Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Rotorcraft Issue Area
Metallic Rotorcraft Structure Working Group

Task 1 – Harmonize 14 CFR/JAR 27 and 29

change is consistent with the Act. Persons making written submissions should file six copies thereof with the Secretary, Securities and Exchange Commission, 450 Fifth Street, NW, Washington, DC 20549–0609. Copies of the submission, all subsequent amendments, all written statements with respect to the proposed rule change that are filed with the Commission, and all written communications relating to the proposed rule change between the Commission and any person, other than those that may be withheld from the public in accordance with the provisions of 5 U.S.C. 552, will be available for inspection and copying in the Commission's Public Reference Room, 450 Fifth Street, NW, Washington, DC Copies of such filing will also be available for inspection and copying at the principal office of the Amex. All submissions should refer to File No. SR–Amex–00–06 and should be submitted by April 26, 2000.

For the Commission by the Division of Market Regulation, pursuant to delegated authority.[9]

Margaret H. McFarland,

Deputy Secretary.

[FR Doc. 00–8323 Filed 4–4–00; 8:45 am]

BILLING CODE 8010–01–M

[9] 17 CFR 200.30–3(a)(12).

DEPARTMENT OF TRANSPORTATION

Office of the Secretary

Minority Business Resource Center Advisory Committee; Cancellation of Meeting

Notice is hereby given of the cancellation of the Minority Business Resource Center Advisory Committee meeting for Tuesday, April 18, 2000, at 10:00 a.m. until 12:00 p.m. in Room 4438–4440 at the Department of Transportation, 400 7th Street, SW., Washington, DC 20590. (Originally announced at Vol. 65, No. 53, FR 14640, March 17, 2000.)

Issued in Washington, DC on March 27, 2000.

Luz A. Hopewell,

Director, Office of Small and Disadvantaged Business Utilization.

[FR Doc. 00–8324 Filed 4–4–00; 8:45 am]

BILLING CODE 4910–62–P

DEPARTMENT OF TRANSPORTATION

Coast Guard

[CGD08–00–002]

Lower Mississippi River Waterway Safety Advisory Committee

AGENCY: Coast Guard, DOT.

ACTION: Notice of meeting.

SUMMARY: The Lower Mississippi River Waterway Safety Advisory Committee (LMRWSAC) will meet to discuss various issues relating to navigational safety on the Lower Mississippi River and related waterways. The meeting will be open to the public.

DATES: LMRWSAC will meet on Wednesday, April 26, 2000, from 9:00 a.m. to 12 noon. This meeting may close early if all business is finished. Written material and requests to make oral presentations should reach the Coast Guard on or before April 17, 2000. Requests to have a copy of your material distributed to each member of the committee should reach the Coast Guard on or before April 17, 2000.

ADDRESSES: LMRWSAC will meet in the basement conference room of the Hale Boggs Federal Building, 501 Magazine Street, New Orleans, LA. Send written material and requests to make oral presentations to M.M. Ledet, Committee Administrator, c/o Commander, Eighth Coast Guard District (m), 501 Magazine Street, New Orleans, LA 70130–3396. This notice is available on the Internet at http://dms.dot.gov.

FOR FURTHER INFORMATION CONTACT: For questions on this notice, contact M.M. Ledet, Committee Administrator, telephone (504) 589–6271, Fax (504) 589–4999.

SUPPLEMENTARY INFORMATION: Notice of this meeting is given under the Federal Advisory Committee Act, 5 U.S.C. App. 2.

Agenda of Meeting

Lower Mississippi River Waterway Safety Advisory Committee (LMRWSAC). The agenda includes the following:

(1) Introduction of committee members.

(2) Remarks by RADM P. Pluta, Committee Sponsor.

(3) Approval of the September 8, 1999 minutes.

(4) Old Business:

a. PAWSS update.

b. Soft Dikes Working Group Report.

(5) New Business: Physical Oceanographic Real-Time System (PORTS).

(6) Next meeting.

(7) Adjournment.

Procedural

The meeting is open to the public. Please note that the meeting may close early if all business is finished. At the Chair's discretion, members of the public may make oral presentations during the meeting. If you would like to make an oral presentation at the meeting, please notify the Committee Administrator no later than April 17, 2000. Written material for distribution at the meeting should reach the Coast Guard no later than April 17, 2000. If you would like a copy of your material distributed to each member of the committee or subcommittee in advance of the meeting, please submit 28 copies to the Committee Administrator at the location indicated under Addresses no later than April 17, 2000.

Information on Services for Individuals With Disabilities

For information on facilities or services for individuals with disabilities, or to request special assistance at the meetings, contact the Committee Administrator at the location indicated under Addresses as soon as possible.

Dated: March 13, 2000.

K.J. Eldridge,

Captain, U.S. Coast Guard, Acting Commander, 8th Coast Guard Dist.

[FR Doc. 00–8378 Filed 4–4–00; 8:45 am]

BILLING CODE 4910–15–M

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee Rotorcraft Issues—New Task

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of new task assignments for the Aviation Rulemaking Advisory Committee (ARAC)

SUMMARY: Notice is given of two new tasks assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Mark Shilling, Rotorcraft Standards Staff (ASW—119), Federal Aviation Administration, 2601 Meacham Blvd, Fort Worth, Texas 76137–4298; phone (817) 222–5110; fax (817) 222–5961 email Mark.R.Schilling@faa.gov.

SUPPLEMENTARY INFORMATION:

Background

The FAA has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the FAA Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the FAA's rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the FAA's commitment to harmonize the Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

The Task

This notice is to inform the public that the FAA has asked ARAC to provide advice and recommendations on the following harmonization tasks:

Task No. 1: Damage Tolerance and Fatigue Evaluation of Metallic Rotorcraft Structure

• The project is to be a harmonized Joint Aviation Regulation (JAR)/FAR 27/29 ARAC program.

• Evaluate: the European Association of Aerospace Industries and the Aerospace Industry Association's White Paper, the recommendations contained in the Technical Oversight Group for Aging Aircraft letters to the FAA, and the ongoing activities and results of rotorcraft damage tolerance research and development.

• Identify the information needed to commence rulemaking and define an acceptable means of compliance.

• Recommend appropriate changes to FAR/JAR 29 regarding damage tolerance and fatigue evaluation of metallic structure, and recommend appropriate changes to FAR/JAR 27 that would allow damage tolerance as an option. Any recommended changes should be practical and appropriate to the unique characteristics of rotorcraft. Where feasible and appropriate, provide consistency with FAR/JAR 23/25.

• Evaluate and revise, as appropriate, the following advisory materials: AC 29–2; AC 27–1; and AC 20–95, Fatigue Evaluation of Rotorcraft Structure; and related guidance.

• The recommendation should be forwarded to the Federal Aviation Administration (FAA) and the Joint Aviation Authorities (JAA) in the format of a proposed rule.

Although this tasking for metallic structure does not depend on the completion of the composite structure project, the Composite Rotorcraft Structure and Metallic Rotorcraft Structure working groups should communicate to avoid possibly conflicting recommendation to amend the same regulatory sections.

The FAA requests that ARAC draft appropriate regulatory documents with supporting economic and other required analyses, and any other related guidance material or collateral documents to support its recommendations. If the recommendation results in one or more notice of proposed rulemaking (NPRM) published by the FAA, the FAA may ask ARAC to dispose of any substantive comments the FAA receives.

A progress report should be provided at each Joint Harmonization Working Group meeting. The recommendation should be forwarded to the FAA and the FAA by September 2002.

Task No. 2: Damage Tolerance and Fatigue Evaluation of Composite Rotorcraft Structure

• The project is to be a harmonized FAR/JAR 29/29 ARAC program.

• Revise current FAR/JAR 27 and 29 to add regulations for composite structure. Consider creating a new FAR/FAR 27/29.573 to address composite structure.

• Evaluate and revise, as appropriate, the regulations and the following advisory materials: AC 20–107A, Composite Aircraft Structure; AC 27–1; AC 29–2; and related guidance to achieve the goal of improved tolerance to flaws and defects in composite structure with methodology and procedures which are practical and appropriate to rotorcraft. Where feasible and appropriate, provide consistency with FAR/JAR 23/25.

• The recommendation should be forwarded to the FAA and JAA in the format of a proposed rule.

Although this tasking for composite structure does not depend on the completion of the metallic structure project, the Composite Rotorcraft Structure and Metallic Rotorcraft Structure working groups should communicate to avoid possibly conflicting recommendations to amend the same regulatory sections.

The FAA requests that ARAC draft appropriate regulatory documents with supporting economic and other required analyses, and any other related guidance material or collateral documents to support its recommendations. If the recommendation results in one or more NPRM's published by the FAA, the FAA may ask ARAC to dispose of any substantive comments the FAA receives.

A progress report should be provided at each Joint Harmonization Working Group meeting. The recommendation should be forwarded to the FAA and JAA by November 2002.

ARAC Acceptance of Task

ARAC has accepted the tasks and has chosen to establish two new working groups, the Composite Rotorcraft Structure working group and the Metallic Rotorcraft Structure working group. The working groups will serve as staff to ARAC to assist ARAC in the completion of the assigned tasks. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepted the working groups' recommendations, ARAC will forward them to the FAA as recommendations.

Working Group Activity

The Composite Rotorcraft Structure working group and the Metallic Rotorcraft Structure working group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working groups are expected to:

1. Recommend a work plan for completion of the task, including the rationale supporting such a plan, for consideration at the Rotorcraft Issues ARAC meeting held following publication of this notice.

2. Given a detailed conceptual presentation of the proposed recommendations prior to proceeding with the work stated in item 3 below.

3. Draft appropriate regulatory documents with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations.

4. Provide a status report at each meeting of ARAC held to consider rotorcraft issues.

Participation in the Working Group

The Composite Rotorcraft Structure working group and the Metallic Rotorcraft Structure working group will be composed of technical experts having an interest in the assigned tasks. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire, describing his or her interest in the task, and stating the expertise he or she would bring to the working group. All requests to participate must be received no later than April 10, 2000. The requests will be reviewed by the

assistant chair and the assistant executive director, and the individuals will be advised whether or not the request can be accommodated.

Individuals chosen for membership on the working group will be expected to represent their aviation community segment and participate actively in the working group (*e.g.*, attend all meetings, provide written comments when requested to do so, *etc.*). They also will be expected to devote the resources necessary to ensure the working group meets any assigned deadline(s). Members are expected to keep their management chain advised of working group activities and decisions to ensure that the agreed technical solutions do not conflict with their sponsoring organization's position when the subject is presented to ARAC for a vote.

Once the working group has begun deliberations, members will not be added or substituted without the approval of the assistant chair, the assistant executive director, and the working group chair.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the FAA by law.

Meetings of ARAC will be open to the public. Meetings of the working groups will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on March 28, 2000.

