CHAPTER III. NONDESTRUCTIVE INSPECTION (NDI) PANEL DISCUSSIONS

The average number of participants in the NDI panel discussion was about 60. The principal speakers were ATA, manufacturers, FAR 121 operators, maintenance personnel, and a metallurgist/consultant. Persons representing foreign civil airworthiness authorities and operators participated to a lesser extent. There were apparently no FAR 135 operators present until the very end of the meeting, and few FAR 135 issues were addressed as a result.

NDI Panel Members

CHAIRMAN: Barry Clements, Aircraft Certification Division Manager, ACE-100

COCHAIRMAN: Fred Duval, Aircraft Evaluation Group, ANM-270

PANEL MEMBERS: Larry Ryan, Airworthiness Section Supervisor, Denver FSDO
Bruce Kozinski, Airworthiness Safety Inspector, MPLS FSDO
Doyle King, Principal Inspector, Boeing Wichita MIDO
Doug Sharman, Manager, Structures and Dynamics Section, ANM-120L

Notetakers: Don Plouffe, Aircraft Safety Inspector (MGF), AWS-200
Melanie Miller, Regulatory Program Specialist, AWS-200

A. STANDARDS FOR NDI TRAINING AND QUALIFICATIONS

It was generally agreed by all participants that there is an insufficient number of qualified NDI inspectors, although one carrier stated that there is no shortage for large carriers, only small ones. One mechanic representative complained that NDI training by airlines is minimal, and that NDI is sometimes performed on an aircraft during the night shift when the only qualified NDI inspectors were assigned to the day shift, and that there is pressure to get paperwork OK'd even if inspectors are uneasy with the results. Others stated that such a situation would be the fault of the operator, not the system.

Nevertheless, most agreed that the FAA should issue minimum standards for training, recurrent training, and qualification of NDI inspectors, as well as take steps to upgrade the NDI training of its own inspectors and engineers. There was a widely held perception that the FAA also lacks NDI expertise, and that Principal Maintenance Inspections (PMIs) and FAA engineers should receive training in the area. Without such knowledge, one operator pointed out, PMIs shouldn't be approving the NDI portion of manuals.

The idea of adopting the American Society of Nondestructive Testing (ASNT) system of qualification in whole, or in part, was also discussed; it appeared that most agreed that ANST material could be used as a basis for development of material by the FAA, but that operators should incorporate the FAA's material into their training program; it was emphasized by an operator that being ASNT qualified doesn't mean the inspector can accomplish aircraft inspections. Others suggested adding NDI to the airframe and powerplant (A&P) license. Only two operators stated that their training programs currently used ASNT-type standards. FAA certification of NDI inspectors was not favored by many; most preferred the notion of incorporation of standardized material

into their operating specifications instead. The ATA suggested putting together a draft AC for the FAA's use. One unidentified participant asked whether this action would be workable for small carriers; no one responded.

Foreign operators mentioned that the United Kingdom CAA certifies and closely regulates NDI inspectors, as do other countries.

An air carrier suggested that the FAA encourage aviation schools to add NDI to their curriculum or beef up current courses. The mechanic representative stated that manufacturers' NDI training is far superior to that of the airlines, and a manufacturer agreed.

ATA expressed considerable concern that other agencies such as states or the Nuclear Regulatory Commission (NRC) may take over regulation of aviation NDI.

A GAMA representative stated that there are many service centers doing NDI for small outfits, but that they may have no aircraft structural experience, and that GAMA has, therefore, set up a certification program for such labs.

C. AIRWORTHINESS DIRECTIVES AND SERVICE BULLETINS INVOLVING NDI

There were many concerns expressed with respect to the AD and SB system.

1. Alternative methods of compliance. There was considerable feeling expressed by operators that ADs do not adequately provide for -- nor, operators complained, do manufacturers adequately support -- alternative methods of accomplishment. Air carriers complained that they are "bound by the manufacturers' recommendations," and if they attempt to improve on them they're subject to enforcement actions unless they get FAA approval. Operators and the ATA complained that the FAA's approval process is too time-consuming (one carrier said this was because PMIs are untrained in NDI), and that the FAA should not require each one of them to ask individual approval of an alternate method, but that approval to one operator should be approval to all. The JT8D burner can AD was cited as an example of this problem.

Operators also complained of occasional inconsistencies between ADs and SBs. Finally, they pointed out that many older ADs, which are still effective, call out obsolete inspection techniques, and should be updated or amended. The manufacturers did not respond to this suggestion, except to say that there is a question as to what's a detectable flaw size, and in determining the ability to identify it repeatedly.

One air carrier countered with the assertion that the Supplemental Structural Inspection Documents (SSID) program under which it operates does offer alternative NDI choices.

2. The Aloha AD. Several air carriers complained about the Aloha AD, and requested a quicker but equally accurate inspection technique. The manufacturer responded that the 737 eddy current procedures were more reliable than faster techniques, and that was why they were called out; however, they are looking into the possibility of using quicker methods.

3. Clarity of ADs and SBs. Generally, the participants agreed that ADs and SBs were reasonably clear, although operators complained that there are occasional inconsistencies in such matters as compliance time, which they found frustrating (this is further discussed below). One air carrier mentioned that some manufacturers now use videotapes to demonstrate procedures, which was very helpful.

Transport Canada and a foreign operator made separate comments that they would like to see ADs specify the training level required for the inspectors accomplishing the AD.

One operator complained about implementation of SSIDs by ADs, stating that they don't know what to do with cracks they find.

4. Disparities between manufacturers. The mechanic representative pointed out that disparities in maintenance and inspection techniques between manufacturers (e.g., the Douglas vs. Boeing methods) are a burden on the airlines, and asserted that the FAA should issue a list of approved procedures.

5. Inspection intervals. A manufacturer stated that it is the manufacturer's function to determine inspection interval, using statistical methods, and that generally operators are consulted in setting the intervals before the SB is issued; most operators use the recommended intervals. The ATA agreed, although it noted that operators use different ABCD check intervals. The FAA asked if the operators should be forced to make these intervals consistent, to which one airline researcher/consultant agreed. One operator said it should be left to the operator and its PMI. Another operator complained that whenever an SB is turned into an AD, it is to be accomplished before further flight, depriving the operator of flexibility.

The related issue was inconsistency between manufacturer's recommendations for inspection intervals and the FAA's mandate in the AD. The operators argued that they should be the same, and that the manufacturer's recommendation should be used by the FAA since the manufacturers have the computer programs. The operators also noted that their personnel generally only look at the accomplishment instruction part of the SB, rather than the intervals specified in the AD, and may get into problems as a result.

D. DISBONDS

The audience was asked how they currently detect disbonds. There was little response. One manufacturer said it used ultrasound, with a wide variety of instruments, but that this only detects a void. An air carrier agreed, noting that visual inspections don't work. When asked if eddy current was used, the audience did not respond.

E. POST-ALOHA INSPECTIONS

There was no response from the participants to the question of what they had found in their post-Aloha accident inspections, except that one operator noted a "quick change" in their maintenance philosophy, that is, to try and take more preventive measures for corrosion.

F. LIFETIME OF AIRCRAFT

The participants appeared to agree that the safe lifetime of an aircraft is and should remain an economic determination: as long as it is profitable to pay for maintenance and repair should be the definition. None agreed that there should be an absolute cutoff date; one metallurgist consultant and the NTSB urged that there should be a point beyond which visual and NDI inspections and repairs shouldn't be considered enough, but no operators or manufacturers agreed. NASA pointed out the reverification of one of the Boeing military aircraft after the Vietnam war, asserting that such "proof-testing" could be accomplished on commercial aircraft as well. ATA disagreed, arguing that this would be too hard on aircraft.

ATA urged that aircraft are almost entirely replaced with new frames, panels, and stringers, and are thus renewed constantly, and that it would be impossible to set a specific retirement date. The manufacturers disagreed strongly with the notion that after a certain point NDI and visual inspections are inadequate; one said "if one visual inspection is good, then 1,000 are good." Supplemental structural inspection documents were mentioned by operators as a working and adequate means of continuing aircraft use safely.

G. INSPECTION ASSUMPTIONS

The audience made no response to the Administrator's question as to whether inspection assumptions in aircraft design, structural repair manuals, ADs, or SBs were "in tune with" today's maintenance and operational programs.

H. NATIONAL RESOURCE SPECIALIST

All participants appeared to endorse appointment of a national resource specialist for NDI. One operator asked if the specialist could be used to okay alternative AD compliance methods, since FAA currently lacks NDI expertise to process such requests quickly.

I. AIA/ATA RECOMMENDATIONS

The AIA/ATA recommendations were read aloud to the participants, and since most of the points appeared to reflect the discussions already held, there were few comments made on most of them. Participation by the FAA in the ATA NDT forum was again heartily endorsed, and a representative of the military recommended the Department of Defense's NDT forum as well. The ATA also mentioned the ASNT NDT forum, noting that it isn't aviation-oriented.

With respect to the proposal of acquiring and tearing down older aircraft, one independent consultant described a possible program that FAR 135 operators could use to get the most of their more limited resources, by joining together to test one aircraft or requiring sampling of the aircraft in their combined fleet.

Generally, the participants did not concur with the statement by one participant (a consultant) that competition and fear of liability have squelched open communications between the airlines and manufacturers. Instead, most agreed that particularly in the area of maintenance and NDI, people are open. ATA stated, and two manufacturers agreed, that communications between manufacturers and commuter airlines are not good.

Many seemed to agree with ATA's expressed dislike of the current service difficulty reporting (SDR) system, in that it takes too long and is of questionable value, since ADs rarely result from it. The participants indicated that communications with the FAA could be better, and in particular, better contacts with the regional offices. With respect to ATA's recommendation of a task force on NDI to consist of manufacturers, NASA, FAA,

and the airlines, ATA volunteered to implement this proposal itself. One small airline requested that the FAA set up seminars to talk to nonmanagement personnel in the smaller airlines about the FARs and advisory circulars (ACs).

CHAPTER IV. HUMAN FACTORS OF INSPECTIONS PANEL DISCUSSIONS

The number of participants attending fluctuated between 80 and 100 persons. The audience was composed of representatives from foreign and domestic air carriers, charter operators, aircraft leasing companies, manufacturers, European and Canadian civil airworthiness authorities, the Air Transport Association, and the Flight Safety Foundation. Some individual participants included airframe and powerplant mechanics, aviation consultants, airline pilots, DARs, an industrial psychologist, a representative from the General Aviation Manufacturers Association (GAMA), and a writer from an airline-oriented periodical.

A number of these individuals addressed the concerns of the FAR 135 operators and their needs, although only one person identified himself as a member of this industry. The thrust of the meeting was oriented toward the problems and needs of the major air carriers.

Human Factors Panel Members

CHAIRMAN: Ray Ramakis, Aircraft Maintenance Division, AFS-300.

COCHAIRMAN: Leroy Keith, Manager, Aircraft Certification Division, ANM-100.

PANEL MEMBERS: Rich Yarges, ANM-120S
Bill Perella, ANM-120S
Gary Goodwin, ANM-270
Jim Ortize, CHI ACDO 31
Al Santarelli, AWS-201
Gale Braden, ASF-300

Notetakers: Owen Schrader, ANM-120S
Dick Edwards, CHI ACDO 31

A. INDUSTRY PROGRAMS

It was generally agreed by the U.S air carriers that an audit be conducted by the operators, manufacturers and the FAA to standardize the accomplishment, reporting, and recordkeeping requirements of the inspection process, and to incorporate a separate inspection activity to deal with Airworthiness Directives (ADs). A FAR 121 operator agreed and suggested the establishment of a quality index to support air carrier responsibility.

B. INSPECTION PROCEDURE PREPARATION

It was expressed by an aircraft manufacturer that inspection procedures should be based on the Maintenance Review Board (MRB) document and not amended or diluted by the operator. An air carrier quality assurance representative suggested that the factors of available time, whether the inspection was a one-time action or a repetitive one, company carryover policies and the desired result of the inspection be considered in the preparation of the inspection procedure. One air carrier responded by noting the differences in inspection requirements and quality between those inspections conducted in daylight and those accomplished in darkness. However, as one aircraft lessor stated, it is required that clear and concise instruction be provided for the procedure to be effective.

One U.S. carrier expressed the need for defined inspection and production responsibility within the procedures.