Anthony F. Fazio,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 00–8382 Filed 4–4–00; 8:45 am]

BILLING CODE 4910–13–M

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Notice of Availability of Draft Environmental Impact Statement; Piedmont Triad International Airport, Greensboro, NC

SUMMARY: Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended, as implemented by the Council on Environmental Quality (40 CFR Parts 1500–1508), the Federal Aviation Administration (FAA) will file with the Environmental Protection Agency, and make available to other government and interested private parties, the Draft Environmental Impact Statement (DEIS) for the proposed Runway 5L/23R, a proposed air cargo sorting and distribution facility (FedEx Mid Atlantic Hub), and associated development at Piedmont Triad International Airport, Greensboro, North Carolina. The DEIS will be on file with the EPA and available to the public for review starting April 6, 2000, after 1 p.m. at locations listed under **SUPPLEMENTARY INFORMATION**. A Public Hearing and Information Workshop will be held on May 23, 2000; between the hours of 5:00 p.m. and 8:00 p.m. at the Greensboro Coliseum Exhibit Hall, 1921 W. Lee Street, Greensboro, North Carolina. Written comments on the DEIS will be accepted by the FAA until June 7, 2000, or 45 days after the publication of this Federal Register Notice, whichever is later.

FOR FURTHER INFORMATION CONTACT: Ms. Donna M. Meyer, Environmental Program Specialist, Federal Aviation Administration, Atlanta Airports District Office, 1701 Columbia Avenue, Suite 2–260, College Park, Georgia 30337–2747, Phone (404) 305–7150.

SUPPLEMENTARY INFORMATION: The Piedmont Triad Airport Authority (PTAA), owner and operator of the airport is proposing airside and landside improvements to the Piedmont Triad International Airport. The PTAA's proposed project consists of a new widely spaced Transport Category parallel runway (Runway 5L/23R) that would be 9,000 feet long and 150 feet wide. The runway would be located on the western side of the airport. Other associated projects include the development and operation of an air cargo sorting and distribution facility (FedEx Mid-Atlantic Hub), surface transportation improvements, NAVAIDS for new Runway 5L/23R, property acquisition and relocation of several airport tenant operations. The DEIS has examined the sponsor's proposed project and improvements along with other reasonable alternatives to the proposed project. The Federal Highway Administration (FHWA) is acting as a cooperating agency to the FAA in this DEIS.

A Public Hearing will be held by the FAA to afford interested parties the opportunity to provide their comments on the merits and findings of the DEIS and to consider the economic, social, and environmental effects of PTAA's proposed development and its consistency with the goals and objectives of such urban planning as has been carried out by the community. The Public Hearing will be conducted in conjunction with an informal Information Workshop. During the Information Workshop, participants will be able to view project related materials and speak with representatives of the FAA and the consulting team.

In addition, the public is invited to comment in one of four ways during the Public Hearing/Information Workshop: (1) Written comments may be submitted anytime during the Hearing/Workshop; (2) Pre-addressed written comment forms may be mailed to the Individual listed above, (3) Private oral comments may be given to a certified court reporter anytime during the Hearing/Workshop, and, (4) Oral comments may be made in front of the Hearing Officer who will be present to preside over and conduct the Public Hearing. The FAA encourages interested parties to review the DEIS and provide comments during the public comment period.

For the convenience of interested parties, the DEIS may be reviewed at the following locations:

Greensboro Public Library, 219 No. Church Street, Greensboro
Hege Library of Guilford College, 5800 West Friendly Avenue, Greensboro
High Point Public Library, 901 North Main Street, High Point
Forsyth County Library, 660 West Fifth Street, Winston-Salem
Piedmont Triad International Airport, 6415 Airport Parkway, Greensboro
Federal Aviation Administration, Atlanta District Office, 1701 Columbia Avenue, College Park, Georgia

Dated: Issued in Atlanta, Georgia, March 31, 2000.

Scott L. Seritt,

Manager, Atlanta Airports District Office.

[FR Doc. 00–8383 Filed 4–4–00; 8:45 am]

BILLING CODE 4910–13–M

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

RTCA, Inc.; Free Flight Steering Committee

Revised Agenda

The April 13 RTCA Free Flight Steering Committee Meeting announced in the **Federal Register**, 65 FR 16240 (Monday, March 27, 2000), third column, has been revised.

The revised agenda reads as follows: The agenda will include: (1) Welcome and Opening Remarks: (a) Recognize Departing Members of the Steering Committee; (b) Welcome Incoming Members. (2) Review Summary of the Previous Meeting; (3) Reports from FAA on: (c) Free Flight Phase 1 Baseline Data and Performance Assessments Update; (d) Controller-Pilot Data Link

7313 Janetta Drive
Fort Worth, Texas 76180

September 26, 2005

Mr. Nicholas A. Sabatini
Associate Administrator for Regulation and Certification
FAA National Headquarters, AVR-1
800 Independence Avenue, SW
Washington, D.C. 20591

Dear Mr. Sabatini:

The Aviation Rulemaking Advisory Committee (ARAC) Working Group activity associated with the Fatigue Tolerance Evaluation of Metallic Structure Task has been completed. The ARAC examined the results of the working group's activity in public meetings on February 7, 2005, and September 8, 2005, and approved them.

This task was originally intended to be harmonized with the Joint Aviation Authorities (JAA). European industry personnel participated throughout the development of the package; however, the JAA participated only until they were replaced by the European Aviation Safety Agency (EASA). EASA decided not to continue participation in the completion of the task.

Accordingly, the ARAC hereby submits, without change, the proposed NPRM and associated Advisory Circular package developed by the working group with a recommendation that it be processed for publication.

Very truly yours,

John D. Swihart, Jr.
ARAC Assistant Chair for Rotorcraft Issues

cc: Mr. Ronald Priddy, ARAC Chair
Mr. Craig Bolt, ARAC Vice Chair
Mr. Tony Fazio, ARAC Executive Director
Mr. Mark Schilling, ARAC Assistant Executive Director
Mrs. Sharon Miles, FAA Working Group Representative
Mr. Doug Tritsch, Working Group Chair
Mr. Charles Chung, Helicopter Association International
Mrs. Caren Waddell, FAA, ARM-200
Mrs. Gerri Robinson, FAA, ARM-200
Mrs. Kathy Jones, FAA, ASW-111

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of Rulemaking
800 Independence Ave., SW.
Washington, DC 20591

December 14, 2005

Mr. John Swihart
Aviation Rulemaking Advisory Committee
Assistant Chair, Rotorcraft Issues Group
7313 Janetta Drive
Fort Worth, TX 76180

Dear Mr. Swihart,

This letter acknowledges receipt of your September 26, 2005 letter transmitting the Rotorcraft Issues Group (RIG) recommendation on the fatigue tolerance of rotorcraft metallic structure. The two-part recommendation includes a proposed rulemaking and an advisory circular.

I would like to thank the Aviation Rulemaking Advisory Committee (ARAC), particularly those members associated with the RIG and the Fatigue Tolerance Evaluation of Metallic Structure Harmonization Working Group. I appreciate the work and resources they spent in developing the recommendation.

We consider your submittal of the recommendation as completion of the task. Therefore we have closed the task and have forwarded it to the Rotorcraft Directorate for review and decision. We will continue to keep you apprised of our efforts on the ARAC recommendation at future RIG meetings. Further, if the proposed rule and advisory material generate substantial or controversial comments once they publish in the Federal Register, the FAA may task the RIG to dispose of any comments received in response to the documents.

Sincerely,

Anthony F. Fazio
Executive Director, Aviation Rulemaking Advisory Committee

Recommendation

DRAFT

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 29

[Docket No. FAA-YYYY- ; Notice No.]

RIN 2120-

Title: Fatigue Tolerance Evaluation of Metallic Structures

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This document proposes an amendment to the airworthiness standards for fatigue tolerance evaluation (FTE) of transport category rotorcraft metallic structures. This proposal would revise the FTE safety requirements to address advances in structural fatigue substantiation technology for metallic structures. An increased level of safety would be provided by avoiding or reducing catastrophic fatigue failures of metallic structures. These increased safety requirements would help ensure that should serious accidental damage occur during manufacturing or within the operational life of the rotorcraft, the remaining structure could withstand fatigue loads that are likely to occur, without failure, until the damage is detected or the part is replaced. In addition to the improvement in the safety standards for FTE of all principal structural elements (PSE), the proposed amendment would be harmonized with international standards.

DATES: Send your comments on or before [Insert date 90 days after date of publication in the Federal Register].

ADDRESSES: You may send comments [identified by Docket Number *[Insert docket number, for example, FAA-200X-XXXXX]*] using any of the following methods:

- DOT Docket web site: Go to http://dms.dot.gov and follow the instructions for sending your comments electronically.
- Government-wide rulemaking web site: Go to http://www.regulations.gov and follow the instructions for sending your comments electronically.
- Mail: Docket Management Facility; US Department of Transportation, 400 Seventh Street, S.W., Nassif Building, Room PL-401, Washington, DC 20590-001.
- Fax: 1-202-493-2251.
- Hand Delivery: Room PL-401 on the plaza level of the Nassif Building, 400 Seventh Street, S.W., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

For more information on the rulemaking process, see the SUPPLEMENTARY INFORMATION section of this document.

Privacy: We will post all comments we receive, without change, to http://dms.dot.gov, including any personal information you provide. For more information, see the Privacy Act discussion in the SUPPLEMENTARY INFORMATION section of this document.

Docket: To read background documents or comments received, go to http://dms.dot.gov at any time or to Room PL-401 on the plaza level of the Nassif Building, 400 Seventh Street, S.W., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Sharon Y. Miles, Regulations and Policy Group, Rotorcraft Directorate, ASW-111, Federal Aviation Administration, Fort Worth, Texas 76193-0110, telephone number (817) 222-5122; facsimile (817) 222-5961, e-mail sharon.y.miles@faa.gov.

SUPPLEMENTARY INFORMATION:

Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. We also invite comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments will reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. We ask that you send us two copies of written comments.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the ADDRESSES section of this preamble between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. You may also review the docket using the Internet at the web address in the ADDRESSES section.

Privacy Act:

Using the search function of our docket web site, anyone can find and read the comments received into any of our dockets, including the name of the individual sending the comment (or signing the comment on behalf of an association, business, labor

union, etc.). You may review DOT's complete Privacy Act Statement in the Federal Register published on April 11, 2000 (65 FR 19477-78), or you may visit http://dms.dot.gov.

Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring additional expense or delay. We may change these proposals based on the comments we receive.

If you want the FAA to acknowledge receipt of your mailed comments on this proposal, include with your comments a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it to you.

Availability of Rulemaking Documents

You can get an electronic copy using the Internet by:

(1) Searching the Department of Transportation's electronic Docket Management System (DMS) web page at http://dms.dot.gov/search;

(2) Visiting the Office of Rulemaking's web page at http://www.faa.gov/avr/arm/index.cfm; or

(3) Accessing the Government Printing Office's web page at http://www.gpoaccess.gov/fr/index.html.

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue S.W, Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

Authority for this Rulemaking

The FAA's authority to issue rules regarding aviation safety is found in Title 49 of the United States code. Subtitle I, Section 106 describes the authority of the FAA Administrator. Subtitle VII, Aviation Programs, describes in more detail the scope of the agency's authority.

This rulemaking is promulgated under the authority described in Subtitle VII, Part A, Subpart III, Section 44701, "General requirements," Section 44702, "Issuance of Certificates," and Section 44704, "Type Certificates, production certificates, and airworthiness certificates." Under Section 44701, the FAA is charged with prescribing regulations and minimum standards for practices, methods, and procedures the Administrator finds necessary for safety in air commerce. Under Section 44702, the FAA may issue various certificates including type certificates, production certificates, air agency certificates, and airworthiness certificates. Under Section 44704, the FAA shall issue type certificates for aircraft, aircraft engines, propellers, and specified appliances when the FAA finds that the product is properly designed and manufactured, performs properly, and meets the regulations and minimum prescribed standards. This regulation is within the scope of these authorities because it would promote safety by updating the existing minimum prescribed standards, used during the type certification process, to address advances in metallic structural fatigue substantiation technology. It would also harmonize this standard with international standards for evaluating the fatigue strength of transport category rotorcraft metallic primary structural elements.

Background

Statement of the Problem

Fatigue of rotorcraft dynamic components was first addressed in the 1950's by means of safe-life methodology. Historically, the application of this methodology, such as that described in AC 27-1B MG 11, has been successful in providing an adequate level of reliability for transport category rotorcraft. In addition, manufacturers currently include in their maintenance program inspections for detecting damage, such as scratches, corrosion, wear, or cracks, in addition to other routine inspections of the rotorcraft. The inspection intervals were not determined by analysis or tests, but were based on previous experience with similar designs, engineering judgment, and good design practices. This helped minimize the effect of damage in service. However, it was recognized in the 1980's that higher levels of reliability might be realized by taking into account the fatigue strength reducing effects of damage that experience has shown can occur during manufacture or in operational service. The introduction of composites led the manufacturers and regulatory authorities to develop a more robust safe-life methodology by considering the specific static and fatigue-strength reduction due to aging, temperature, moisture absorption, impact damage, and other accepted industry practices. Furthermore, where clearly visible damage resulted from impact or other sources, inspection programs were developed to maintain safety. In parallel, crack growth methodology has been successfully used for solving short-term airworthiness problems in metallic structures of rotorcraft and as the certification basis for civil and military transport aircraft applications. These advances in design, analytical methods, and other industry practices made it feasible to address certain types of damage that could result in fatigue failure. Consistent with this, the regulatory requirements of §

29.571 were substantially revised by Amendment 29-28. While many years have passed since its introduction, Amendment 29-28 has not been used often for certification of completely new rotorcraft designs, because there have been only a limited number of new rotorcraft designs since 1989, when that Amendment became effective. However, the general understanding by the rotorcraft community of rotorcraft fatigue tolerance evaluation has developed considerably in the interim. Also, there has been much discussion within the technical community about the meaning of Amendment 29-28 and the merits of the methodologies that are prescribed in it. These methodologies have been the subject of a series of meetings between the FAA, the rotorcraft industry, and the Technical Oversight Group for Aging Aircraft (TOGAA). As a result of these meetings, the industry position was documented in a White Paper entitled “Rotorcraft Fatigue and Damage Tolerance”, and TOGAA made a recommendation to the FAA. TOGAA recommended that current safe-life methods be complemented by damage tolerance assessment methods and that the flaw-tolerant safe-life method, introduced in Amendment 29-28, be removed from the regulations. The rotorcraft industry White Paper, on the other hand, agreed that safe-life methods should be complemented by damage tolerance methods, but recommended retention of the flaw-tolerant safe-life method as an available option. Since both groups recommended changes, the FAA decided to consider revision of the regulations.

History

The FAA requested that the Aviation Rulemaking Advisory Committee (ARAC) study the need to revise the regulations on fatigue evaluation in light of advancements in technology and operational procedures and to develop regulatory recommendations.

The ARAC was established on February 5, 1991 by notice in the Federal Register (56 FR 2190, January 22, 1991), to assist the FAA in the rulemaking process by providing advice from the private sector on major regulatory issues affecting aviation safety. The ARAC includes representatives of manufacturers, air carriers, general aviation, industry associations, labor groups, universities, and the general public. The ARAC's formation has given the FAA additional opportunities to solicit information directly from significantly affected parties who meet and exchange ideas about proposed and existing rules that should be either created, revised, or eliminated.

Following an announcement in the Federal Register (65 FR 17936, April 5, 2000), an ARAC Working Group was chartered to study and make appropriate recommendations concerning whether new or revised airworthiness standards are appropriate regarding fatigue evaluation of transport rotorcraft metallic structures.

The working group, co-chaired by representatives from a U.S. manufacturer and a European manufacturer, included technical specialists knowledgeable in the area of fatigue evaluation of rotorcraft structures. This broad participation is consistent with FAA policy to have all known interested parties involved as early as practicable in the rulemaking process.

The working group evaluated the industry White Paper, TOGAA recommendations, and the continuing activities and results of rotorcraft damage tolerance research and development. As a result, the working group recommended changes to the fatigue evaluation requirements for transport rotorcraft found in 14 CFR § 29.571 to improve currency and understanding. The ARAC accepted those

recommendations and presented them to the FAA. This rulemaking proposal is based on those recommendations.

Statement of the Issues

Prior to Amendment 29-28, there were no requirements to consider the impact of damage on the fatigue performance of any rotorcraft structure. The strategy used to manage fatigue was limited to retirement before the probability of crack initiation became significant, and the “safe-life” method was used to establish retirement times.

It was generally agreed, based on in-service experience, that not accounting for damage could be a serious shortcoming. Accordingly, Amendment 29-28 made it a requirement to consider damage when performing fatigue evaluations unless it was demonstrated to be impractical. This amendment also prescribed two methods to account for damage and one method to be used if the use of either of those two methods was shown to be impractical. The two methods that could be used to account for damage are referred to as flaw-tolerant methods. These two methods, the “flaw-tolerant safe-life” method and the “fail-safe” method, are considered equivalent options within the context of the current § 29.571. The “flaw-tolerant safe-life” method is based on crack initiation time in a purposely “flawed” PSE and results in a retirement life. The flaw tolerant “fail-safe” method is based on a crack growth life in a purposely “flawed” PSE and results in inspection requirements. The “safe-life” method is based on a crack initiation time in a “non-flawed” PSE and results in a retirement life. Although the “safe-life” method does not explicitly account for any damage, under current § 29.571, it is the prescribed default fatigue evaluation method if the applicant establishes that neither of

the two flaw tolerant methods can be achieved within the limitations of geometry, inspectability, or good design practice.

One of the primary issues addressed by the working group was the equivalency of the two flaw-tolerant methods. While both can be used to address damage, their equivalency, from a technical perspective, is difficult to address without specific factual details.

Two concerns considered by the working group were establishing inspection requirements using the flaw-tolerant safe-life method, and establishing retirement times using the fail-safe method. While both are theoretically possible, an evaluation of the effectiveness is not possible without considering the details of a specific application. Additionally, while using the flaw-tolerant safe-life method for establishing an inspection interval is clearly not within the intent of the Amendment 29-28, the fail-safe method for establishing retirement times has been accepted as meeting its intent.

Reference Material

1. Industry White Paper “Rotorcraft Fatigue and Damage Tolerance”, prepared for the TOGAA, January 1999.

2. TOGAA memo to the FAA, dated 15 March 1999.

General Discussion of Proposals

The proposals would improve the currency and clarify the intent of the rule and thereby facilitate evaluation consistency and result in equal levels of safety among applicants. Some of the more significant revisions to the current rule are summarized below.

We have determined that a descriptive phrase is needed that makes general reference to the entire fatigue process (including crack initiation, crack growth, and final failure) with or without the influence of damage. Consistent with the current rule, the words “fatigue tolerance” are proposed for this purpose. Also, we propose not to use words or phrases that have different meanings depending on their usage context (e.g. flaw-tolerant, fail-safe).

Additionally, we have determined that the current rule is too prescriptive when it directs the applicant to use specific methodologies to meet the objective. Further, we determined that the significance of the basic objective of evaluating fatigue tolerance was de-emphasized in practice because the primary focus is on means of compliance. Consequently, the entire rule has been rewritten to emphasize the basic objective and be less prescriptive as to specific methodologies. Therefore, we propose to delete all reference to specific fatigue tolerance evaluation methods (e.g. safe-life, flaw-tolerant safe-life, and fail-safe).

Further, we have determined that there are various fatigue tolerance evaluation methods used by industry; all of these methods have merit and could potentially be effective, depending on the specifics of the damage being addressed. The proposed rule requires a specific result, but does not specify the method to achieve the result. However, the proposed rule does require that all methods be validated by analysis and test and the methodology used for compliance be approved.

We have determined that, in general, the safest metallic structures use both retirements and inspections together to mitigate the risk of catastrophic failure due to

fatigue. Consequently, there is now a requirement proposed in § 29.571(g) to establish inspection and retirement times or approved equivalent means.

Also, we have determined that a key element that had to be included in the evaluation was identification of all threats that needed to be considered so damage could be quantified. Consistent with this, a specific requirement in paragraph (d)(4) is proposed to require a threat assessment.

We have recognized that an inspection approach may not be possible for some kinds of damage so a provision has been included wherein inspections need not be established if they are shown to be impractical, provided other actions are implemented to minimize the probability of the damage occurring or contributing to a catastrophic failure.

Section-by-Section Discussion of the Proposals

This proposal would revise § 29.571 as follows:

The heading of § 29.571 would be revised to read “Fatigue Tolerance Evaluation of Metallic Structures”. This heading emphasizes that it applies to metallic structures.

Paragraph (a) is new and provides a general summary of the requirements. It points out that all principle structural elements (PSE) must be evaluated and, based on the results of the evaluations, appropriate actions must be established to avoid catastrophic failure. It also states that the effects of damage must be considered.

Paragraph (b) is new and requires FAA approval of the compliance methodology.

Paragraph (c) is new and requires identification of all PSE, and includes a definition of PSE.

Paragraph (d) is new and identifies the elements of each evaluation.

Paragraph (e) is new and specifically addresses residual strength assessment load requirements used to support inspection interval requirements.

Paragraph (f) is new and requires that the effect of damage on stiffness, dynamic behavior, loads, and functional performance be considered.