During the discussion of this question, the subject of disciplinary action toward inspectors arose. Very diverse opinion was generated regarding the situation of an inspector who finds a defect, and on reporting it, causes the delay or removal of an aircraft from service. One U.S. carrier felt that if the inspector did not find the defect, he should be disciplined. One operator stated that the inspector should not be disciplined, and all employees of an air operator should be inspectors. A foreign carrier commented that he could not understand the concept of discipline for the finding of a defect. He noted that good judgment factors and deferral or delays for repair can be utilized to correct most findings. No conclusions arose from this discussion because of the diversity of opinions presented.

C. UNDERSTANDING AIRWORTHINESS DIRECTIVES AND MAINTENANCE MANUALS

When the question as to whether or not airworthiness directives were hard to understand was posed, the majority of the response centered on the clarification of nomenclature, the use of more simplified English terminology, the processing of the AD by engineering groups and the planning staff who amend or dilute the text of the AD before the mechanic effects the required action. When asked how the mechanic's actions were influenced by the methods of the engineering group responsible for preparing the AD, one airline mechanic responded : "We work them the way they write them." Aircraft lessors and small operators expressed their difficulty in interpreting some ADs as they are presently written. A U.S. carrier stated that there exist checks and balances within the present system which support reliability and maintain separation between quality control and production activities. One manufacturer asked if when ADs are initiated whether the interface of items controlled by the MSG-2 and MSG-3 (Maintenance Steering Group Planning Methods) sampling programs is recognized and reflected. A member of the United Kingdom CAA responded that their policy was to obtain approval from the manufacturer before initiating any action involving the steering group items.

One carrier commented that the problem found with manuals is that for contract maintenance, the contractor often does not have the manuals. Another U.S. carrier responded that company mergers create a problem in that the maintenance manuals are not always retained in the transfer.

An airline consultant stated that the manuals were least often used, while an operator countered that they were frequently used in practice.

A U.S. carrier noted that most of the manuals were well written, but that they can become out of date. Several others agreed, saying that they received manufacturers' support, and that many of the manuals are supported by work cards. The operator has to update the manuals to account for advances in technology. It was also stated that some mechanics may rely on memory for a certain procedure, rather than looking it up in the manual. There can be problems with effectivity when working with the Illustrated Parts Catalog (IPC) since many parts look alike.

No response was received to the question on whether or not training in the use of the maintenance manuals was currently adequate.

One carrier responded that a list of applicability of service bulletins (SBs) is required. It was noted that, as an example, "worn" is not defined. How worn is worn out? Also stated was the fact that the structural repair manual (SRM) only describes repairs, it does not provide fly back limits, and Designated Engineering Representative (DER)/FAA approval is required to fly the aircraft with a crack present. One U.S. carrier commented that the Boeing SRM has a table of crack limits that can be flown. A member of the technical panel responded that the FAA does not provide blanket approval on cracks except in service bulletins (SBs). One U.S. manufacturer noted during this discussion that some type of corrective action, i.e. a stop drill, is required before the DER can approve continued flight.

The question was asked if the maintenance manuals give the mechanic enough information. A U.S. carrier responded that when a mechanic finds a crack, and he knows what the previous action had been on having detected this crack previously, there is often a resistance to report the finding. An overseas operator noted

that the mechanic will be the person with the problem if he does not report the finding of cracks.

When asked if aircraft are manufactured with maintenance in mind, a U.S. carrier agreed but stated that a better design is yet to be achieved. It was noted that design engineers are improving access to certain areas. The fact that post-delivery aircraft modifications do cause restricted access to some parts of the aircraft and engines was noted by one manufacturer.

Is there a need to begin a specialization process for mechanics for private aircraft and those for air carrier operations? A representative from the United Kingdom CAA stated that the U.S. system is antiquated and there is a need to consider specialization to be effective in maintaining modern passenger-carrying aircraft. A U.S. carrier suggested that the present system is adequate and specialized training for individuals adequately covers their needs. A FAR 121 operator said that consideration for a mechanic's training based on aircraft type and a technical grade based on his ability to perform his duties would satisfy their needs. An overseas carrier responded that licensing of mechanics for the U.S. and overseas should be the same.

D. NDI TRAINING AND INSPECTOR QUALIFICATIONS

There was general agreement among the attendees that there should be good basic NDI training for all new airframe and powerplant (A & P) mechanics. There should be an effort to restructure the current training program to reduce the time currently spent on dope and fabric and radial engine repair.

Regarding current training programs, it was expressed by the group that there are too few inspectors having complete visual inspection and NDI qualifications. It was also noted that there are no standards established for inspector qualification, that no sample defect models are provided for the inspection operator, and that some of the inspection processes in use are not applicable to detect certain defects. Mechanics of limited experience are utilized to conduct the inspection of complex structure, and components and industry sampling results indicate that human inspection results vary from 60% to 80% accuracy. A U.S. carrier made the comment that even well-trained experienced persons can make mistakes. An industrial consultant noted that the design of the job lends itself to problems, and that the job should be divided into components. A U.S. carrier suggested that preventive maintenance was the key factor in reducing the likelihood of crack formation. An overseas carrier noted that with used aircraft, the new operator may not have an adequate history of the maintenance program, and be unaware of the SBs which have been accomplished.

Two carriers responded to the issue of NDI training and qualifications, stating that they provide company training, arrange for factory training, and have test set-ups available for their operators. NDI is only performed by a limited group of inspectors, with industry standards enforced. An overseas operator commented that his company also has a training program with a manual defining all standards, while a United Kingdom CAA

representative stated that all NDI standards are set and approved by the CAA. The point was raised by a small U.S. carrier that there was not enough work to keep his qualified inspectors current. One airline consultant made the observation that more government control will not stop the problem of missing cracks when asked if more standardization was required for NDI qualification and certification. A FAR 121 operator responded that the FAA could not legislate confidence in detection, and that the present programs were effective. One U.S. carrier thought that too much emphasis was being placed on the licensing aspect of qualification, while a manufacturer suggested that persons conducting NDI be tested to determine their level of capability in detecting defects. A FAR 121 operator asked the question as to whether, during training, the NDI equipment manufacturer qualified persons as to their ability to detect defects of a given severity. An A & P mechanic proposed a practical approach, asking the group to go out on the midnight shift and talk to the mechanics and inspectors in order to determine the needs of the people actually doing the job.

When asked if the operators qualify their NDI personnel, one stated that the NDI was contracted out. A foreign operator stated that his inspectors were qualified and licensed at level 2 standards.

The question was asked as to whether or not the airlines would participate in a program of testing precracked panels in order to determine the probability of detecting cracks. One overseas carrier commented that he could see no point in such an experiment, while the Air Transport Association (ATA) suggested the NDI workshop at NASA Langley Research Center in Hampton, Virginia. A U.S. carrier responded to the question with the suggestion that an FAA/airline/manufacturer team be assembled to evaluate inspection techniques on actual ADs. This activity

would concentrate on specific inspection tasks in a real-life environment.

When asked whether the different types of readout on available NDI equipment create a human factor problem, one U.S. carrier responded that all new equipment naturally has a learning curve. Experienced persons can adapt quickly to different equipment. The operators, however, would need to be requalified on the new equipment.

E. REPETITIVE INSPECTION PERFORMANCE

An overseas operator suggested that repetitive inspection assignments be rotated, and that while conducting the inspection the inspector be advised of what the expected finding should look like. A U.S. carrier suggested that some factors to be considered include the frequency of the assignment, the qualification of the inspector, the accessibility of the work area, as well as the specialization of the inspection process and the equipment and products required for its completion. A small aircraft manufacturer noted that inspections are designed to avoid the missed crack, while another manufacturer stated that SSID inspection frequencies are designed from reports of previous missed cracks. A FAR 121 carrier asked if the manufacturers take boredom into account when preparing the Maintenance Review Board (MRB) documents.

Regarding the issue of reduction of error due to repetitive inspections, one U.S. air carrier noted that planning/scheduling cause a required inspection to be missed. Another carrier countered with the statement that their inspectors are not concerned with the scheduled availability of the airplane, and will keep the aircraft until the completion of the inspection.

F. CRACK DETECTION PERCENTAGE

When asked about crack discovery percentages, all agreed that it is important to eliminate a large part of the human factor problems to improve crack detection rates. Other factors that need to be considered are the time restraints on meeting scheduled flight times the next morning, the night shift, 24-hour a day work schedules, the availability of "expert" support at night and proper equipment. An inspector for a U.S. carrier noted a lack of support at night for maintenance as well as instructions to deviate from the manuals. Suggestions for improved crack detection rates include the following: improved tools, automation to remove the human element, incorporate human factors lectures into inspectors' training, service bulletins highlighting problems and presenting the results of failure to locate the problem, and a system similar to the Aircraft Safety Reporting System (ASRS) for mechanics. A U.S. carrier stated that the present system is effective and that repair manuals are up-to-date, there is 24-hour engineering support, and that on major repairs FAA-approved data is used. A U.S. manufacturer commented that his field representatives and DERs are available at all hours of the day. One inspector for a U.S. airline commented that the airlines consider interior items as minor and will not report or correct them.

G. ON-THE-JOB PRESSURE

A Canadian operator stated that pressure due to schedule requirements exists, but that quality control groups have the authority to override the production schedule and provide protection for the inspection personnel. An aircraft lessor proposed a study to determine the demand and conditions under which the inspectors must perform. A FAR 121 carrier proposed a study to determine the human factors effects of the time allocated for the job, as well as inspectors' reactions to pressures outside the job environment. A writer from an airline periodical expounded on the "Kill the Messenger" syndrome by relating an incident of discipline involving relocation of employees to other assignments. A U.S. carrier suggested a research program into the causes of unexpected failure in inspector performance, specifically, those well qualified, adequately trained, experienced, long-time inspection personnel who miss obvious, blatant defects.

A FAR 121 operator noted that the experience level of the the maintenance staff is declining due to retirements. A U.S. carrier agreed, stating that older aircraft are going to newer operators who have newer mechanic groups. The aging aircraft are in need of the expertise of the persons who gained experience handling these aircraft. Retirement activity is removing these experienced persons from the work force. An aircraft lessor noted the same problems in the air carrier management and flight operations group.

H. CURRENT MEANS OF IDENTIFYING PROBLEMS

When asked whether there should be changes in the current means of identifying potential problems, an A & P mechanic responded that some situations exist when visual inspection must be augmented by effective nondestructive testing (NDT) at specific locations. An air carrier manufacturer discussed the need for the operators to get the specific failure data back to the manufacturer. His remarks indicate that this process is not occurring within a reasonable time frame. A manufacturer of small aircraft, utilized by FAR 135 operators, restated the lack of fault data being transmitted to the airworthiness authorities and the manufacturers.

A non-scheduled operator commented that an inherent weakness in the present system of aircraft exchange is that older aircraft go to small operators who cannot financially support their needs. He also noted that exposure is greatest in these areas and that certification requirements need to be adjusted. An aircraft lessor responded that the small operators terminate more aircraft than the major carriers who utilize an engineering staff to extend the life of the "in-place" components.

Regarding the human factors involved in changing from phase check to major check, an air carrier inspector expressed concern that there is generally not enough time available on phase checks to do any extra NDI on suspect areas. An operator from the United Kingdom commented that phase checks were adequate on new aircraft but, on older aircraft, the operator should go to the major inspection programs. An air carrier inspector for a FAR 121 operator stated that the "times" (interval between inspection procedures) get stretched as the history of an airplane grows. Inspection frequencies are never increased. It

is his recommendation that inspection frequencies be increased as the airplane ages. A U.S. operator replied that his program does call for reduced times between inspections for older airplanes.

I. SUPPLEMENTAL TYPE CERTIFICATES

On the issue of handling supplemental type certificates (STCs) one aircraft lessor remarked that some standards of preparation and data requirements are needed. Different FAA offices require different specifications. A manufacturer proposed constructing a database for STC information. One mechanic stated that when deviation from an approved STC is disclosed, no one reports these events. The NASA Immunity Program for mechanics should be initiated and the FAA should advise mechanics of its availability. He also stated that the reporting process should be kept simple; mechanics do not like to write. A U.S. carrier brought service difficulty reports into the discussion and stated that some parts of the industry considered them to be an indication of poor performance and that the reporting system is not being utilized as it should be.

CHAPTER V. ENGINES PANEL DISCUSSIONS

The average number of participants in the engines panel session was approximately 120 persons. The principal speakers were representatives from civil manufacturers and airlines, both foreign and domestic, foreign airworthiness authorities, overhaul/maintenance shops, and trade associations.