Paragraph (g) is new and requires that applicants for a transport category rotorcraft type certificate address the technical issue of structural metal fatigue by inspections and retirement times or approved equivalent means. It also requires this information to be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness.

Paragraph (h) is new and requires that supplemental procedures must be established if inspections for the critical damage, as determined by a threat assessment, cannot be established within the limitations of geometry, inspectability, or good design practice.

Paperwork Reduction Act

This proposal contains the following new information collection requirements. As required by 44 U.S.C. § 3507(d) of the Paperwork Reduction Act of 1995, the FAA has submitted the information requirements associated with this proposal to the Office of Management and Budget for its review.

Title: Fatigue Tolerance Evaluation of Metallic Structures.

Summary: This proposal would revise the FTE safety requirements to address advances in structural fatigue substantiation technology for metallic structures. An increased level of safety would be provided by avoiding or reducing catastrophic fatigue failures of metallic structures. These increased safety requirements would help ensure

that should accidental damage occur during manufacturing or within the operational life of the rotorcraft, the remaining structure could withstand fatigue loads that are likely to occur, without failure, until the damage is detected and repaired or the part is replaced. In addition to the improvement in the safety standards for FTE of all PSE, the proposed amendment would lead to harmonized international standard.

Use of: To obtain type certification of a rotorcraft, an applicant must show that the rotorcraft complies with specific certification requirements. To show compliance, the applicant must submit substantiating data. FAA Engineers and designated engineer representatives from industry would review the required data submittals to determine if the rotorcraft complies with the applicable minimum safety requirements for fatigue critical rotorcraft metallic structures and that the rotorcraft has no unsafe features in the metallic structures.

Respondents (including number of): The likely respondents to this proposed information requirement are applicants for certification of fatigue critical metallic parts for transport category helicopters. A conservative estimate of the number of applicants affected by this rule would average 10 applicants per year.

Frequency: The frequency of collection of this information is not a set time; it is established as needed by the respondent to meet their certification schedule. The respondent must submit the required information prior to type certification, which can span a number of years.

Annual Burden Estimate: It is current practice to submit a compliance methodology to the FAA. Hence, there is little or no additional cost burden in requiring the collection of this information.

The agency is soliciting comments to--

(1) evaluate whether the proposed information requirement is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility;

(2) evaluate the accuracy of the agency's estimate of the burden;

(3) enhance the quality, utility, and clarity of the information to be collected; and

(4) minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology.

Individuals and organizations may submit comments on the information collection requirement by *[Insert date 60 days after publication in the Federal Register],* and should direct them to the address listed in the **ADDRESSES** section of this document. Comments also should be submitted to the Office of Information and Regulatory Affairs, OMB, New Executive Building, Room 10202, 725 17th Street, N.W., Washington, DC 20053, Attention: Desk Officer for FAA.

According to the 1995 amendments to the Paperwork Reduction Act (5 CFR 1320.8(b)(3)(vi)), an agency may not collect or sponsor the collection of information, nor may it impose an information collection requirement unless it displays a currently valid OMB control number. The OMB control number for this information collection will be published in the Federal Register, after the Office of Management and Budget approves it.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA determined that ICAO annex 8, part IV, Chapter 3, paragraph 3.8 corresponds to these proposed regulations. The proposed regulations are consistent with the ICAO standards and recommended practices.

Executive Order 12866, DOT Regulatory Policies and Procedures, Economic Assessment, Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandates Assessment

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. §§ 2531-2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. And fourth, the Unfunded Mandates Reform Act of 1995 requires agencies to prepare a written assessment of the costs, benefits and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local or tribal governments, in the aggregate, or by the private sector, of $100 million or more, in any one year (adjusted for inflation.)

The FAA has made initial determinations that the least cost alternative to the proposed rule: (1) has benefits which do justify its costs, (2) does not impose costs sufficient to be considered “significant” under the economic standards for significance under Executive Order 12866 or under DOT’s Regulatory Policies and Procedures, (3) would not have a significant economic impact on a substantial number of small entities, (4) would not constitute a barrier to international trade, and (5) would not constitute an unfunded mandate. The FAA has placed these analyses in the docket and summarized them below.

The proposed rule would amend Part 29 of Title 14, Code of Federal Regulations (14 CFR) to modify the regulations applicable to transport category rotorcraft structures. This proposed rule would revise the FTE safety requirements to address advances in fatigue substantiation technology for metallic structures. This proposed regulation is the result of information gathered from a review of catastrophic fatigue failures, and it is intended to improve the level of safety. The proposed rule would assure that should serious accidental damage occur during manufacturing or within the operational life of the rotorcraft, the remaining structure could withstand fatigue loads that are likely to occur, without failure, until the damage is detected and repaired or the part is replaced. In addition to improving the level of safety for FTE of all principal structural elements (PSE), the proposed rule would harmonize Federal Aviation Administration (FAA) standards with requirements by the European aviation authorities.

In the absence of a new rule, future rotorcraft metallic fatigue accidents could occur. A key benefit of the proposed rule would be avoidance of these accidents.

Summary of the Cost-Benefit Analysis

Overview of Costs and Benefits

The FAA estimates the present (2003) value of the total quantifiable safety benefits over 20 years to be about $26.4 million. In addition, the cost savings that would accrue due to harmonization of this rule would contribute to a large potential harmonization savings. The total cost over 20 years of the proposed rule is approximately $1.79 million in present or discounted cost. The fleet studied is an assumed fleet of 4 certifications, each with a ten-year production run; as described in this evaluation. Accordingly, if the rule would be more than 6.8% effective (1.79/26.4 = 0.0678), benefits would exceed costs.

The proposed rule would require rotorcraft manufacturers and operators to take additional actions including the following: (1) perform a more thorough threat assessment, (2) submit a compliance methodology report to the FAA for approval, (3) perform a more rigorous residual strength assessment, and (4) conduct inspections. It is current practice for rotorcraft manufacturers to submit voluntarily a compliance methodology report to the FAA for approval. Hence, for those applicants, there are no additional costs associated with this methodology report. The rotorcraft manufacturers currently perform a threat assessment and a residual strength assessment, but those would become more robust under the proposed rule. The current rule mandates that manufacturers establish inspection intervals or retirement times, which are included in the Airworthiness Limitation Section of the Instructions for Continued Airworthiness. The proposed rule mandates that both retirement times and inspection intervals be established and included in the Airworthiness Limitation Section of the Instructions for

Continued Airworthiness. Except for the four items discussed above, the proposed standard would not have a significant effect on U.S. manufacturer's cost compared to the current rule.

Costs

Based on information from industry representatives on the ARAC Working Group, the FAA estimates that the average additional cost to perform a more thorough threat assessment would be $100,000 per certification; the average additional cost to perform the more rigorous residual strength assessment proposed by this rule would be an additional $50,000; and putting both retirement times and inspection intervals in the airworthiness limitation section of the Instructions for Continued Airworthiness would cost on average an additional $54,000. Based on information received from industry representatives, the FAA also estimates that over the next 20 years, Part 29 rotorcraft structures will be comprised of approximately 50% metallic parts and 50% composite parts. Hence, the additional certification cost under this proposed rule would be $50,000 for a threat assessment ($100,000 * 0.5 = $50,000), $25,000 for a residual strength assessment ($50,000 * 0.5 = $25,000), and $27,000 for putting both inspection intervals and retirement times in the airworthiness limitation section ($54,000 * 0.5 = $27,000). Therefore, the FAA estimates that the total certification cost per new type certification would be $102,000 ($50,000 + $25,000 + $27,000 = $102,000). The total certification costs would be $408,000 (4 certifications at $102,000 per certification) over 20 years in undiscounted costs or about $287,573 in discounted costs (assuming a 7% discount rate).

Industry representatives on the ARAC Working Group also estimated that approximately 30 components would require additional inspection as a result of this proposal, and that it would take a mechanic one hour to inspect each component. Hence, an inspection would take 30 man-hours. At the mechanic wage rate of $60 per hour, each inspection would cost $1,800 (30 man-hours * $60 per hour = $1,800). Based on information received from industry representatives, the FAA estimates that inspections would occur on average approximately every 1250 flight hours. From 1998 - 2000, turbine rotorcraft flew an average of 412 flight hours annually. (FAA Aerospace Forecasts, Fiscal Years 2001-2012, p. VI-3; FAA Aerospace Forecasts, Fiscal Years 2002-2013, p. VI-3) Hence, inspections would occur on average about once every 3 years (1250 / 412 = 3.03).

According to the “2003 Aerospace Source Book” by Aviation Week & Space Technology (January 13, 2003), the growth of the civil helicopter market is expected to be flat for the next several years, with perhaps a few percent growth per year. According to the “FAA Aerospace Forecasts: Fiscal Years 2002-2013” (March 2002), the number of turbine powered rotorcraft is expected to total 4570 by 2013—an increase of only 100 rotorcraft over the 2000 level. Hence, the rate of new rotorcraft production is assumed to approximate the rate of rotorcraft attrition.

Representatives from Sikorsky and Bell estimated that there would be one new type certificate every 10 years for each of their respective companies. For cost estimation purposes, the FAA assumes that the new models would be certificated in years 1 and 11 during the 20-year analysis period, and that each future aircraft certification would have a production run of 10 years. The forecasted production rates

for a new Sikorsky model is taken from the forecast of units produced of the S-92 in the "World Rotorcraft Overview" (July 2002) by the Teal Group. Based on forecasted production rates for the Bell 230, 430, UH-1, 212, and 214 in the "World Rotorcraft Overview", the FAA assumes that Bell's production rate for a new model would be roughly 1.5 times that of Sikorsky's. The FAA estimates that the total inspections costs over the 20-year analysis period would be $3,825,000 (2,125 inspections at $1,800 per inspection) in undiscounted costs or about $1,507,000 in discounted costs (by applying a 7% discount rate). Therefore, the total costs of this proposed rule over 20 years is estimated to be $4,233,000 in undiscounted costs ($3,825,000 + $408,000 = $4,233,000) or about $1,795,000 in discounted costs ($1,507,165 + $287,573 = $1,794,738).

Benefits

Discounted at 7 percent annually, total potential benefits for significantly reducing the likelihood of fatigue-related accidents for Part 29 rotorcraft metallic structures amount to an estimated $26.4 million over the 20-year analysis period. In the absence of a new rule, it is likely that future fatigue-related accidents will occur on Part 29 rotorcraft in a manner similar to what has happened in the past. A key benefit of the proposed rule would be the avoidance of these accidents.

In the review of the accident and incident history, the FAA only considered accidents that were relevant to metallic rotorcraft structure fatigue problems. In addition, the FAA did not consider events in which externally aggravating circumstances existed, such as operation of the aircraft outside of its weight and balance limitations.

Databases that the FAA examined include the NTSB Aviation Accident Database & SynoPSE and the National Aviation Safety Data Analysis Center (NASDAC) database.

Since 1982, 13 accidents were identified that may have been prevented if this rule had been in effect. These accidents resulted in 12 fatalities, 5 serious injuries and 6 minor injuries. In addition, all of the aircraft involved in the accidents were either destroyed or received substantial damage.

In order to quantify future benefits, the FAA needed to calculate the costs of a future averted accident as a direct result of this proposed rule. The minimum value of a statistical aviation fatality avoided is set at $3.0 million, that of a serious injury (assumed to be the average of a severe, serious, and moderate injury) at $260,500, and that of a minor injury at $6,000. The associated medical and legal costs for a fatality is $132,700, a serious injury (assumed to be the average of a severe, serious, and moderate injury) $46,633.33, and that of a minor injury, $2,500. In addition, the average replacement cost of a destroyed turbine rotorcraft greater than or equal to 7,000 pounds is represented by a value of $1,651,000, and a NTSB accident investigation costs about $26,000. The number of fatalities, serious injuries and minor injuries represents the average number of such casualties in the thirteen accidents. Based on the above information, the FAA estimates the average value of avoiding a fatigue-related metallic rotorcraft accident is $3.8 million.

Given that thirteen accidents have occurred, without preventative action a number of accidents could occur in the future. The Poisson probability distribution provides a good model for estimating the number of “rare events” observed in a given unit of time. Using the Poisson probability distribution, the FAA estimated probabilities

associated with the projected number of future accidents (rare events) for the proposed rulemaking. Based on the Cumulative Poisson probability distribution with mean equal to 13, over the next 20 years, there is a probability of approximately 83% that there would be 10 or more accidents, and a probability of over 99% that there would be 5 or more accidents.

The present value benefit estimate assumes that the probability of an accident is equally likely in any year of the 20-year study period. If 13 accidents were avoided over the next 20 years, the present value benefit would be approximately $26.4 million. If 10 accidents were avoided over the next 20 years, the present value benefit would be approximately $20.3 million.

The benefits of the proposed regulation include the acceptance by the European aviation authorities of a harmonized standard. Such acceptance will offer the benefit of improved acceptability in European countries of products that have been certificated. The harmonized standard would increase the current standard of safety for FAA certificated rotorcraft by mandating inspections as well as retirement times. The FAA has not attempted to quantify the cost savings that may accrue due to harmonization of this rule, beyond noting that they contribute to a large potential harmonization savings. Safety under the provisions of this rule would be at least equivalent to operational safety under the previous regulations.

Comparison

The FAA estimates the discounted present value (2003) benefits of the proposed rule to be $26.4 million. In the absence of this proposed rule, it is highly likely that future fatigue-related metallic rotorcraft accidents will occur. The FAA finds that on

average 13 accidents within the fleet included in this analysis could be prevented by the enactment of this proposed rule. The benefit of the proposed rule would be the avoidance of these accidents. As previously discussed, the probability of 5 or more accidents occurring in the absence of this rule is 99%. The benefit of avoiding 5 accidents is about $10 million. Accordingly, based on this analysis, there is a 99% probability that the benefits of this proposal will exceed costs by a factor of over 5.5 (10/1.79 = 5.59). These benefits are derived from preventing accidents due to fatigue.

The FAA seeks comments with supportive justification regarding these benefit estimates. It is estimated that the discounted present value (2003) cost of the proposed rule would be $1.79 million. The cost figure above includes the cost of systems design, qualification, certification, equipment purchase and installation, testing, and inspections. The FAA seeks comments with supportive justification on these cost estimates.

The estimated $26.4 million benefits of this proposed rule far exceeds the estimated $1.79 million costs. Thus, the FAA concludes that the benefits of the proposed rule do justify the costs of the proposed 14 CFR Part 29 rule. The $26.4 million in benefits assumes that all future fatigue accidents are prevented within the aircraft produced under the 4 new certifications. Hence, if this rule is more than 6.8% effective (1.79/26.4 = 0.0678), then benefits will exceed costs.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes “as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to

regulation." To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule would have a significant economic impact on a substantial number of small entities. If the determination is that it would, the agency must prepare a regulatory flexibility analysis as described in the Act.

However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

The FAA believes that this proposed rule would not have a significant economic impact on a substantial number of small entities because all United States Part 29 aircraft manufacturers exceed the Small Business Administration small-entity criteria of 1,500 employees for aircraft manufacturers. Currently U.S. manufactured Part 29 aircraft type certificate holders include Sikorsky Aircraft and Bell Helicopters (a subsidiary of Textron Inc.). The operators would bear the costs of inspections. However, it is very difficult to identify who the operators would be. The FAA believes that there would be no significant economic impact on a substantial number of small operators because the operators will purchase the rotorcraft only if the additional costs can be recovered in the marketplace. Given that there are no small entity

manufacturers of Part 29 aircraft, the FAA certifies that this proposed rule would not have a significant economic impact on a substantial number of small entities.

International Trade Impact Assessment

The Trade Agreement Act of 1979 prohibits Federal agencies from establishing any standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this proposed rule and determined that it would harmonize the U.S. standards with the international standards thereby lowering the costs of international trade.

Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year. This proposed rule does not contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any year, therefore the requirements of the act do not apply.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action would not have a

substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this notice of proposed rulemaking would not have federalism implications.

Regulations Affecting Interstate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in Title 14 of the CFR in any manner affecting interstate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this proposed rule would apply to the certification of future designs of transport category rotorcraft and their subsequent operation, it could, if adopted, affect interstate aviation in Alaska. The FAA therefore specifically requests comments on whether there is justification for applying the proposed rule differently in interstate operations in Alaska.

Environmental Analysis

FAA Order 1050.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this proposed rulemaking action qualifies for the categorical exclusion identified in paragraph 312f and involves no extraordinary circumstances.

Regulations That Significantly Affect Energy Supply, Distribution, or Use

The energy impact of the proposed rule has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) Public Law 94-163, as amended (42

U.S.C. 6362) and the Department of Transportation implementing regulations, specifically 14 C.F.R. § 313.4, that defines a "major regulatory action." We have determined that this notice is not a "major regulatory action under the provisions of the EPCA. Additionally, we have analyzed this proposal under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). We have determined that it is not a "significant regulatory action" under Executive Order 12866, and it is not likely to have a significant adverse affect of the supply, distribution, or use of energy.

List of Subjects in 14 CFR Part 29

Air transportation, Aircraft, Aviation safety, Rotorcraft, Safety.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend part 29 of Title 14, Code of Federal Regulations, as follows:

PART 29 - AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY ROTORCRAFT

1. The authority citation for part 29 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701 – 44702, 44704

2. Amend § 29.571 by revising § 29.571 to read as follows:

§ 29.571 Fatigue Tolerance Evaluation of Metallic Structure.

(a) A fatigue tolerance evaluation of the principal structural elements (PSE) defined in paragraph (c) of this section must be performed and appropriate inspections and retirement time or approved equivalent means must be established to avoid catastrophic failure during the operational life of the rotorcraft. A catastrophic failure is an event that

could prevent continued safe flight and landing. The fatigue tolerance evaluation must consider the effects of both fatigue and the damage determined in paragraph (d)(4) of this section. Parts to be evaluated include PSE of the rotors, rotor drive systems between the engines and rotor hubs, controls, fuselage, fixed and movable control surfaces, engine and transmission mountings, landing gear, and their related primary attachments.

(b) The compliance methodology must be submitted to the Administrator for approval.

(c) Considering all structure, structural elements, and assemblies, the PSE must be identified. PSE are structural elements that contribute significantly to the carrying of flight or ground loads and the fatigue failure of which could result in catastrophic failure of the rotorcraft.

(d) Each evaluation required by this section must include:

(1) In-flight measurements to determine the fatigue loads or stresses for the PSE identified in paragraph (c) of this section in all critical conditions throughout the range of limitations in § 29.309 (including altitude effects), except that maneuvering load factors need not exceed the maximum values expected in operations.

(2) The loading spectra as severe as those expected in operation based on loads or stresses determined under paragraph (d)(1) of this section, including external load operations, if applicable, and other high-frequency power-cycle operations.

(3) Take-off, landing, and taxi loads when evaluating the landing gear and other affected PSE.

(4) A determination for the PSE identified in paragraph (c) of this section of the probable locations, types, and sizes of damage considering fatigue, environmental effects,

intrinsic and discrete flaws, or accidental damage that may occur during manufacture or operation.

(5) A determination of the fatigue tolerance characteristics for the PSE with the damage identified in paragraph (d)(4) of this section that supports the inspection and retirement times, or other approved equivalent means.

(6) Analyses supported by test evidence and, if available, service experience.

(e) A residual strength determination is required to establish the allowable damage size. For inspection interval determination based on damage growth, the residual strength evaluation must show that the remaining structure after damage growth is able to withstand design limit loads without failure within its operational life.

(f) The effect of damage on stiffness, dynamic behavior, loads and functional performance must be considered.

(g) Based on the requirements of this section, inspections and retirement times or approved equivalent means must be established to avoid catastrophic failure. The inspections and retirement times or approved equivalent means must be included in the Airworthiness Limitation Section of the Instructions for Continued Airworthiness required by Section 29.1529 and Section A29.4 of Appendix A of this part.

(h) If inspections for any of the damage types identified in paragraph (d)(4) of this section cannot be established within the limitations of geometry, inspectability, or good design practice, then supplemental procedures, in conjunction with the retirement time, must be established that will minimize the risk of each of these types of damage being present or leading to a catastrophic failure during the operational life of the rotorcraft.

Issued in Washington, DC, on

[Name of Office Director]

[Title of Office Director]

[Name and title of the individual signing the NPRM. Generally, the OPI director. If the individual signing the NPRM is "acting" for another individual, this must be noted in the signature block.]

AC 29.571B. § 29.571 (Amendment 29-XX) FATIGUE TOLERANCE EVALUATION OF METALLIC STRUCTURE.

a. Purpose. This advisory material provides an acceptable means of compliance with the provisions of § 29.571 Amendment XX of the Federal Aviation Regulations (FAR) dealing with the fatigue tolerance evaluation of transport category rotorcraft metallic structure. This guidance applies to conventional metallic materials. (Corresponding guidance for composite structure can be found in AC 29–2C, MG 8, supplemented by AC 20-107A). The fatigue evaluation procedures outlined in this advisory material are for guidance purposes only and are neither mandatory nor regulatory in nature. Although a uniform approach to fatigue tolerance evaluation is desirable, it is recognized that in such a complex area, new design features and methods of fabrication, new approaches to fatigue tolerance evaluation, and new configurations may require variations and deviations from the procedures described herein. It should be noted that § 29.571 requires that the methodology used by the applicant be approved by the FAA/AUTHORITY to assure compliance with the regulatory requirements.

b. Special Considerations. The unique performance capabilities of rotorcraft and their typical operational environment make fatigue tolerance evaluations both complex and critically important. Due to the many rotating elements inherent in their design, rotorcraft structures are potentially subject to damaging cyclic stresses in practically every regime of flight. The complexity of the fatigue loading is compounded by the fact that rotorcraft are highly maneuverable and are utilized for many widely varying roles. Corrosion and other environmental damages are not uncommon in rotorcraft operations; neither are inadvertent damages from maintenance that is typically frequent and intensive. For these reasons, special attention should be focused on the fatigue tolerance evaluation of rotorcraft structure.

c. Background.