Engine Panel Members:

CHAIRMAN: Mr. Jay Pardee; Manager, Engine Certification Office (Boston), ANE-140.

COCHAIRMAN: Mr. William White; Manager, Aircraft Evaluation Group (Boston), ANE-250.

PANEL MEMBERS: Mr.Locke Easton; Aerospace Engineer, Engine & Propeller Standards Staff (Boston), ANE-110.
Mr. Robert Guyotte; Manager, Engine Certification Branch (Boston), ANE-142.
Mr. Jim Jones; Aerospace Engineer, Engine Certification Branch (Boston), ANE-141.
Mr.Charles Simmons; Manufacturing Inspection Specialist, Manufacturing Inspection Office (Boston), ANE-182.
Mr.Leo Weston; Manager, General Aviation & Commercial Branch (Washington, DC), AFS-340.

Notetakers: Mr.Chung Hsieh; Project Manager, Engine Certification Branch (Boston), ANE-141.
Mr.Donald Perrault; Acting Manager, Engine & Propellers Standards Staff (Boston), ANE-110.

It was generally agreed by all participants that an engine does not age in a fashion similar to other aircraft components due to structured programs of inspections, teardowns, and shop visits. Certain engine parts already have life limits established - much more so than other aircraft components. Engine trend monitoring and performance monitoring are conducted for measurement of deterioration of major components. Refurbishment, repair, and change-out of engine parts are accomplished before extensive aging occurs. The topics discussed in the engine session have been broken down into twelve areas for the aging fleet.

A. LIFE LIMIT FOR STATIC PARTS

A member of the panel asked whether there should be Chapter 5 life limits on static parts. There is no FAA requirement for tracking of non-life-limited parts, but the FAA recognizes that some static parts may need to be life-limited. An air carrier responded that currently operators do not track engine case lives and wondered how the FAA proposed do this without records. A manufacturer made the statement that setting life limits on cases is the operator's decision to make, based on economics, and also stated that his company is tracking static parts on a random basis. Some technical representatives track cycles and time in service information monthly for parts in the field.

Responding to a panel question regarding the need for research and development to develop case life limits, an air carrier stated that a tremendous amount of study had been done on the issues of service time, average number of cycles, and cost of crack repairs and that no good correlations have emerged. The reason for this is a lack of appropriate control parameters for case life studies. Currently, the operators and the manufacturers jointly review all available information and establish a reasonable life based on a reasonable safety level determination. Specific cases are inspected with NDT techniques based not only on numbers of hours or cycles, but also on laboratory metallurgical results and other information to determine case usefulness.

An air carrier then asked whether or not manufacturers could develop a time/number of cycles criterion for case repair. Another carrier replied that there are so many differences in materials, etc., that determining remaining life in a case is difficult. More R&D is needed to develop a technique to determine the aging process of engine case materials, according to one carrier. A member of an overhaul shop then replied that experience with older cases shows much deformation. Tooling

cannot be developed to determine the age of a part, since repair can often restore the part to new condition. An air carrier stated that R&D into NDI for the purpose of determining life of cases would be supported, but also opposed a uniform standard that would penalize a group.

A carrier made the comment that there is a need for technology to determine the remaining life after multiple repairs to cases. Another member of the panel asked, in reference to case life limits, how the level of case repairs should be limited. A predicted case reinspection interval based on stress and temperature would be useful, but this would require additional work to include complex geometries.

A member of the FAA panel asked whether there was a cyclic count relationship between static and rotating parts. An air carrier responded that long-time on-wing experience is limited, and that differences arise with leased engines. The carriers are not in favor of time and cycle counting requirements; this is viewed as an unnecessary burden.

B. ENGINE CASES, REPAIR AND REPLACEMENT

One manufacturer commented that case repairs, redesigns, and new designs are all based on shop findings and laboratory metallurgical analyses, and recommended structured inspections on aging parts, such as casings, until retirement. The problem is that inspections are required too frequently to economically maintain the engines. Extended life of on-wing cases is a subject of economics and reliability.

The problem with case life is the decision to continue to operate, repair, or replace. What is overhaul, refurbishment, or repair? A standard interpretation of the functions is necessary. A member of the technical panel replied that "overhaul" is defined in the Federal Aviation Regulations (FARs). Another stated that FAR 43 contains all "Maintenance" requirements including recordkeeping for overhaul, rebuild, and replacement, but not "refurbishment." Refurbishment has no regulatory definition.

Case crack research and development is being conducted now, as well as studies to assess crack propagation. Dissemination of this information is through maintenance manuals and company technical representatives.

What is the basis for determining useful life? One manufacturer thought that planning and processing of airline work scope for repair and replacement of engine cases, including economic considerations, was appropriate. This should apply to commuter engines as well. An air carrier responded that inspection methodologies were needed, especially in the area of intra-airline use of cases with prior owners. An air carrier asked whether the Maintenance Review Board (MRB) procedure MSG-3 (Maintenance Steering Group) could be used here. One of the technical panelists stated that MSG-3 addresses on-wing units, and that off-wing engines in shops are subject to different practices.

In addition, it was suggested that an SSID program for engines might be in order. An air carrier stated that case repair orders were not desired; that what was needed was an early notice of where the problem areas may be.

C. ROTATING PARTS

A member of the technical panel asked if there were any problems currently with recordkeeping. One air carrier stated that there was a big push for recordkeeping on rotating parts and asked the group what the problems in doing so might be. Mr. Pardee replied that a new Advisory Circular (AC) was in the works to address recordkeeping of FAA-surveyed life-limited parts. A manufacturer replied that there was variability in the records, especially with the FAR 91 operators. One manufacturer made the following comparison: a FAR 121 operator with an on-wing combustion liner crack gets it welded in-situ, and with no records; while a FAR 135 U.S. operator has reporting responsibility.

One airline made the comment that the JT3D engine manual calls for inspections at a flight/cycle ratio of 3,000 cycles/1,000 hours, and that manufacturers' manuals should make special remarks regarding blade creep and casing inspections. Flight/cycle ratios can cause problems for users.

A panelist asked whether the airlines looked at the documentation trail when buying used parts, to which an airline representative concurred for rotating parts, but not for static parts.

A manufacturer posed the question of life-limiting methodology for rotating parts to the panel, and asked about the differences from that for static parts. The technical panel responded that the procedures are different and noted that pre-Amendment 6 components do not have a life limit, however, and continued airworthiness inspections are in place. Analysis methods for life extension of components vary with manufacturer, but all are approved by the FAA. Mr. Pardee noted that life limits as published in Chapter 5 or in Service Bulletins (SBs) are

inviolate. This statement was followed by a brief discussion on pre-Amendment 6 versus post-Amendment 6 life determination for engine components. A manufacturer noted that in pre-Amendment 6 engines, spacers and shafts were declared for infinite life. He also stated that this does not mean that parts which are not life-limited need to be. A manufacturer stated that the effects of static parts change-out on rotating parts life validity are not understood.

D. SERVICE DIFFICULTY REPORTS, SERVICE BULLETINS AND MANUALS

A member of the technical panel made some opening statements regarding the Service Difficulty Reports (SDRs). This is a program for data and information exchange, which the operators should use. The FAA is looking to improve its usability. A request for a show of hands of all operators present requesting SDR data from their Principal Maintenance Inspector (PMI) revealed that no one made any such requests. An airline representative stated that there are too many restrictions in SDR data reports, and that they do not incorporate shop/inspection findings or trends. A member of the technical panel stated that the SDR system can be used for any type of reporting, not only that specified in FAR 21.3.

Another panelist stated that with the advent of "hush kits" (devices to reduce the noise level produced by older jet engines), a return to older aircraft is being observed, and then asked if any problems were experienced with the engine manuals or the service bulletins (SBs) and whether or not the data in them was current. One manufacturer made the statement that hush-kitted engines have not been a problem, since they have been in continuous service. An airline replied that the major concern has been with the traceability of engine parts for these older engines. One manufacturer stated that the manufacturers' SBs are only recommendations and are not enforceable except through airworthiness directives (ADs).

A technical panel member asked what percentage of SBs were actually put to use by operators. One manufacturer stated that he had no idea of the fraction of SBs actually used by the operators.

Another panelist asked the group about the relationship of FAR 33, Appendix A to SBs, and asked whether an SB was considered an addendum or a revision to the maintenance manual. One

manufacturer said that issued SBs are intended to be incorporated into the Maintenance Manual or Parts Catalog at a later date, at which time the SB is cancelled. Mr. Pardee then rephrased the question in the form: Until the SBs are incorporated in the Maintenance Manual, are they considered an extension to the manual? One manufacturer responded affirmatively, since they are all approved by the FAA.

The SBs are reviewed by a committee and only after approval do they get into the aircraft manual system. This action depends on the type of SB/manual revision. A carrier stated that the SBs are part of the operators' maintenance program but not necessarily part of the engine Maintenance Manual. A manufacturer responded to this stating that service bulletins which release a modification or repetitive inspection should stand alone, but sometimes are incorporated into the Manual per specification ATA-100. He agreed with a previous FAA comment that a statement in the SB indicating that the SB would be incorporated into the Maintenance Manual would be useful. An airline responded that one would need to assess the suitability of an SB implementation before incorporation into the Manual. Since the SB may not be useful, it is not desired to have it automatically incorporated into the Manual. Another representative from an airline stated that automatic incorporation into the manual is a "back-door AD" approach. Safety and economics are related, and airline input/feedback should be presented when the SB is incorporated into the manual.

According to one airline, the SBs have a classification of recommendation for accomplishment, and not all SBs need to be complied with. SB writers need to do a better job of justification. Another airline stated that the SBs are explained within engineering departments and with the manufacturer, if necessary, in order to determine the magnitude of possible impact.

E. REPLACEMENT PARTS

A member of the FAA technical panel stated that parts buyers should check the complete engine repair records, not just the airworthiness tags. Addressing the group, the panelist asked if there were any concerns for third and fourth generation engine owners from the point of view of service experience. An air carrier made a comment related to economic considerations and the serviceability of aging parts. The manufacturers do not lose interest in third or fourth generation owners; they just lose touch because these owners do not bother to communicate. A difficult determination of parts availability from the surplus market needs to be made. A foreign airworthiness authority stated that the economic availability of surplus parts may be similar to that of old radial engines as affected by military spares.

An airline asked how the FAA controls records of used parts which have been repaired or overhauled. One panelist responded that the records are controlled through the regulations. The person doing the repair should file records with a full description of the work performed. The bottom line is: buyer beware. An airline noted that it has very experienced persons doing this kind of work, and asked if there should be FAA surveillance of parts distributors. A member of the technical panel stated that there exist controls over repair stations, but that the FAA has no authority over parts brokers; this is the users' responsibility. It was then asked whether there was evidence of bogus parts causing problems, to which one airline responded negatively, stating that those parts are rejected.

One airline asked about FAA regulation on the spare parts industry, and on the traceability of new, used, and refurbished parts. An FAA panelist stated that there was nothing on the books at the moment relating to regulation of the parts industry, and referred to the United Kingdom CAA attempts to accomplish this.

An airline replied with the question as to whether the FAA would consider parts supplier regulation as the subject of a future meeting, to which Mr. Pardee replied in the affirmative.

A manufacturer noted that no problems as yet were had with PMA parts. Another endorsed the problem of PMA as it exists in the Department of Defense requirement to remove all proprietary legends from drawings so that DoD can contract out for PMA-supplied parts.

The FAA panel changed the course of the conversation, asking for comments on the technical use of corrosion measures. An ALPA representative stated that a tracking system needed to be developed to obtain this type of environmental data, and referred to a U.S. Navy squadron transfer from MacDill to Phoenix, Arizona.

The technical panel then asked if the members of the group looked at the documentation trail when purchasing used parts. An airline replied affirmatively for rotating parts, but not for static parts, and observed that there is an inundation of PMA vendors, and that the quality of brokers' parts is of concern. The technical panel attempted to clarify by asking if the parts were coming back only with tags and without historical documentation. The airline responded that the parts just had tags and that they had to dig deeper to get more information from the seller. Another airline stated that even with tags and documentation, it is unlikely that prior records will be available, and asked if not only the information on the <u>last</u> overhaul was required per FAA regulation.

An FAA member addressed the DoD radial engine type of parts problem, and asked what exactly the manufacturers should be doing. A foreign airworthiness authority stated that the reason there are no technical representatives for radial engines parts is that the military destroyed the manufacturers' interest. Team

representatives will not buy non-OEM parts (that is, broker parts that may have a "serviceable tag") which come mainly from the approximately three thousand parts distributors and brokers.

An FAA panelist stated that scrap parts do return to service and asked the group's opinion on the subject. Should they be destroyed? One airline stated that it is very difficult to destroy parts; there are problems with grinding. Another said that scrap parts are cut up to make them unusable. A foreign authority suggested mutilating the serial numbers on scrap parts. An airline countered with the comment that the part should be totally destroyed.

A member of the FAA technical panel concluded, describing life-extension program Advisory Circulars currently under development. For life-limited parts, the FAA would be hard-pressed to mandate the destruction of parts due to such life-extension programs which may subsequently make such parts reserviceable.

F. ENGINE MAINTENANCE

The technical panel asked if additional maintenance/ inspection procedures should be put in place following major repairs of old engines, in reference to the earlier discussion on crack propagation. The response of one airline revealed that for the most part the manufacturer already supplies this information. Tracing the interactive effects of all major repairs may be impossible. The current assumption is that the repair is suitable for the life of the part if within the manufacturer's recommendation, and no additional procedure is required. Another airline stated that an on-condition maintenance program was in use and that reliability is improving yearly. In-flight shutdowns (IFSDs) are down, and additional FAA requirements are unnecessary.

Problems with "other shops" were discussed, and an airline explained that not all carriers have their own repair/overhaul capability, and that off-wing engines are sent to other shops, making tracking of the repairs by the manufacturers impossible. Small operators develop their own maintenance programs and inspection intervals with their own FAA/FCAA representatives. Reliability is at the operator and airworthiness authority level.

One overhaul/repair person stated that his group had close contact with the manufacturer on aging rotating and static parts in the shop for inspection and repair, and that other manufacturers should have similar programs.

The FAA panel posed the following question: Are the inspection assumptions in tune with today's practices? For example, are the Airworthiness Directives (ADs) realistic about the universality of procedures? A manufacturer responded that the shop processes are adequate, but that technical representatives need to be sent out to the small operators for on-wing procedures. Small operators do not do their own inspections until trained by

the technical representatives, since they are not current in inspection practices due to economics.

Regarding inspections of non-life-limited parts, perhaps field limits should be developed, based on shop observations, in addition to shop limits. High-time sampling is done to fine-tune solutions to real problems with static as well as rotating parts. One manufacturer works this out jointly with the customers, and shares the information with the rest of his clients. Other manufacturers invite the operators to attend shop teardowns to provide first-hand review of the hardware. Smaller operators have a problem with mixed and matched components and modules on older engines which require special detailed sampling programs to assess each case.

Experience, information, and recommendations are promulgated by SBs to all operators and should be used by all manufacturers on all aging parts. No reply was given to an FAA question as to whether airworthiness inspectors should be trained or have specialized training. An airline representative made the comment that the airlines continue to offer orientation courses to the FAA airworthiness inspectors.

G. NONDESTRUCTIVE TESTING

The general work specifications imposed for NDI cover the needed detail to provide the required safety and reliability. FAA ADs sometimes require repetitive and different NDI techniques, such as the eddy-current and ultrasonic methods. In most cases, single methods of NDI have been successful, however, for an area with minimum detectability, dual inspection methods are sometimes required. It has been found that FAA NDI requirements in ADs often require the manufacturer to provide in-house or on-site training, and that sometimes the inspection method called out is not appropriate for the particular component.

On-wing NDT as an area of FAA R & D was discussed, and it was noted that the Society of Automotive Engineers (SAE) conducted a recent study (AIR-4003) and collected results on in-situ inspections.

The NDT groups are very specialized. The FAA concern over inspector training and certification and the adequacy of the ASNT criteria, needs to be resolved by the FAA for itself. The FAA should broaden its use of requirements for NDT technicians. Specialized technical training, not regulations for certification, for difficult or complex NDT situations for AD or Service Bulletin (SB) compliance met with approval from the airlines. Repeated inspection requirements in an AD, where a missed inspection might lead to a failure, should lead to a specification for training requirements.

A foreign authority spoke on the system in use in his country which utilizes the equivalent of a National Resource Specialist (NRS) on NDI. The CAA people carry out the proposed NDT procedures themselves, and when satisfied, issue them in the form of an AD. The speaker was surprised that the FAA did not have an NRS on NDI. A member of the FAA technical panel explained that

the FAA operates two NDT courses at its Oklahoma City Training School, which include the physical criteria for repair stations. NDI expertise is available in the U.S. in the Aircraft Certification Office (ACO).

H. PERFORMANCE MARGIN

No response was received on the panel's first two inquiries on engine performance retention and operator/manufacturer experience with performance retention. Performance margin is an economic issue and not a safety issue. Exceedance limits exist on on non-new engines with higher times, such as twin engine exhaust gas temperature (EGT) exceedances on two-engined aircraft. Are other provisions or instruction clarifications necessary? Performance becomes a safety issue if the engine is not suitable for balanced field length performance. All engines out of the shop should make at least the type certificate (TC) performance margins (could be 30 degrees, 20 degrees, or 1 degree). The top-of-descent instability is a manufacturer's design problem. The airlines have their own limits on rebuilt engines, except those in Chapter 5 of the Maintenance Manual - Life Limits. Engine/module shop visits are based on soft times when they are individually reviewed for further work, if this is deemed necessary.

Intervals for refurbishment to recover power are a function of each operator. Operators establish soft time programs based on deterioration characteristics for each operation and route structure. One airline noted that all his engine maintenance is subcontracted and contracts exist with the vendor and the overhaul shop for minimum acceptable performance. One manufacturer described how his company works with the airline on a work-scope basis to account for maximum on-wing time to cut down on total costs, i.e., to achieve the highest time in service and the maximum performance.

Performance trend monitoring was found to be useful but it is not an indicator of incipient failure. Margins are related to economics, while limits are related to safety. Maintenance standards are the same for a five-year old versus a fifty-year old engine with regard to performance. Small engine performance

problems have mostly been due to erosion based on exposure, not age. Criteria to define an "aging engine" were requested. The application of on-condition and trend monitoring to aging engines from a point of view other than performance was discussed. One example discussed was the temperature-time-stress spectrum for newly built rotorcraft engines. This would be difficult to do with aircraft engines without a sufficient database.

I. INDUSTRY/FAA COMMUNICATION

Information exchanged between the manufacturers, the operators, and the FAA in the engines area consists of records of case repairs, redesigns and new designs (all of which are based on shop findings and have metallurgical lab analyses), as well as structured inspections on aging parts such as cases until retirement. All of this information is to be provided to all interested operators. One manufacturer stated that he was unaware of a coordinated effort on the part of all operators to get this input when the manufacturer does not actually do the repairs on the parts, or the part is not returned to the same repair shop for work. He further stated that he does not receive all the information from the operators, except during all-operators conferences. It is important to have service problem information before failure of the part. At shop level, there appears to be an interface of this information.

A foreign authority explained that a similar type of forum/seminar was conducted on radial engines in Canada some years ago, and would suggest a similar approach for aging engines today. The seminars conducted in the past by the FAA for Part 91 and 135 operators had great exposure, but were discontinued by the FAA about ten years ago. Industry continues to offer seminars yearly on aging rotary engines and propellers.

J. PROPELLERS

Aging propellers and their relationship to aging engines was discussed next. In 1978, FAR 91.173 and Part 135 required life limits on propellers, especially blades and hubs. There were approximately six hundred propeller blade tip failures per year during this period. The number was significantly reduced following a series of FAA/operators' conferences. Propeller failure may be caused by improper maintenance. Unfortunately, it is difficult to track times in service and provide traceability on propellers. Aged propellers are covered by ADs requiring inspections of blades and hubs. In summary, it was found that continuous airworthiness programs must be approved by the manufacturer or by the FAA, and currently, leave much to be desired. Non-original equipment manufacturer (OEM) service information on propellers is uncontrolled and needs to be looked at by FAA maintenance.

K. ATA RECOMMENDATIONS

Appendix 1 contains the complete list of AIA/ATA recommendations. Item 1 received no comment from the engines group.

Referring to Item 2, it was made clear that this measure should not take the place of an "opportunity inspection." It was suggested that NASA may already have such an inspection method, but that this laboratory test is not necessarily more adequate than field repair.

Item 3 would include destructive testing such as pressurization cycles. The simulation would reflect in-service use to the end of life. A Boeing 737 is proposed as the candidate aircraft, but no recommendation is made for an engine. It was also pointed out that this type of fatigue test is not applicable to engines since most components are changed out. Such a test on an engine would be much different than that for the airframe and would consist of a systems test of the engine, including scheduled maintenance.

Items 4 through 8 received no comment from the engines group.

The single-sample relevancy to the rest of the fleet was discussed. A judgment will have to be made on an individual case basis at the time of the test by getting the most knowledgeable people available to assess the outcome of the teardown. The question was posed as to why all the discussion in the engine group concerning parts dealers/brokers was not included in the recommendation. It was explained that the parts issue does not pertain to aging aircraft. However, it was shown that it is important from an engines standpoint on account of the divergence from the build standard with other non-OEM parts. The capability of repair stations to do the work may be a subject for FAA

investigation. A member of the FAA technical panel explained the ongoing NASIP program, which examines ten repair stations per year, both domestic and international.

In closing, a representative from an airline summarized the discussion stating that more economic rather than safety issues had been covered. Static parts have generally not posed a safety threat. Rotating parts are safety-critical, but have been kept under control.

L. RESEARCH AND DEVELOPMENT RECOMMENDATIONS RESULTING FROM AGING AIRCRAFT ENGINE PANEL DISCUSSIONS

I. Develop Enhanced Nondestructive Test (NDT) Methods for Engine Cases and Internal Components

A. Problems and Concerns

1. Inspection of engines on-wing or in an assembled state is extremely difficult due to limited access and tight clearances.

2. Surface conditions of components to be inspected are often not conducive to presently available inspection technology.

3. Resultant inspections are cumbersome, labor-intensive, and require a high degree of operator skill, therefore inspections are occasionally ineffective and defects are missed.

B. Goals and Objectives

1. Develop inspection tools better able to cope with limited access and tight clearance, such as improved borescopes featuring multiple articulation, light source, small diameter, and photographic capability. Similar advances in eddy-current, ultrasonic probes, etc., are desired.

2. Methods desired should provide automated, high confidence inspection/detection of small defects.

3. New techniques should be developed to cope with case/component surface conditions, such as rust,

paint, Sermetal coating, fuel/oil/hydraulic fluid residue.

4. Methods developed should also be compatible with complex part geometry, such as weldments, bosses, flanges, rails, channels, cylinders, etc.

5. Evaluate advanced technology field to determine if new technology advances may be adapted to engine NDT.

II. Develop Life-Predictive Methodologies for Both Repaired and Nonrepaired Engine Cases and Frames To Determine Useful Life and Inspection Intervals.

A. Problems and Concerns

1. Cases/frames do not have established retirement lives, and in many situations, service time or time since repair are unknown.

2. Various combinations of repairs and repair locations introduce life-affecting concerns.

3. Individual operator mission profile, utilization and maintenance practices vary so as to introduce life-affecting concerns.

4. Individual case/frame material properties, dimensions, and manufacturing techniques vary and may affect life.

B. Goals and Objectives

1. Evaluate the technological feasibility of an NDT method, for determining case/frame time in service or fatigue life consumed, and develop such equipment/methodology, such as the carbon dating technique used in archeology.

2. Acquire cases/frames representative of aged high-time components and conduct testing to determine potential failure locations, crack propagation rates, inspection intervals, and maximum useful life.

3. Conduct fleetwide inspection of representative high-time cases and frames, covering a wide range of operator, repairs, etc., and document cracks, damage, or other life-limiting defects. Compile documented results in a format that provides life management information available to all operators.

CHAPTER VI. CLOSING SESSION

At the closing of the conference on Friday, June 3, 1988, Mr. Craig Beard, Director of Airworthiness, and Mr. Bob Goodrich, Director of Flight Standards, were in attendance as representatives of the Office of the Administrator. Following their opening comments, the chairmen of each of the four working groups gave a VU-graph presentation highlighting the important points of discussion of each group.