(1) Fatigue of rotorcraft dynamic components was first addressed in the 1950's by means of a Safe-Life methodology. The application of this methodology, as described in AC 27-1B, MG 11, has proven to be successful in providing an adequate level of reliability for transport category rotorcraft. However, it was recognized in the 1980's that higher levels of reliability might be realized by taking into account the fatigue strength-reducing effects of damage that experience has shown can occur in manufacture or in operational service. The introduction of composites led the manufacturers and regulatory authorities to develop a robust Safe-Life methodology by taking into account the specific static and fatigue strength-reducing effects of aging, temperature, moisture absorption, impact damage, and recognition of an accepted industry standard. Furthermore, where clearly visible damages resulted from impact or other sources, inspection programs were developed to maintain safety. In parallel, crack growth methodology has been successfully used for solving short-term airworthiness problems in metallic structures of rotorcraft, and as the certification basis for civil and military transport aircraft applications. These advances in design, analytical

methods, and industry practices made it feasible to address certain types of damage, which could result in fatigue failure. Consistent with this, the regulatory requirements of § 29.571 were substantially revised by Amendment 28. While many years have passed since its introduction, Amendment 28 has had little exposure to use for certification of completely new rotorcraft designs. However, the general understanding of rotorcraft fatigue tolerance evaluation has developed considerably in the interim and an additional amendment was determined to be appropriate. The latest Amendment XX of Part 29 and the associated revisions to advisory material were introduced to improve the currency and understanding of the rule and clarify the differing approaches and methods available for accomplishing fatigue tolerance evaluation of rotorcraft metallic structure.

(2) This guidance provides material with respect to the fatigue tolerance requirements for metallic structure and is supplemented by AC 27-1C, MG 11 for evaluations using the Safe-Life methodology and other general fatigue considerations.

d. Introduction.

(1) Definitions. The following definitions are applicable when used within the context of this guidance material.

(i) As-manufactured structure is a structure that passes the applicable quality control process and has been found to conform to an approved design within the allowable tolerances.

(ii) Catastrophic failure is an event that could prevent continued safe flight and landing.

(iii) Damage is a detrimental change to the condition of the structure or assembly. In the context of this guidance material it is used as a generic term to describe all types of flaws including those caused by environmental effects and accidental damage arising in manufacture, maintenance or operation.

(iv) Flaw is an imperfection, defect, or blemish and may be either discrete or intrinsic.

(v) Discrete flaw is a flaw that is not inherent in the design and is caused by an external action, such as corrosion, scratches, gouges, nicks, fretting, wear, impact, and potentially cracks initiated by fatigue.

(vi) Intrinsic flaw is a flaw that is inherent in the design and manufacture of the part, situated within it or peculiar to it, such as inclusions, cracks, forging laps, or porosity.

(vii) Damage Tolerance is the attribute of the structure that permits it to retain its required residual strength without detrimental structural deformation for a

period of un-repaired use after the structure has sustained a given level of fatigue, corrosion, accidental, or discrete source damage.

(viii) Fatigue is a degradation process of a structure subject to repeated loads that may involve four phases (e.g., nucleation of many micro-cracks, coalescence of some micro-cracks to one major macro-crack, stable crack growth, unstable crack growth, and immediate failure). The boundaries between these phases are, in practice, not always easily defined. Crack initiation methods (e.g., using the S-N curve and the Miner's Rule) are generally used to address the first two phases. Linear Fracture Mechanics methods (e.g., using da/dn - ΔK and fracture toughness data) are generally used for the latter two phases.

(ix) Fatigue Loads are repeated loads, which induce a repeated variation of stress versus time in a structure.

(x) Fatigue Tolerance is the ability of a structure, either in an as-manufactured or damaged condition, to tolerate specified operational loading for a given period of use without initiating cracks, and assuming they initiate, tolerate their growth, without failure, under specified residual strength loads.

(xi) Inspection interval is the maximum period of usage allowed for a structure between inspections. At the end of this period, the structure is inspected and if there is no damage detected, the structure may be returned to service for another inspection interval.

(xii) Limit Loads are the maximum loads to be expected in service, as defined in § 29.301(a).

(xiii) Multiple Load Path is identified with a redundant structure of multiple and distinct elements, in which the applied loads would be safely redistributed to other load carrying members after complete failure of one of the elements. These may be Active, where two or more elements are loaded during operation to a similar load spectrum, or Passive, where one or more of elements of the structure are relatively unloaded until failure of the other element(s).

(xiv) Principal Structural Elements (PSE) are structural elements that contribute significantly to the carrying of flight or ground loads and the fatigue failure of which could result in catastrophic failure of the rotorcraft.

(xv) Retirement (Replacement) Time of a component is that number of events such as flight hours or landings at which the part must be removed from service regardless of its condition.

(xvi) Residual Strength is the level of strength retained by a structure with damage present.

(xvii) Barely Detectable Flaw (BDF) is the worst-case flaw that is expected to remain on the structure for its operational life.

(xiii) Clearly Detectable Flaw (CDF) is the worst-case detectable flaw that would not be expected to remain in place for a significant period of time without corrective action.

(xix) Safe-Life is the number of events, such as flight hours or landings, for a structural component during which there is a low probability that the strength will degrade below its design ultimate value due to fatigue damage initiating cracks.

(2) General. The objective of fatigue tolerance evaluation is to prevent catastrophic failure of the structure by mitigation of the effects of damage in combination with fatigue throughout the life of the rotorcraft.

(i) Fatigue tolerant design as substantiated by fatigue tolerance evaluation methods such as those outlined in this guidance is required for all PSE's, unless it entails such complications that an effective structure that is tolerant to damage cannot be achieved within the limitations of geometry, inspectability, or good design practice. In such cases, the particular type of damage at issue must be identified and alternative measures should be taken to minimize both the risk of acquiring that damage and its consequences.

(ii) To perform an evaluation first requires an understanding of the potential threats (resulting in damage) that may modify the fatigue behavior of the component. The principal concerns of this guidance are consideration of all damage sources and of the fatigue loads and rotorcraft usage. Further mitigation of the sources of damage may be achieved by adoption of a critical parts plan to help ensure that the condition of the part remains as envisaged by the designer throughout its life cycle (see § 29.602).

(iii) The need for the use of complex inspection techniques or equipment or highly trained personnel (resources that may not be available to the small operator or in remote areas of operation) should be considered when establishing the methodology. When inspections cannot be relied upon for detection of small cracks or other damage, then retirement times must be established that account for the probable types and locations of the damage, including consideration of cracks.

(iv) A retirement time should be provided for all components, including those subject to inspection, whose fatigue behavior is not reliably established to a point well beyond the life of the rotorcraft. This is intended to prevent the continued use of components beyond the point that ultimate load capability may no longer be assumed to exist in the rotorcraft due to the onset of fatigue cracking. This is particularly important for single load path components or a structure prone to widespread fatigue damage.

(v) Experience with the application of methods of fatigue tolerance evaluation indicates that a relevant test background should exist in order to achieve the design objective. It is general practice within industry to conduct tests to obtain design information and for certification purposes. Damage location, fatigue characteristics, and crack growth data based on test results and service history of similar parts, if available, should be considered when establishing inspections and retirement times. The FAA/AUTHORITY should agree upon the extent of supporting evidence necessary for each phase of the evaluation process outlined below.

(3) Essential Considerations. In order to satisfy the requirements of § 29.571, consideration should be given to the following issues in order to demonstrate compliance.

(i) Selection of PSE. All structure, structural elements, and assemblies, the failure or undetected failure of which could result in catastrophic failure of the rotorcraft, should be identified as PSE [see paragraph f(2)]. To do this, a failure mode and effects analysis or similar method may be used. Specific areas of interest within the PSE that may require particular attention include the following:

(A) Irregularly shaped parts, or those containing numerous or super-imposed fillets, holes, threads, or lugs;

(B) Parts of unique design for which no past service experience is available;

(C) New materials or processes for which there is no previous experience;

(D) Bolted or pinned connections;

(E) Parts subject to fretting;

(F) Complex casting; and

(G) Welded sections.

(ii) In-flight measurement to determine the loads or stresses (steady and oscillatory) for the PSEs in all critical conditions throughout the range of limitations in § 29.309 (including altitude effects), except that maneuvering load factors need not exceed the maximum values expected in operations. See paragraph f(3).

(iii) Loading spectra as severe as those expected in operation including external load operations, if applicable, and other high frequency power cycle operations. See paragraphs f(3) and f(4).

(iv) A threat assessment of probable damage, including a determination of the probable locations, types, and sizes should be performed. In particular, the

assessment should include an evaluation of the details of the specific work processes used on each component, operational environment, and maintenance practices to determine the potential for damage. See paragraph f(5).

(v) Inspectability of the rotorcraft, inspection methods, and detectable flaw sizes should be compatible with the chosen fatigue tolerance methods and validated by trials conducted under realistic conditions. See paragraph f(6).

(vi) For each PSE, one or more fatigue tolerance methodologies should be selected to ensure each specific damage resulting from the threat assessment is addressed and to satisfy the requirement for inspections and retirement times as discussed in paragraph e. of this guidance. The fatigue tolerance characteristics (including variability) of the structure and materials therein should be evaluated as necessary to support the evaluation. Generally this will include understanding the fatigue strength, fatigue crack propagation characteristics of the materials used, and of the structure and the residual strength of the damaged structure. See paragraphs e., f(7) and f(8).

(vii) Fatigue Tolerance Results of the evaluation should be used to provide data in the Limitations Section of the Instructions for Continued Airworthiness. See paragraph f(9).

e. Fatigue Tolerance Evaluation. A fatigue tolerance evaluation, by analysis and tests, of the PSE is required to establish inspections and retirement times, or approved equivalent means, to avoid catastrophic failure due to fatigue cracking during the operational life of the rotorcraft. The evaluation should consider the impact of the probable threats identified on the fatigue performance and residual strength of all critical areas of each PSE. A number of different fatigue evaluation methods have evolved over the years. Seven of these methods are recognized and discussed in detail in this guidance. The seven methods are summarized as a table in Figure AC 29.571B-1. Also noted in the table is the safety management strategy the specific method supports, the analysis category in which they belong, and whether the specific method can be used to address the types of damage identified in the threat assessment.