A. AIRFRAME DISCUSSION PANEL SUMMARY

Chairman: Tom McSweeny
Co-chairman: Bob Cook

One of the first discussion topics covered by the group was the Administrator's question on whether the current certification criteria were adequate. One individual comment indicated that there was no international system in place to assure that there are complete maintenance records available when aircraft change hands, while others seemed to imply that there were. Certification and qualification standards for inspectors was brought up as an important issue. Regarding the safe life of aircraft, it was proposed that airplanes, when they reach their tested lifetimes, be recertified using STC, with this being the only way that they could fly beyond that lifetime. It was suggested that the current aging aircraft (or their derivatives) be subjected to current fatigue standards. Generally, it was felt that it wasn't the rules that posed the problem, but the interpretation of the rules.

The next question from the Administrator concerned the adequacy of our current corrosion control techniques. The nearly unanimous response to this was that they are not adequately addressed in the present maintenance programs. A need exists for research and development on both corrosion prevention and protection. Better inhibitors need to be developed. One operator commented that only 5% of his aircraft removals were due to fatigue-related problems and that the rest were on account of corrosion damage. The U.S. Navy presented some of the current work going on in the study of corrosion. It was noted that there is to be a meeting in Scotland in March on the topic. There is International Air Transport Association (IATA) material on corrosion in publication. There was a strong indication that an Advisory Circular (AC) on corrosion was needed.

The question as to whether or not aircraft usage should be restricted based on fatigue life sparked a very lengthy conversation. The two-lifetime fatigue test was discussed. Some present indicated that using this test to determine safe operational life was not correct. Fatigue tests are only used to define critical areas of structure. More important is assuring adequate inspections. One comment was made stating that the aircraft should fly to 75% of its tested fatigue lifetime and then be scrapped.

The other questions posed by the Administrator dealt with research and development. Strong feelings were expressed that the R & D should come "without strings" and should not lead to mandatory programs (regulations). In other words, the agency [FAA] should not be doing R & D of the type that it did on flammability, and then mandate that everyone comply. It was felt that the R & D should be done by impartial groups. Rather than reinvent the wheel, groups like NASA, the Department of Transportation (DOT), the Advisory Group for Aerospace Research and Development (AGARD) and those in the international community who have done work in this area previously should be surveyed. Research and development is necessary to improve the detection of cracks and to better identify scatter factors for use in fatigue studies. Automation of NDT was presented as a method of removing human error from the inspection process. Goals and guidelines for the research and development in NDT need to be established, however. It was strongly advised that before the FAA embarks on a lot of R & D, that it ought to define exactly what it intends to find with this new technique and the size of the cracks it needs to be able to detect. Reliable means of evaluating composite and metal-to-metal bonds in service is necessary. Improvements and standardizations in training in NDT are needed as well.

Relative to the Supplemental Structural Inspection Documents (SSID) it was concluded that they really do not address corrosion - although some of them talk about corrosion in general. There is a strong sentiment that the current system works well and that we shouldn't try to fix something that isn't broken. The majority felt that the SSID were well conceived and headed in the right direction, but that improvement was possible, perhaps by including an SSID on corrosion. It was indicated that SSIDs should be mandated for commuter airplanes. It was pointed out that the current commuter fleet (with single spar wings) is being used more than anticipated and that many of their maintenance practices are less sophisticated than other carriers. This needs to be considered in the development of inspection requirements.

Regarding multiple site damage (MSD), it was noted by several that the failsafe philosophy can be compromised in the presence of MSD, and that more research is needed to understand this phenomenon. Teardowns of aging airplanes to evaluate MSD are not necessary, according to an independent consultant. This could be accomplished by laboratory testing of hundreds of precracked panels, and would provide less expensive and more repeatable results. It was indicated that the two-lifetime fatigue test does not ensure that MSD will not occur during the first lifetime of the airplane. One person noted that widespread MSD is an economic issue and that in some cases may be too expensive to repair.

Some issues were raised relative to the role of the FAA. It was felt that FAA inspectors should spend their time inspecting aircraft instead of inspecting paperwork. FAA inspectors should ensure that the airlines have adequate analysis and surveillance programs and that maintenance programs are actually followed.

The Aircraft Industries Association/Air Transport Association (AIA/ATA) recommendations (see Appendix 1) were discussed next. Regarding item 1, it is believed that the present system works if complied with. It was stated that even the paperwork system is adequate if the guidelines are followed. Proper inspection was questioned regarding the Aloha 737.

Recommendation 3, the teardown plan, was well received by the majority of the group, however the statement was made that one teardown yields one airplane-specific data point, and applicability to the rest of the fleet is questionable. Continuous monitoring of the older aircraft to determine the fleet profile is suggested. It was also not agreed as to which service bulletins (SBs) would be included on the test aircraft and which would be most representative of the rest of the fleet. One of the more important points made at this time was the fact that the test program would take two to three years to accomplish and even longer for the teardown thereafter. What happens to the aging fleet in the meantime? The first AIA/ATA recommendation was determined to be the best course of action for the interim. Teardown inspections are time-consuming and expensive. The question was raised as to whether it should be a government- or industry-sponsored program. The proposed legislation (H.R. 4686) was discussed, and the general feeling was that the wording of the bill would permit the conduct of this type of testing.

Airline, manufacturer, and FAA intercommunication is addressed in recommendation 7. One individual in attendance made the comment that the proposal was relative to all communications and not solely the problematic ones. Aircraft lessors and maintenance contractors should be included in the recommendation. There was an indication that the FACA (Foreign Airworthiness Certification Authority) should communicate more with the FAA on

their problems, and vice versa. It was felt that the FAA did not have enough interaction with operators, especially with the Aloha AD. In this proposal, the letters "FAA" should be replaced with "Foreign Airworthiness Authority," since we really expect other authorities to do the same job on their aircraft that we do on our originally manufactured airplanes. One airline noted that problems are sometimes found, but fear of receiving an FAA violation causes them to go unstated. A freer sharing of information would be possible if this fear could be alleviated.

The establishment of task forces to continue the work begun in the workshop (recommendation 8) was supported by virtually all in attendance. It was suggested that it might be inappropriate to approach organizations like SAE or AIAA, since the response time might be shorter at other agencies. Task forces of the kind Administrator McArtor created (the Pilot Task Force) are in order at this time. Another idea involved getting a small group of experts together, locking them in a room with a problem - and not letting them out until a solution was obtained.

Lastly, industry noted that this proposal was not an attempt to get the FAA off and running trying to do too much too fast. It realizes the difficulties experienced with the advisory committee act and the scheduling conflicts which arise. It was the opinion of industry that it could take on this responsibility and complete it.

B. NONDESTRUCTIVE INSPECTION (NDI) DISCUSSION PANEL SUMMARY

Chairman: Mr. Barry Clements
Co-chairman: Mr. Fred Duval

We had a representative mix of FAR 121 operators, repair modification centers, transport and general aviation manufacturers both foreign and domestic, and other government agencies such as NASA, NTSB, etc. We did not have any FAR 135 operators and there should be another forum to get similar recommendations and feedback from that segment of industry. The group interacted very openly and dynamically. Some 130 comments, suggestions, recommendations were received. Many of these were diverse, some of them very profound and quite a number of them will require further consideration by the FAA for possible action.

First, there was a common acceptance of recommendation of the FAA to take a lead in developing NDI standards and criteria for training and recurrent training in NDI and issuing advisory material. We have identified a need for greater standardization of NDI procedures in the industry, as well as the need for more qualified FAA inspectors in NDI and in the industry itself, and the FAA should explore the requirements of other regulatory agencies.

Next, the FAA should sponsor research and development for improvement of NDI technology. Some of the specifics given were that the FAA would acquire a test frame for a test bed and using that vehicle would evaluate existing and new NDI methods with full participation of the operators and manufacturers. We should also sponsor R&D on nondestructive testing. Another suggestion was the possible use of artificial intelligence and computer-enhanced imagery.

Third, the operators need and want some means for alternate methods of compliance with service bulletins and ADs for non-destructive inspection requirements. They see a definite need to improve the timeliness of the approval of the alternate inspection method. The basis for some of their concerns were that the service bulletins call out the simplest equipment and many operators who use more advanced equipment are unable to use the former for that length of time during the approval process. Many of the older ADs call out antiquated equipment and inspection methods.

There is a recommendation that the FAA should provide some means for generic approval of equivalent or alternate compliance methods and techniques. The current requirement that each operator obtain his own approval is cumbersome, time-consuming, and redundant.

The fourth recommendation is that the FAA must upgrade their own expertise in NDI inspection. This will enable better evaluation of alternate methods of compliance with airworthiness directives from manufacturers' techniques and provide greater familiarity with the state-of-the-art NDI and NDT techniques. Perhaps most importantly we need to establish a focal point, a pocket of expertise within the FAA to keep abreast of the work of industry on NDI state-of-the-art technology. We suggest the establishment of a national resource specialist position.

The next point, brought up by one of the opening speakers, questions the need to establish a threshold beyond which you would not use NDI to ensure the continued airworthiness of the aircraft. I believe the major input from the group was that the current state of the art with NDI makes it unnecessary to establish a threshold for retirement of the aircraft but at the same time some testing, if nothing else, to show the adequacy of the NDI should be considered.

The sixth point consisted of a very strong suggestion that the FAA should take the lead in identifying and arranging (perhaps not sponsoring) needed industry conferences.

C. HUMAN FACTORS OF INSPECTIONS DISCUSSION PANEL SUMMARY

Chairman: Ray Ramakis
Co-chairman: Leroy Keith

Approximately 102 persons attended this particular session at various times, and a wide range of human factors issues were discussed. There were many answers to the issues that range from "Everything is OK with the present system" to those who believe that improvement is necessary. Our team would like to compliment the Worldwide Aviation Community Group for their interest and assistance in bringing to the forefront the major issues that we all face in human factors. Are the human factors realities of repetitive visual and nondestructive inspections being properly accounted for in the design and expectations of inspection programs? The answers we got in the discussions were mixed. But generally, the group believed that more standardization was necessary in nondestructive inspections and that qualifications were certainly important. We need a set experience level and there is a shortage of experienced persons doing this kind of work and certainly that more training is necessary. Some of the foreign civil airworthiness authorities believe that even a double inspection is necessary to ensure that the NDI was done properly. Finally, accessibility in design plays an important part and they believe that the manufacturers should perhaps look into that.

We asked some of these questions of the FAA point of view, and many questions were raised from the floor. One of the important ones is "Are airworthiness directives hard to understand?" The group believed that, "Yes they are." Standard terminology would be important for the human factors area, small operators had problems because they don't have large engineering staffs to take ADs and scale them down to something more usable.

There is a problem with service bulletin conversion. When an AD comes out, many times it references a service bulletin, and that service bulletin is converted to an AD which, in turn, is converted to work cards. In the process, occasionally, something gets lost. The AD should be written in simplified English to the extent possible. Legal terminology should be at a minimum. Ultimately, the person that is the recipient of these documents is the mechanic. He is the one that is affected in the human factors area the most.

Do air carriers consider human factors when preparing inspection procedures? The answers we received to this were variable. There was a mixed reaction. Some of the things that were suggested were that maintenance procedures that are taken directly from the Maintenance Review Board process are sometimes hard to understand and need to be simplified. In some cases, environmental factors are not considered, such as the time of day or night, and the weather. Some carriers develop work cards in easily understood tasks.

A very important area is the effects of repetitive inspections. Some of the answers were boredom and complacency. What happens to an inspector as he looks down a row of 1,800 rivets. After he inspects the first 100 what happens to the next 1,700? What can we do in the human factors area to ensure that he will look at each and every one the same way. One of the suggestions from the group was rotation of assignments to improve inspection results and that boredom and repetitive inspections result in scanning in lieu of detailed inspection. These are issues that we are facing today in human factors.

What can be done in human factors to reduce the problems of missed findings? Some of the suggestions were to limit the man-hours of the inspectors. We need to implement the specific

inspector qualifications. Some suggestions were to improve the training procedures for airframe and powerplant mechanics and implement maintenance awareness training. And again back to the manufacturer, more thought given to the design of the airplane with maintenance in mind.

Another area is human factors aspects considered in the development of maintenance manuals and work cards. The manufacturers and airlines point of view is that they believe that the manuals and work cards were well written and there is some evidence to support this. On the other hand, the mechanics that were present at the session reported that while the manuals were good, they needed work in the areas of wear limits, crack limits, and work card breakdowns.

Another issue raised was whether or not adequate studies have been conducted regarding the liability of inspections under realistic conditions? By realistic we mean actual inspection conditions, those that are done outside, those that are done on the midnight shift, in the hangar, on the line and so forth. Most pointed out that human errors have occurred, but we don't understand the cause of errors and they are not understood in all cases. The group recommended that studies should be conducted to identify reasons for these errors.

Another area was should A & P mechanics' training include nondestructive inspection emphasis in the area of human factors? There was a recommendation to update the standards for A & P mechanics' licenses and perhaps that they should be specialized and divided in general aviation and in air carriers. The FAA made a point to let everyone know that they are in the process of revising the FAR 147 rule that covers the aviation technician education schools. We will review everything in there on NDI and Human Factors and apply the learnings of this session to our action.

One of the more important issues was the effect on a mechanic when he is faced with the pressure to meet schedules. Some of the airlines reported that they held the aircraft until the task was completed and so, therefore, there wasn't a problem. On the other hand, the mechanics looked at it differently, stating that the time constraints and accompanied pressure often affected their performance.

There were some specific recommendations to the FAA for future consideration. It was recommended that we establish a program for FAA engineers and inspectors to visit operators and manufacturers to gain hands-on experience in conforming with inspection airworthiness directives. They said we need to get out there on the floor and talk one on one with technicians, A&P mechanics, engineers, etc., to define the problems they have in complying with an AD. What problems do they run into during visual inspections at night looking for cracks? What problems do they have with paint, with dirt, with lights and all the other things that happen? How tough is it to boroscope a combustion chamber on an engine? And what happens on a non-destructive inspection of 1,200 rivets?

They also asked us to bring test cases where airworthiness directives were complied with, (that were signed off but failure still occurred that the airworthiness directive would have precluded). They recommended that the review should try to establish what went wrong from a human factors standpoint. We should establish a working group, to identify the research and development needed for improvement on the inspections, and to define human factors which contribute to nondetection of structural defects.

Finally, they recommended that we provide immunity to mechanics similar to the Aviation Safety Reporting System for pilots. A study is needed to determine how communication service problems can be improved between the manufacturers, the carrier and the FAA since communication is the most important part of human factors.

D. ENGINES DISCUSSION PANEL SUMMARY

Chairman: Jay Pardee
Co-chairman: William White

The engines discussion panel was probably the smallest group. The initial question discussed by the group was that posed by the Administrator which addressed unique aging inspection issues related to engine design and use. The working session concluded that the effects of engine aging differ from those related to airframe aging primarily because of the shop visit programs, coupled with the structural inspection programs, critical part life limits, and the changing out of rotating components. In essence, the opportunity to inspect engines at the piece/part level, during shop visits, is impossible in the realm of airframe inspection.

The engines discussion group reviewed the following issues related to potential age-affected areas. Performance, replacement parts, NDT, non-life-limited rotating parts, industry-FAA communications, and life limits for static parts were discussed. Engine performance retention following repair was discussed first. It was concluded that this is really not an issue since proper bill standard instructions for the repairs existed including limit exceedance, and secondarily adequate monitoring procedures were in place for engine performance retention between shop visits. Replacement parts were discussed at great length, limited not only to those related to aging engines. Specifically, the group explored how these aged engines might be more likely candidates due to their total time in operation. A need was felt that the FAA should control the quality of replacement parts, and the practices of replacement parts distributors and brokers. General concern was expressed about parts manufacturer approval (PMA), PMA-contract government

parts, and, in the long term, liability. It was also requested that the FAA consider industry regulation to monitor spare parts distributors. Many attendees expressed concern at the lack of standard repair records available for replacement parts. It was concluded by the manufacturers, operators, and repair personnel that life-limited and non-life-limited parts were adequately managed by the Instruction for Continued Airworthiness in the form of service bulletins (SBs) from the manufacturer and airworthiness directives (ADs) from the FAA.

Industry does not support FAA certification of any NDT personnel. Existing qualification standards were considered adequate. In cases where there was a complex or specifically unique NDT inspection technique required, it was thought that perhaps an AD would be in order. It was also pointed out that the manufacturers do provide specialized training on complex special procedures and equipment.

Regarding industry/FAA communication, it was recommended that the FAA consider a seminar cochaired by manufacturers and the FAA to exchange data, specifically on lessons learned; to provide each other with information on aging engines. It was also suggested that the industry/FAA utilization of the service difficulty reporting systems be improved. The current communications system consists of an information flow to the operators in the form of letters, maintenance and overhaul manuals with revisions, and service bulletins that provide additional airworthiness information.

Another issue analyzed during the session was the established basis for the evaluation of static parts, in particular, cases and frames. Industry would recommend and support research and development of enhanced inspection methods for NDT of cases and static structure, and for the development of

life prediction methods for repaired and nonrepaired cases and static structure. Most of the group agreed that the adoption of a uniform standard that would economically penalize individual operators.

On the issue of propellers, the group concluded that airworthiness concerns are generally controlled by instructions contained in aircraft maintenance manuals and airworthiness directives. The absence of propeller manufacturers and experienced operators prevented this issue from being fully discussed. The group, therefore, concluded that it would follow on with discussions with propeller manufacturers and operator groups to discuss aging issues associated with propellers.

E. CLOSING COMMENTS FROM MEMBERS OF INDUSTRY

Speaker: Mr. Hatsuki Yasakowa, Senior Airworthiness Engineer
Japan Civil Aeronautics Board (JCAB)

Since joining JCAB in 1967, I have dealt with the FAA often. First, I shall describe our jet fleet. There are 228 jet transport aircraft operated by Japanese carriers. The inventory breakdown is as follows:

eighty-seven	747s
forty-three	767s
twenty-seven	DC9s
twenty-one	DC10s
twenty-one	737s
eleven	L1011s
and six	727s

Two hundred fifteen of the two hundred twenty-eight (95%) are American made. Thirty of the eighty-seven Boeing 747s are equipped to carry over five hundred passengers, and are operating on domestic routes with flight times on the order of one hour.

Nine of our 747s on file are at least fourteen years old and are the fleet leaders in their specialized utilization. The lead aircraft is approaching 24,000 flight cycles. Three 747s have exceeded 20,000 cycles. One 767, which is only five years old, is in the lead group for flight cycles. Five other 767s are now over 10,000 cycles.

Currently in Japan, better inspection for corrosion and disbonding, as well as inspection of fuselage skin joints is in progress. Multiple site damage has been examined also. Attending the Airframe Session, I was impressed by the capability

of the FAA and the aviation industry. With this capability I am sure that the recommendations, all of which I support, will not be difficult to enact once they are put on the table. Better inspection of older aircraft is vital. Being conservative, sampling in the SSID seems like a good idea.

JCAB has always been willing to supply safety information on our fleet to the FAA. Japanese carriers have always been in close contact with the manufacturers. Current inspections and part replacements in Section 41 of the 747s is a good example of the present system working properly. The safety of our jet fleet, in light of the items just mentioned, can only be maintained through continued cooperation with the FAA and the manufacturers. The present system can attack the aging problem through accurate reporting and inspection.

Speaker: Mr. Nicholas Baas, International Air Transport Association (IATA)

The IATA, composed of 171 airlines members, endorses the AIA/ATA recommendations and shares its opinion that there is no technical reason why aircraft cannot continue to fly safely virtually indefinitely. To do so, the maintenance program, which controls the periods between inspections, the inspection technique used, and the areas inspected, should be modified to reflect service experience, the number of flights flown, and the operational environment of the aircraft. These variables and their influence on the maintenance program are known to the aircraft manufacturers, and take the form of maintenance recommendations to the airlines and the airworthiness authorities. This is a never-ending process of refinement as service experience accrues and new materials and techniques are developed for manufacture and repair. The IATA sees this initiative by the FAA as a welcome and natural part of this process and offers its full support.

Speaker: Mr. John Bristow, United Kingdom Civil Aeronautics Board (CAA)

This problem is truly an international concern, not just an FAA concern. The SSID was discussed often. It is more than an inspection program. Many operators think of the inspection as the outcome, but it really is only one part of the total structural integrity review of aging aircraft. Other results of this review include the possibility of modification of the aircraft or new life limitations. In the future, the outcome of the integrity review is going to include some of each. It is no longer a question of just inspections.

In the United Kingdom, for the last eight years, the whole process has been named "structural audits." Here is a review of our experience in structural audits and their application over the last nine or ten years.

The first viewgraph depicts results of the last few years of application of structural audit program. The full-scale structural test provides a good foundation on which to build analyses of crack growth, inspection thresholds, and residual strength studies. This analytical process has proven difficult on aircraft that have had the full-scale structural test. The high-time teardown may be a good substitute, but should probably be viewed as a supplement to a full-scale structural test for certification. In the supplemental inspections that have been carried out, some problems were predicted, while others are replaced with new problems. The system seems to be working very well. The inspections and data feedback must now be accurate. If, for example, a fleet leader sampling program were begun, one would be relying on feedback from inspections conducted outside of your airline, outside your country, even outside your

hemisphere. The international part of such a program is essentially the inspection results feedback. Such inspections must be mandatory worldwide. These inspections will not occur unless there is a firm legal requirement for them to be conducted. Mandatory service bulletins made mandatory by airworthiness directives (ADs) must apply to all aircraft in your fleet regardless of the country in which they are located. All countries must cooperate or the process doesn't work. Other information resulting from the structural audit includes identifying aircraft which have been repaired, where the repair differs from the type design. There must be a good and swift process for coping with that. The structural audit needs to be expanded to cover the effects of corrosion on the subsequent cyclic response. The word "fatigue" was deliberately avoided because it is crack growth and residual strength that are important here. An invitation is extended to the FAA to visit CAA in Gadwich for future discussion on topics such as approving and licensing of NDI inspectors, a pilot study that was done on the human factors involved in designing inspections, and some formative work that has been done on corrosion interaction with crack growth and fracture that is unpublished and in a wider JAR format. Several countries in Europe have experience in extended airframe cycling. The FAA is urged to join the JAR structure study group to discuss this problem. This would help solve the problem of how to handle aircraft manufactured in other nations once extended high-time airframe testing has been conducted by the FAA in the U.S.

Speaker: Mr. Stan Green, General Aviation Manufacturers Association (GAMA)

GAMA represents the manufacturers of aircraft which carry less than twenty passengers. These aircraft are used primarily in commuter service, but more and more are in use in business,

corporate, and personal applications. The commuter carrier fleet is very large. These aircraft are built under FAR 23 and FAR 41 regulations. The commuter category has the advantage of simplicity of design and an excellent safety record.

This can, however, like anything, improve. GAMA supports this FAA exchange of views and discussion of concepts to ensure continued airworthiness of its fleet of airplanes. Much of what is learned about the problems associated with air carrier and commuter airplanes is going to be useful for application to the fleet of general aviation aircraft not used in general service. These include the air taxis, the on-demand people, and the corporate, business, and personal users. GAMA and its member companies have recognized that the fleet is aging both in years (half of the fleet is over twenty years old) and in number of hours flown (these small commuter aircraft amass almost as many flight hours per year as the large airliners). The average flight is less than one hour. The number of cycles per aircraft is far in excess of that for the larger airliners. However, averages are meaningless when the issue is the safety of any particular aircraft during any one particular operation. The recognition that some airplanes of various makes and models have accumulated many years and operating hours, and have led to the establishment within GAMA of a committee, the Continued Airplane Airworthiness Group, whose goal is to provide the means to develop, distribute, and act upon information to prevent catastrophic failure of older aircraft. Under GAMA sponsorship, the committee developed an outline for an SID for commuter aircraft. The idea was to cover the entire airplane: all systems, all equipment, and all structure. The outline is then used within a company to develop a program for each airplane type certificated. This promotes uniformity in all companies and makes maintenance and the following of the program much easier for mechanics and those responsible in the field. The

information necessary to develop these programs comes chiefly from information feedback from the manufacturers, the various operators, the repair stations, and overhaul facilities. Much of this information comes from the manufacturer's own effort involved in overhaul and inspection work on its own aircraft. Lots of technical information is evaluated by the FAA, and data from other products of similar type and construction is used in many cases.