(1) Each approach results in information that can be used to support establishment of retirement times or inspection requirements. Four methods are used to support safety-by-retirement strategies and they result in retirement times. The other three methods are used to support safety-by-inspection strategies and the result is in-service inspection requirements.

(2) In some cases application of one method may be sufficient to achieve acceptable fatigue tolerance. In other cases more than one method may be needed. For example, use of Safe-Life Retirement in combination with Crack Growth Inspections could be an effective way to manage fatigue due to all possible sources.

(3) All the methods listed, with the exception of Safe-Life Retirement, were developed to explicitly address some level of damage. All the methods can theoretically be implemented analytically or by test. However, some of the methods are more practically implemented analytically and some are best implemented by test.

METHOD	PARAGRAPH	STRATEGY	ANALYSIS CATEGORY	THREAT ASSESSMENT RESULTS
Safe-Life Retirement	e.(6)(i)(A)	Retire	Crack Initiation	Not Included
Safe-Life Retirement with BDF(s)	e.(6)(i)(B)	Retire	Crack Initiation	Not Including Cracks
Safe-Life Retirement with CDF(s)	e.(6)(i)(C)	Retire	Crack Initiation	Not Including Cracks
Safe-Life Inspection for CDF(s)	e(6)(i)(D)	Inspect	Crack Initiation	Included
Safe-Life Inspection for a failed element	e.(6)(i)(E)	Inspect	Crack Initiation	Included if Considered for all Elements
Crack Growth Retirement	e.(6)(ii)(A)	Retire	Crack Growth	Included if Crack Bounds Damage
Crack Growth Inspection	e.(6)(ii)(B)	Inspect	Crack Growth	Included

Figure AC 29.571B-1. Seven Fatigue Evaluation Methods discussed in this guidance

(4) From an analytical standpoint these methods fall into one of two categories, crack initiation or crack growth. Each of the seven methods is briefly described below in paragraphs e(6)(i) and e(6)(ii), depending on the category.

(5) In-service experience may be used to support establishing fatigue tolerance characteristics when it is shown on a similar structure.

(6) Fatigue Evaluation Methods.

(i) Crack Initiation Methods. The methods described in this section are categorized as crack initiation methods since they involve quantifying the time it takes for a crack to initiate at a critical area in an as-manufactured part or at a critical area that has sustained some level of damage. Analytically these methods depend on fatigue data (e.g., stress versus number of cycles (S-N) curves) and cumulative fatigue damage algorithms (e.g., Miner's Rule) to establish a high margin retirement time. Testing that supports these methods employs specimens that are as-manufactured or ones that have been preconditioned with damage as identified in the threat assessment.

(A) Safe-Life Retirement. Safe-Life Retirement is a crack initiation method that accounts for damage induced by fatigue loading but does not account for flaws and defects due to manufacturing and in-service conditions. Application of this method results in a replacement time based on the time to initiate a crack in an as-manufactured part. Analysis or tests may be used to determine the crack initiation life. The rationale behind this method is based on part replacement before the probability of initiating a crack becomes significant. This method needs to be supplemented by other methods to account for damage. For compliance details see paragraph f(7)(i).

(B) Safe-Life Retirement with a Barely Detectable Flaw (BDF). Safe-Life Retirement with a BDF is a crack initiation methodology that explicitly addresses the effect of damage that is considered barely detectable and is therefore likely to go unnoticed for the life of the part. Application of this method results in a replacement time based on the time to initiate a crack from a BDF. Analysis or tests may be used to determine the crack initiation life. The rationale behind this method is based on part replacement before the probability of initiating a crack is significant. Damage in excess of the BDF must be addressed using other methods. For compliance details see paragraph f(7)(ii).

(C) Safe-Life Retirement with a Clearly Detectable Flaw (CDF). Safe-Life Retirement with a CDF is a crack initiation methodology that explicitly addresses the effect of damage that is considered clearly detectable but conservatively recognizes that it would remain in place without corrective action prior to the retirement time of the part. Application of this method results in a retirement time based on the time to initiate a crack from a CDF. Analysis or tests may be used to determine the crack initiation life. The rationale behind this method is based on part replacement before the probability of initiating a crack is significant. Use of this method by itself could achieve acceptable fatigue tolerance and may preclude the need for any mandated directed inspections. See paragraph f(7)(iii) for compliance details.

(D) Safe-Life Inspection for a CDF. Safe-Life Inspection for a CDF is a crack initiation method that explicitly addresses the effect of damage that is considered

clearly detectable and would therefore not be expected to remain in place without corrective action for any significant period of time. Application of this method results in a directed inspection task with an interval based on the time to initiate a crack from a clearly detectable flaw. Analysis or tests may be used to determine the crack initiation life. The rationale behind this method is based on visual detection and disposition of the flaw before the probability of initiating a crack is significant. Damage that is not detectable must be addressed by other methods and the cumulative effects of fatigue prior to and following the advent of the damage should be considered. For compliance details see paragraph f(8)(i).

(E) Safe-Life Inspection for a failed element. Safe-Life Inspection for a failed element is a crack initiation method. It results in an inspection for a completely failed load path with an interval based on the crack initiation life of the adjacent structure accounting for internal load redistribution due to failure of the load path that is to be inspected. This method can only be applied if the structure is initially designed for limit load capability with the failed element. The rationale behind this method is based on visual detection and disposition of the failed load path before the probability of initiating a crack in the adjacent structure becomes significant. Therefore it may not be appropriate if the damage that has led to the failure of the first load path could similarly affect the remaining path. For compliance details see paragraph f(8)(ii)(B)(3).

(ii) Crack Growth Methods. The methods described in this paragraph are categorized as crack growth methods since they involve quantifying the time it takes a crack at a critical area to grow from some initial size to some final size. Analytically these methods depend on crack growth rate properties (e.g., da/dN vs. ΔK vs. R) and fracture properties (e.g., K_{IC}). Using these properties, Fracture Mechanics based tools are used to predict crack growth and final fracture. Testing that supports these methods employs specimens that contain cracks and involves close monitoring to document actual crack growth and final fracture.

(A) Crack Growth Retirement is a crack growth method that explicitly addresses the largest damage that could occur during manufacture or operation of the rotorcraft. This damage is modeled as a crack with a bounding equivalent crack (BEC) established based on the results of the threat assessment. Application of this method results in a retirement time based on the time for the initial crack to grow large enough to reduce the residual strength to design limit level. Since typical BECs are relatively small and thus difficult to induce in test specimens, this method is typically implemented analytically. The rationale behind this method is based on part retirement before the largest probable damage, modeled as a crack, would reduce the residual strength below design limit. Use of this method by itself could achieve acceptable fatigue tolerance and preclude the need for any mandated inspections provided all threats are accounted for by the BECs. For compliance details see paragraph f(7)(iv)

(B) Crack Growth Inspection is a crack growth method that explicitly addresses damage that could occur during manufacture or operation of the rotorcraft. An in-service inspection method is selected that defines a detectable crack size, which

could be as large as a completely failed load path. An inspection interval is established based on the time for the detectable crack to grow to critical size or for the residual strength of the adjacent structure to drop to design limit due to continuing crack growth in it. This method is applicable to single or multiple load path structure and inspection for a completely failed load path or less. This method may be addressed by analysis supported by test depending on the difficulty of introducing into the specimen the inspectable crack or failed load path. The rationale behind this approach is based on detection and disposition of a crack or failed load path before residual strength is reduced below the design limit load. For compliance details see paragraph f(8)(ii).

f. Means of Compliance.

(1) GENERAL. The results of the fatigue tolerance evaluation required by § 29.571 are used to establish operational procedures that are meant to minimize the risk of catastrophic failures during the operational life of the rotorcraft. It is required that the evaluation performed considers the effect of damage that could result from potential threats present during manufacture and operation. An assessment of probable threats is required to identify the damage that must be considered in the fatigue tolerance evaluation.

(i) The fatigue tolerance evaluation should establish both retirement times and inspection intervals, or approved equivalent means, to prevent any catastrophic failures. Retirement times should be set to ensure that baseline ultimate strength capability is not compromised for as-manufactured structures and structures where the damage is likely to be undetected during the operational life. Intervals for inspections for detectable damage must be established so that strength capability will never fall below maximum design limit level. The intent is that if damage does occur, the structure will retain the capability to withstand reasonable loads without catastrophic failure or excessive structural deformation until the damage is detected and the structure is replaced or repaired. If inspections cannot be established within the limitations of geometry, inspectability, or good design practice, then supplemental procedures, when available, should be established that would minimize the risk of damage being present or leading to a catastrophic failure.

(ii) The following considerations will assist the successful design of a fatigue tolerant structure.

(A) Use multiple-element and multiple load path construction with provisions for crack stoppers that can limit (arrest) the growth of cracks while maintaining adequate residual strength.

(B) Select materials and stress levels that preclude crack growth or crack initiation from flaws or that provide a controlled slow rate of crack propagation combined with high residual strength after initiation of cracks. Test data should substantiate material properties.

(C) Design for detection of damage (i.e., cracks and flaws) and retirement or repair.

(D) Provide provisions that limit the occurrence of damage and the probability of concurrent multiple damage, particularly after long service.

(iii) Section 29.571 requires that the applicant's proposed compliance methodology must be submitted to the Administrator in order to obtain their concurrence and approval. Therefore, the applicant should coordinate the involvement of the FAA/AUTHORITY from an early stage. The proposed means of compliance should include the following items.

(A) A list of PSEs to be evaluated.

(B) The results of threat analyses for each PSE including type, location, and size of the damage that will be considered in order to establish retirement times, inspections, or other procedures.

(C) Inspection criteria that includes an estimate of detectability or inspectability, along with any supplemental procedure to minimize the risk of damage.

(D) The analysis methods and supporting test data that will establish retirement times, inspections, or other procedures.

(2) IDENTIFICATION OF PSE. The fatigue tolerance evaluation should first consider all airframe structure and structural elements, and assemblies in order to identify the PSE. The structural elements and assemblies identified as PSE should be formally submitted to the FAA/AUTHORITY with justification based on good design practice, service history with similar structure, drawing reviews, static analysis issues, or other appropriate means.

(i) A Failure Mode and Effects Analysis or similar method may be used to identify structures whose failure due to fatigue can lead to catastrophic failure of the rotorcraft. The need to design PSE for fatigue tolerance when they are supplied by third parties (e.g., actuators) should be clearly identified in the rotorcraft manufacturer’s specification for the part. The list of PSE will likely include structural elements and assemblies that will be subjected to significant fatigue loading expected during the operational life of the rotorcraft. This may include the following rotorcraft parts:

(A) Rotors: blades, hubs, hinges, attachment fittings, vibration dampening devices;

(B) Rotor drive systems (parts connecting rotors to engines): gears, shafts, gear housings, couplings;

(C) Rotor control systems: actuators, pitch control system, swashplate, servo flaps;

(D) Fuselage (airframe): rotor system support structure, landing gear attachment;

(E) Fixed and movable control surfaces: stabilizer;

(F) Engine, transmission or equipment mountings: APU, auxiliary gearbox;

(G) Landing gear;

(H) Folding systems: main blade, tail beam.