The title "supplemental inspection" means information that is supplemental to that provided in the original maintenance document. This supplemental information is developed to cope with the realities of actual operation of the aircraft that were not or could not be included or known at the time the original maintenance manual for the aircraft was developed. Our efforts have led to the development of some recommendations which were assembled prior to this meeting. One recommendation requests that the FAA initiate additional research into aircraft structural deterioration and methods to detect and prevent such deterioration. A better transfer of current technical knowledge through seminars sponsored by the FAA, NASA, or whomever is necessary. More information needs to be exchanged on the current status of NDT, including current information on what is available as well as how it is being used. Improved collection and dissemination, through the manufacturers, of defects found in their products or those of manufacturers of similar products, will permit action to prevent catastrophic failures. Better training and certification requirements for individuals who are doing the specific tasks on specific aircraft is requested. A training standard should be developed, and individuals (be they mechanics certified for use of specific equipment to search for cracks on specific airplanes or other persons doing the same type of work) should be trained to meet this standard. FAR 43 should be modernized, particularly FARS 43.15, 43.16, and Appendix B.

Lastly, the maintenance tasks that can be performed by a pilot need to be examined and possibly expanded. This perhaps has more applicability in general aviation or the on-demand air carrier, though it does have some utility in the smaller commuter operations. The pilot should be trained and certified after proving that he can do certain tasks. The more that a pilot who is responsible for the flight knows about the specifics of the airplane, the structure, the engines and the avionics, the more will be identified before a flight problem.

Speaker: Mr. Sarwoko, Indonesian Airline Representative

Safe aircraft begin with correct installation of parts and proper maintenance. Experience has shown that aircraft have indefinite life if maintained properly. From an airline point of view, we propose that the airlines, the manufacturers, and the government authorities decide on a life limit for the airplanes. Once a life limit has been established, one can begin the planning process for replacing the plane. The manufacturer can provide aircraft of equal performance to replace the aging plane.

If the airplane is maintained correctly, it will last five times longer than the design lifetime. This is because the load spectrum in the real world is much lower than the design spectrum. The load used to develop the design life is, in our experience, the landing load. Normally the landing is done quietly, with the load rarely exceeding 2.5 gs. To address Mr. Hoover's question on the economics of maintaining aircraft as they get older and older, experience has shown that maintenance costs do not increase as the aircraft ages. The cost curve tends to flatten after ten years. Therefore, we can economically maintain the airplane throughout its life. Structural failure is not related to the age of the aircraft in our experience. Structural failures can occur on new airplanes as well. Failure

could occur in Section 41 of a 747 as easily as on a DC-10 horizontal stabilizer panel.

It is encouraged that the members of this industry, the airlines, and the government authorities share current knowledge of discoveries made on other airplanes. Training is required for engineers as well as inspectors. Engineers need to be trained in stress analysis, damage tolerance, and crack growth analysis. This type of training gives them a better feel for the structure and greater capability at designing the structure. This is from personal experience. I was trained by an aircraft manufacturer in stress and load analysis and damage tolerant design. The responsibility for the evaluation of a failure is on the engineering department of the airline. A structural failure is indicative of the quality of the engineering, since the engineer has the tools available to manage the planning.

Airworthiness directives (ADs) should be written as simply as possible and should be correlated with the service bulletins (SBs). When contradictions are encountered, one document must be revised.

Speaker: Mr. Bob Goodrich, Director of the Office of Flight Standards, FAA

We need to guard against getting too smart, too quick. This is an old problem, and I don't think anything really new was discussed here. A lot of us meet several times each year and discuss the same things. It is important to keep the energy from this gathering going and assemble the right groups to look at these problems. The beginnings of the solution to this problem are attending this conference. The solution is certainly not the FAA. It is easy to point to the regulator for answers. "FAA should ... FAA should ... " was stated several times. Think

of the FAA as the vehicle toward a solution of these problems. This is really an international problem, and the FAA certainly has to work with its colleagues from England, JCAB, and the rest of the world.

It is hoped that the FAA did not act prematurely or write any bad rules or propose bad legislation. If we follow through, knowing what has to be done, that type of thing will not occur. Many of us came to this conference to see what was going to happen, to hear what was going to be implemented, instead of really contributing - and that is part of the problem. There are many problems to be faced. Information sharing is very easy to say, but difficult to accomplish once everyone is in their separate roles. Timely information transfer from one airline through the FAA to another airline can mean economic advantage forfeited. Maybe that is the role for the FAA. The regulator's role is to see that all suffer equally. Smart rules need to be written so that economic advantage is not given to the operator everyone knows is using a short-cut, short-term maintenance program while penalizing those who have put together a first-class maintenance organization.

Manufacturers have to give equal design consideration to maintenance as they do to the cockpit in regard to human factors. Maintenance issues seem to be one of the leaders in the events that are making the front pages of the world's newspapers. Maybe this is an indicator that the fleet is aging and that one leg of that particular stool has not had equal servicing. Maybe it has been a little shorter because of economic impact and not direct revenue impact. Maybe the maintenance leg is not equal to the operational leg because it does not appear to bring revenue. This is where my role becomes very important in interacting with you. Many things discussed here were very interesting and can result in some beneficial activity. If money is available for

research, it is important to do it right. It has been said that the FAA has been a cheap source of labor for industry in a quality assurance sense. It's cheaper to pay the regulators than to maintain a class program. I believe the FAA has been misused at times and that it is coming out of that era.

The FAA needs to get smarter to work smarter, to work with you. It can't do a great deal to inspect and solve problems, it can't put quality into your maintenance program, but it can try to make sure that we all suffer equally.

This is all great, but we need to keep the momentum rolling. The single most important issue we're facing is how to share information without cutting off someone else's leg of the stool.

Speaker: Mr. Craig Beard

The term "plain English" has been used often during the conference. The term itself is an oxymoron, a conflict in terms. A lot of work needs to be done in this area.

In closing this conference, it is obvious to everyone that the work has only really begun. The laws of physics know no national boundaries. Aviation safety issues are transnational, and that it is particularly important that so many representatives have come from so far on such short notice to share their perspectives. One of the most immediate benefits from this conference is the fact that everyone has come together, outside traditional thinking groups, to take the time to understand the views of others concerning the safety of aircraft. FAA action will follow very soon. But the FAA cannot act alone. Individuals, companies, associates, and colleagues in other governments are encouraged to begin action on their own, and the FAA welcomes invitations to participate. The flight standards

organization, the aircraft certification organization, and the R & D organization will take the products of this conference into consideration and begin to work in action groups and with the industry to address the issues of continued airworthiness. Aviation safety begins with safe aircraft.

APPENDIX 1
COPY OF PROPOSALS MADE BY AIA/ATA

AIRLINE/MANUFACTURER RECOMMENDATIONS
INTERNATIONAL CONFERENCE ON AGING AIRPLANES
JUNE 1-3, 1988

1. Continue to use our present system of maintenance and inspection with diligence and thoroughness. Find out why a single aircraft suffered major structural failure and adjust the system as necessary.

2. Initiate research to find better ways to assess structural condition and detect structural problems.

3. Continue to pursue the concept of teardown of oldest airline aircraft to determine structural condition, and conduct fatigue tests of older airplanes per attached proposal.

4. Pursue transfer of the currently available body of knowledge of NDT and its application to aircraft inspection.

5. Put R&D money into improving NDT techniques and methods.

6. Examine all aspects of Human Factors involved, including training and qualification of airline inspectors.

7. Ensure that the communications systems between airlines, manufacturers, and FAA are adequate.

8. Establish task forces from the airlines, manufacturing industry, FAA, and NASA to continue the work begun in this workshop.

PROPOSAL FOR FATIGUE TESTING OF OLDER AIRCRAFT

For selected aircraft models, it is proposed that the FAA and/or NASA acquire high-time airplanes and fund the following program:

1. Assess and record aircraft condition through a comprehensive visual and NDT inspection. Review ship's log to evaluate significant in-service incidents/occurrences.

2. Selectively incorporate the manufacturers' recommended structural service bulletins (preventative modifications and terminating actions/repairs) prior to starting the test.

3. Subject complete airframe to representative flight-by-flight cycling to establish:

   a Economic repair life with modifications;

   b Any previously undisclosed problem sources; and

   c Incorporate remaining manufacturers' recommended structural service bulletins at appropriate times throughout the test.

4. Conduct (and assess the affectivity of) a typical inspection/maintenance program throughout the test (agreed between airlines/FAA/manufacturers). Evaluate damage discovered during the test for possible service action.

5. Conduct appropriate damage tolerance/residual strength test near the end of cyclic fatigue testing.

6. Conduct thorough teardown inspections as appropriate.

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1 The service corrosion environment should be considered in the test airplane selection.

2 The test program would be conducted by the model manufacturer.

APPENDIX 2

COPY OF RECOMMENDATIONS MADE BY SINGAPORE AIRLINES

Aubrey Dim
Singapore Airlines
3/6/88

To: FAA Technical Panel on Aging Aircraft

Thank you for the opportunity to participate in your conference.

I am writing this to expand on my earlier suggestion during the NDI workshop on reconsidering aircraft design factors. I am also bringing out another item that is totally unrelated to NDI. I would like you to treat my letter as coming from an observer and not from an expert.

With respect to design factors, I feel that a review should be made on how they were derived and whether in-service experience has shown that the formula is correct, wrong, or totally wrong.

If a component cracks earlier than expected, it means that design criteria were grossly off as there is a buffer in the safety factor. You can't get fatigue cracks unless the component is stressed beyond its yield point. If components crack during normal operation, it is indicative that design consideration of loading is grossly off. The FAA should pose the following questions when manufacturers submit SBs and ADs.

1. Why did the part fail?

2. Where did the design go wrong?

3. What steps are being implemented to avoid future errors in design consideration?

It is also obvious to me that manufacturers are opting for inferior materials so that the production cost of the aircraft would be kept low so as to keep it competitive.

Take the B747 pylon midspar fuse pin which is a high alloy steel. During in-service operation it was found to be susceptible to fatigue cracking. The Boeing SB recommended a change from maraging steel to Inconel (which incidentally costs about 10 times more). It is obvious that pylons are subjected to extremely high cyclic loading and a choice of maraging steel which has low fatigue cracking characteristics should not have been selected. Replacement of high alloy steel for Inconel is widespread in Boeing SBs. Manufacturers are doing this to keep the original sale price of their aircraft low so as to keep competitive. But it is up to FAA to decide which they want.

I am strongly opposed to the idea of purchasing high time aircraft and destructively testing them. No offense but I think it is a waste of time and money. Even if you do disagree, how long before the results come out and are implemented? I think you would have lost a few more aircraft and hundreds of lives during the interim.

My second proposition is this:

1. Flight crew to be trained immediately on emergency procedure should depressurization, as a result of structural failure, occur.

2. Reassessment of pressurization system function during structural failure.

You see, human factors will remain human factors. There will be slipups and there will be large cracks that will go undetected. There will be similar Aloha and Air India incidents. We must overcome this part with a backup.

Cabin/atmospheric differential pressures exert tremendous loads on the skin, frames, and stringers. If a crack gets big enough it will propagate quite rapidly. The rapidity of propagation is directly proportional to the load on the members. If the load is reduced, the rate of cracking is reduced proportionally.

In the case of Aloha, when the crack got big enough, it started to depressurize the cabin rapidly. Unfortunately, the pressure controller sensed a gain of cabin altitude and started to close the outflow valve. This action maintained the high loading on the cracking members and encouraged the members in cracking. Finally, the cabin roof separated and a horrified stewardess found herself hurtling toward certain death. I hope this never happens again.

This is my detailed recommendation:

1. Flight crew trained to handle depressurization due to structural failure.

2. Install guarded "Depressurization" switches at each flight attendant station to alert the flight crew that depressurization has occurred.

3. Install a guarded "Emergency Depressurization" switch which will override the pressure controller to open outflow valves and shut all pressurization sources.

4. Install a new pressure controller that can detect off-schedule depressurization synonymous with structural failure to open the outflow valves and shut all pressurization sources.

APPENDIX 3

COPY OF VU-GRAPHS BY WORKING GROUPS PRESENTED AT THE CLOSING SESSION

AIRFRAME WORKING GROUP VU-GRAPHS

ARE CERTIFICATION CRITERIA ADEQUATE?

- o No international system to ensure adequate maintenance records follow the airplane as it changes hands
- o Certification and qualification of inspectors
- o Recertification of airplanes (STC) when they reach their tested lifetime.
- o Certify derivative airplanes to latest fatigue standards.
- o Interpretation is more of a problem than lack of rules

# #

ARE CORROSION CONTROL TECHNIQUES ADEQUATE?

- o Not adequately addressed in present maintenance program
- o R&D on corrosion prevention/protection needed
- o Better inhibitors
- o Detection F&D essential
- o 5% removals for fatigue - rest for corrosion
- o Navy program discussed
- o Corrosion meeting in Scotland in March
- o Needs further discussion
- o IATA guidance material published
- o Need Advisory Circular on corrosion

# #

USAGE RESTRICTED BASED ON TESTED FATIGUE LIFETIME

- o Discussed two lifetime fatigue tests
  - Some for
  - Some against
- o Cannot use fatigue tests in this manner as they were intended only to identify critical areas
- o Ensuring adequate inspections is more important than two lifetime tests
- o Fly to 75% tested lifetime, then scrap the airplane

# #

RESEARCH AND DEVELOPMENT

- o Should come without political strings
- o Should not necessarily lead to mandatory program
- o No one with axe to grind should do research
- o Start by surveying NASA/DoD/International/AGAARD to see what is already done
- o Easier detection of cracks
- o Better identify scatter factors

# #

NONDESTRUCTIVE TESTS

- o Develop automated techniques - take human element out
- o Before NDT techniques are developed, objectives must be set
  - What do we want to find?
  - What amount/size?
- o Need good reliable method to detect condition bonds in service
- o Improve and standardize training

# #

SUPPLEMENTAL INSPECTION DOCUMENT (SID)

- o Does not adequately address corrosion
- o Otherwise works fine. Do not mess with it (majority)
- o Worthwhile relooking at it though
- o Need corrosion SID
- o Need SID for commuter airplanes:

  - Should they be mandated?
  - Airplanes used beyond what was anticipated
  - Single spar wings
  - Less sophisticated maintenance programs

# #

MULTIPLE SITE DAMAGE (MSD)

- o FAR fail-safe philosophy can be compromised by the presence of MSD
- o Need more research on MSD phenomenon
- o Do not need to tear down aging airplanes to evaluate MSD

  - Can do hundreds of lab panel tests
  - May be cheaper
  - More repeatability

- o Two lifetime test ensures no significant MSD in one life
- o Widespread MSD is an economic matter. May be too expensive to fix
- o Lots of other discussion with no real conclusions or recommendations

# #

FAA ISSUES

- o FAA inspectors should inspect airplanes, not paperwork
- o Inspectors should ensure airlines have adequate analysis and surveillance programs
- o Inspectors should ensure that maintenance programs are followed

  - Contract maintenance person said inspections had been done, but damage undetected

# #

AIA/ATA RECOMMENDATION NUMBER 1

- o Many comments that present systems are okay if properly used
- o Paper system works - if followed
- o Question as to whether or not inspection actually done properly on Aloha

# #

AIA/ATA RECOMMMENDATION NUMBER 3

- o Most look favorably on it
- o Some question that you only get one data point - applicable to whole fleet?
- o Do not know the airplane flight history
  - May be able to put monitors on early airplanes to gain flight history
- o Which manufacturers SBs should be incorporated?
  - Define selected
- o Discussed 2-3 years required to do all this
  - Would this be timely for today's aging fleet?
- o Teardown inspection is very time-consuming and expensive
- o Should this be an industry or Government-funded program?
  - "The applicant must demonstrate. . . ."
  - Proposed bill interpreted to give us the freedom
- o While this is being done, must rely on diligence and thoroughness of current inspectors

# #

AIA/ATA RECOMMENDATION NUMBER 7

- Whole communications system not just problem areas
- Wanted lessors and maintenance organizations to be included
- Foreign authorities wanted more and more valid information
- Not enough interaction with operators on Aloha AD
- FAA should include FCAAs
- Airlines find a problem, but do not tell anyone for fear of FAA violation

# #

AIA/ATA RECOMMENDATION NUMBER 8

- Do not want to bring in SAE, etc., as it slows down the process
- Looking for task force like McArtor's Pilot Task Force
- Small groups - locked up - with a goal and a deadline
- Not looking to FAA to head up because of Advisory Committee Act conflicts

# #

NONDESTRUCTIVE INSPECTION (NDI) WORKING GROUP VU-GRAPHS

NDI SESSION

- Representative mix of 121 operators, transport and general aviation manufacturers, domestic and foreign, repair/mod facilities, FCAA, other Government agencies, etc. (No Part 135 operators)
- Group interacted fairly openly and dynamically
- 130 comments, recommendations, suggestions made
- Inputs were diverse, many profound, very appropriate for further FAA consideration and possible action
- Seven recommendations appear to capture major areas of concern or group energies

# #

FAA SHOULD DEVELOP NDI STANDARDS AND CRITERIA FOR TRAINING AND RECURRENT TRAINING AND ISSUE THEM IN ADVISORY MATERIAL

- Need for greater standardization of NDI procedures and training
- Need for more qualified NDI inspectors
- FAA could explore NDI inspector training requirements in other countries

# #

FAA SHOULD SPONSOR RESEARCH AND DEVELOPMENT FOR IMPROVEMENT OF NDI METHODS

- FAA should acquire and test high time airframes
  - Evaluate existing and new NDI methods with full participation of manufacturers/operators
- FAA should sponsor an R&D symposium
- Use of artificial intelligence in NDI
- Computer enhanced signaling

# #

OPERATORS WANT SBs/ADs TO PROVIDE FOR ALTERNATE METHODS OF COMPLIANCE

- Need to improve timeliness of approval of alternate methods suggested by operators/manufacturers
- SBs currently call out simplest inspection equipment; large operators with more sophisticated equipment are unable to utilize it
- Old ADs call out antiquated inspection methods; should be updated or amended

# #

FAA SHOULD PROVIDE FOR GENERAL APPROVAL OF ALTERNATE COMPLIANCE METHODS; CURRENT REQUIREMENT THAT EACH OPERATOR OBTAIN INDIVIDUAL APPROVAL IS CUMBERSOME

# #

FAA MUST UPGRADE NDI EXPERTISE

- To enable evaluation of alternate methods for ADs
- FAA needs greater familiarity with state-of-the-art NDI techniques
- FAA needs to establish a focal point on NDI for industry contacts

# #

FAA SHOULD TAKE THE LEAD IN IDENTIFYING AND ARRANGING NEEDED GOVERNMENT/INDUSTRY CONFERENCES OR WORKSHOPS

# #

CURRENT STATE-OF-THE-ART NDI PROCEDURES MAKE IT UNNECESSARY TO ESTABLISH A RETIREMENT THRESHOLD FOR AIRCRAFT

# #

HUMAN FACTORS OF INSPECTIONS WORKING GROUP VU-GRAPHS

ARE THE HUMAN FACTORS AND REALITIES OF REPETITIVE VISUAL AND NDI INSPECTIONS BEING PROPERLY ACCOUNTED FOR IN THE DESIGN EXPECTATIONS OF THE INSPECTION PROGRAMS?

- Standardization - qualifications
- Experience level
- Training
- Double inspection
- Accessibility - design

# #

ARE AIRWORTHINESS DIRECTIVES HARD TO UNDERSTAND?

- Clarification of nomenclature
- Small operators
- Service bulletin conversion
- Simplified English
- Legal terminology
- Mechanic

# #

DO CARRIERS CONSIDER HUMAN FACTORS WHEN PREPARING INSPECTION PROCEDURES?

- Variable
- Procedures taken directly from MRB
- Environmental factors are not considered (day/night/weather)
- Some carriers develop work cards in easily understood tasks

# #

WHAT ARE THE EFFECTS OF REPETITIVE INSPECTIONS?

- o Boredom and complacency
  - Rotation of assignments improve inspection results
- o Scanning in lieu of detail inspection

# #

WHAT CAN BE DONE IN HUMAN FACTORS TO REDUCE THE PROBLEMS OF MISSED FINDINGS?

- o Limit the staff-hours of inspectors
- o Implement inspector qualification
- o Improve training procedure for A&P
- o Implement maintenance awareness training
- o Design airplane with maintenance in mind

# #

ARE HUMAN FACTORS ASPECTS CONSIDERED IN THE DEVELOPMENT OF MAINTENANCE MANUALS AND WORK CARDS?

- o Manufacturers/Airlines - well written
- o Mechanics - adequacy of:
  - Wear limits
  - Crack limits
  - Work card breakdown

# #

HAVE ADEQUATE STUDIES BEEN CONDUCTED REGARDING RELIABILITY OF INSPECTIONS UNDER REALISTIC CONDITIONS?

- o Human errors have occurred
- o Cause of errors not understood in all cases
- o Studies should be conducted to identify reasons for errors

# #

SHOULD A&P MECHANIC'S TRAINING INCLUDE MORE NDI EMPHASIS?

- Update standards for A&P mechanic's license
- FAR Part 147

# #

WHAT IMPACT DOES IT HAVE ON A MECHANIC WHEN HE IS FACED WITH THE PRESSURE APPLIED TO MEET SCHEDULES?

- Some airlines reported they hold aircraft until task completed
- Some mechanics stated time constraints and company pressure affect performance

# #

SPECIFIC RECOMMENDATION FOR FUTURE CONSIDERATION

- Establish a program for FAA engineers and inspectors to visit operators and manufacturers to gain "hands-on" experience in complying with inspection airworthiness directives
- Talk one on one with technicians to define what problems they have in compliance with airworthiness directives
- Visual inspection for cracks - point, dirt, lights
- Boroscope on flap
- NDT on 1200 rivets
- Review past cases where AD's were complied with (signed off) but failure still occurred. The review should try to establish what went wrong from human factors standpoint
- Establish working group/work shop to identify what R&D needed for improved NDI
- Establish working group to define human factors which contribute to nondetection of structural defects
- Provide immunity for mechanics similar to the aviation safety reporting system (ASRS)
- Study needed to determine how communication of service problems can be improved between manufacturers, carriers, and FAA

# #

ENGINES WORKING GROUP VU-GRAPHS

ARE THERE UNIQUE AGING AND INSPECTION ISSUES RELATED TO ENGINE DESIGN AND USE?

- Engine aging differs from airframe aging through:
  - Structured inspection programs
  - Shop visit programs
  - Trend monitoring
  - Critical part life limits
  - Part/module changeout
- Industry agreed that nonlife limited static structures, such as cases, could be age-affected and require inspections, repairs, and knowledge of usable life

# #

POTENTIAL AGE-AFFECTED AREAS:

- Performance
- Replacement parts
- NDT
- Nonlife limited rotating parts
- Industry/FAA communications
- Life limits for static parts
- Propellers

# #

ENGINE RELATED NDT ISSUES

- Industry does not support FAA certification of NDT personnel
- Existing qualification standards are considered adequate
- Manufacturers provide specialized training for new, complex inspection procedures and equipment

# #

NONLIFE-LIMITED ROTATING PARTS

- Retirement lives not required under earlier regulations for spacers, shafts, seals per FAR 33, pre-Amendment 33-6
- These parts are adequately managed by instructions for continued airworthiness
- No additional actions required

# #

INDUSTRY/FAA COMMUNICATIONS

- Recommendation made to consider FAA/manufacturer seminars to exchange data, "lessons learned" information on aging engines with all operators
- Improve FAA/Industry utilization of service difficulty reporting system (SDR)
- Information flow to operators is ensured by all-operator wires, maintenance/overhaul manual, revisions, and service bulletins which provide additional airworthiness information

# #

SHOULD RETIREMENT LIVES BE ESTABLISHED FOR STATIC PARTS?

- Cases have not shown good correlation for lifing methods by time or cycles
- Industry would recommend/support R&D for NDT of cases/static structure for enhanced inspection methods
- Industry does not want an inflexible uniform standard imposed that would economically penalize individual operators
- Manufacturers recommend/support R&D for developing life predictive methods for both nonrepaired and repaired cases and static structure

# #

ENGINE PERFORMANCE MARGIN RETENTION FOLLOWING REPAIR

- Not an issue since proper build standard instructions and control of repairs exist to preclude limit exceedance
- Adequate on-wing inspection and monitoring procedures exist to ensure performance retention between shop visits

# #

REPLACEMENT PARTS

- Need for FAA control of replacement parts distributors and brokers
- Government contract PMA parts
- FAA request to consider spare parts distributor industry regulation for future meeting
- Concerned about lack of repair status records

# #

PROPELLER ISSUES

- Generally controlled by instructions contained in the aircraft maintenance manual and airworthiness directives
- Issue not fully discussed due to absence of propeller manufacturers and operators
- Recommend follow-on discussion with representative propeller manufacturer and operator group to review aging issues

# #

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