(ii) Analyses and fatigue tests on complete structures or representative sub-element structures can determine the locations within PSE that need to be identified for fatigue tolerance evaluation. The following should be considered:

(A) Strain gauge data on undamaged structure that can identify high stress points.

(B) Analysis that shows high stress or small margin of safety values.

(C) Locations where permanent deformation occurred in static tests.

(D) Locations where failure has occurred in as-manufactured structure fatigue tests.

(E) Locations where the potential for fatigue damage has been identified by analysis.

(F) Locations where the maximum allowed stress occurs when an adjacent element fails.

(G) Locations in structure needed to maintain adequate residual strength that has high stress concentration values.

(H) Locations where detection would be difficult.

(I) Locations where service experience with similar components indicates potential for fatigue or other damage (e.g., fretting, corrosion, wear).

(3) FLIGHT LOADS MEASUREMENT PROGRAM. The simulation of expected spectrum loads for each PSE should be based on flight recorded strain gauge data collected as part of a structured flight test program. The PSE spectrum loads include

the steady state, transient, and vibratory loads that are expected in operation. AC 27-1B, MG 11, provides further detail for development and use of flight measured loads as the basis for spectrum loads used in the fatigue tolerant evaluations.

(4) ROTORCRAFT USAGE SPECTRUM.

(i) The usage and loading spectrum should be developed so that it is unlikely that the actual usage and loads will cause fatigue damage or crack growth rates beyond those associated with the defined spectrum used in the fatigue tolerance evaluation. The usage spectrum allocating percentage of time or frequencies of occurrence to flight conditions or maneuvers should be based on the expected usage of the rotorcraft. Considerations should include flight history, recorded flight data, design limitations established in static strength requirements, and recommended operating conditions and limitations specified in the rotorcraft flight manual.

(ii) The fatigue load spectrum developed for fatigue testing and analysis purposes should be representative of the anticipated service usage. Low amplitude load levels that can be shown not to contribute fatigue damage may be omitted (truncated). Simplification of the spectrum loads may also include summing (binding) of percent times or cycles with common steady and vibratory load values.

(iii) The steady state, transient, and vibratory flight load assigned to each regime in the spectrum and utilized in the fatigue tolerance evaluations for each condition should take into account combinations of altitude, center of gravity (CG), gross weight (GW), airspeed, etc., considered to be representative of expected GW/CG mission configurations.

(iv) The usage spectrum should be presented to the FAA/AUTHORITY for their concurrence. It should include normal operation over the range of rotorcraft configurations including a percent time under ‘external load’ conditions. This spectrum should represent a “composite worst-case” compilation that includes all of the critical conditions that the rotorcraft is expected to experience during performance of the design missions.

(v) AC 27-1B, MG 11, provides further detail for the development of the usage spectrums used in the fatigue tolerance evaluations.

(5) THREAT ASSESSMENT.

(i) A determination should be made of all potential threats that could occur during the manufacturing and service life that may cause damage to each PSE. A threat assessment should be performed for each PSE. To acquire sufficient knowledge of the component and of its global environment, the following items must be identified:

(A) manufacturing process

(B) quality control process

(C) prescribed storage, transport, handling, assembly and maintenance aspects of the component, and of the surrounding components

(D) operational environment

(E) potential for corrosion including that from contamination by corrosive fluids

(F) potential for impact damages from debris, dropped tools, hail, tramping underfoot during maintenance, etc.

(G) potential for wear

(ii) To determine types, locations, and sizes of the probable damages, considering the time and circumstances of their occurrence, the following should be considered:

(A) Intrinsic flaws and other damage that could exist in an as-manufactured structure based on the evaluation of the details and potential sensitivities involved in the specific manufacturing work processes used.

(B) Damage that could be expected to occur during prescribed activities associated with storage, transport, handling, assembly, maintenance, overhaul, repair and operation of the component and of the surrounding components including impacts, scratches, fretting, corrosion, contamination, wear, and loss of bolt torque.

(C) Previous experience and data collected on similar events and on similar components; materials, and processes should be considered in identifying risks and causes of damages and their effects in inducing flaws or cracks.

(D) Metallurgical evaluations, manufacturing records and overhaul and repair reports, field service reports, incident and accident investigations, and engineering judgment may be used as supporting data.

(E) When data are not available, the threat should be experimentally simulated and the effect established through tests and analysis. With agreement of the FAA/AUTHORITY, an upper cut-off value may be established for each class of damage.

(F) Credit may be given to manufacturing, transport, handling, installation, and maintenance instructions finalized to minimize or avoid damages. Examples of these processes or instructions could be: "frozen manufacturing processes," Flight Critical Parts programs, material selection to mitigate intrinsic flaws like inclusions and defects, procedures to reduce deviations from nominal structures, etc.

(G) Credit may be given to protection of structures, such as the use of protective coatings, shielding and plating against corrosion, fretting, and impacts.

(H) Critical areas will be assumed as typical location of the damage, unless proper justification is provided to limit the applicability to specific areas or sections of the part.

(iii) Classification of Damage.

(A) The results of the threat assessment are used to classify the damage used in the fatigue tolerance evaluation. The process employed to classify the damage will depend on the fatigue tolerance evaluation method to be used. Depending on the method, a BDF, a CDF, a BEC, or an initial inspectable crack must be established.

(B) For each damage type identified, the sizes to be considered should be representative of the maximum sizes that might not be detected by the inspection techniques established for the component. Sizes exceeding those that are likely to occur do not need to be considered. Standard sizes of damage or standard level of aggression may be derived from previous experience. Each applicant will be required to present justification for damage and crack sizes to be used in the fatigue tolerance evaluations. Within the operational life, defect sizes that have been found in service should be correlated with the sizes used in the design certification.

(C) Barely Detectable Flaw (BDF). For retirement time analysis, flaw sizes that are “barely detectable” may be used to conservatively represent the worst case of undetectable flaws. Alternatively, when the detectable size is larger than the one identified by the threat assessment, a smaller size, but one not less than the flaw size likely to occur, can be used. Sometimes an “allowable” detectable size is established as acceptable for a specific manufacturing process, such as castings, to remain in place for the life of the structure. When it is impossible to simulate that maximum allowable size in the test specimen, the sizes available in the specimen may be used, provided the subsequent analysis of the test result conservatively accounts for the shortfall in the damage size.

(D) Clearly Detectable Flaw (CDF). For inspection intervals, flaw sizes that are “clearly detectable” may be used. The largest discrete size of a CDF to be considered may be limited to the maximum size of the CDF that is likely to remain in place for a significant period of time and not be detected during routine inspections for general conditions and normal observations by knowledgeable personnel. The damage size used may be limited to the maximum probable size identified in the threat assessment. For multiple load path structure, the number of failed load paths to be considered should be established.

(E) Bounding Equivalent Crack (BEC). A Bounding Equivalent Crack must be defined to determine a retirement time using the Crack Growth Retirement

method. The size of the BEC should bound the life reducing effect of damage that could occur as a result of manufacturing, maintenance, or the service environment. The size may be established by analytical back calculations from coupon or service fatigue life data accounting for material variability effects in the data. In any case, there should be no probable damage from any source that would lead to failure of the part in less time that it would take the BEC to reach critical size. Each applicant must justify the BEC sizes used in the analysis; however, there has been some limited experience that indicates that the following BEC sizes could be appropriate.

(1) 0.015 inch or 0.380 mm radius semicircular surface crack for precision-machined mechanical parts

(2) 0.050 inch or 1.270 mm radius quarter-circular corner crack in fastener holes for typical aluminum airframe structure

(F) Initial Inspectable Crack. The size and shape of the initial inspectable crack (a_{DET}) must be established when the Crack Growth Inspection approach is used. The inspection interval is based on the time for the initial inspectable crack to grow to a size (a_{CRIT}) that would result in catastrophic failure of the rotorcraft if limit loads were applied. The initial inspectable crack is a function of the inspection method that is used to detect it. Regardless of the inspection method, the probability of detecting this size crack should be high and it should be substantiated.

(6) INSPECTABILITY AND INSPECTION METHODS. This section provides guidance on selecting and substantiating damage detection methodology for use with the methods of paragraphs f(8) (Inspection Intervals) and f(10) (Approved Equivalent Means). The methods of paragraph f(8) can result in a mandated inspection program that must be included in the Airworthiness Limitations Section (ALS) of the Instructions for Continued Airworthiness in accordance with § 29.1529 of the regulatory requirements. Qualified personnel must conduct these inspections at the specified interval using the approved method or methods. Additionally, § 29.571 allows that substantiation may be accomplished by “Approved Equivalent Means,” which is discussed in paragraph f(10). These Approved Equivalent Means may include actions that detect damage or flaws indirectly and are substantiated using the methods of paragraph f(8). These actions should be shown to be reliable and systematically conducted by knowledgeable personnel. The following are considerations for establishing inspections, inspection methods, or indirect damage detection.

(i) Inspectability. The ease of conducting an inspection should be a design goal for principal structural elements. Design features such as open construction, access panels or ports, or other easy access to fatigue critical areas for needed inspections should be considered. A design that requires disassembly in order to conduct a required inspection, other than during a scheduled maintenance disassembly, should be avoided.

(ii) The specific inspection methods that are used to accomplish fatigue substantiation should be:

(A) Compatible with the threats identified in the threat assessment, paragraph f(5) and provide a high probability of detection in the threat assessment and their development under the operational loads and environment.

(B) Consistent with the capabilities, facilities, and resources of the potential operators of the helicopter. The need to conduct complex or difficult field-level inspections should be avoided, especially when the projected usage of the helicopter may include extended periods of operation in remote areas.

(C) Developed and substantiated for each specific application by means of a full-scale test program, or by experience with similar methods in similar applications.

(D) Included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness in accordance with § 29.1529 as required by § 29.571(g).

(iii) Detectable Damage Size Assessment.

(A) In the case where the substantiation is predicated on the detection of a specific flaw or crack size, an assessment should be conducted to assure that the selected inspection method will be highly reliable in detecting that size of damage in service. This assessment may be based on the known capability of currently available inspection methods and equipment, provided that this capability is verified by a full-scale test program or by experience with the method in service for similar structure and damage.

(B) If the current capability of a specific inspection method is in question, or if the capability of a specific method needs to be extended to a smaller damage size, then a systematic assessment and substantiation of the method for the intended purpose is appropriate. This assessment could include the determination of the Probability of Detection (POD) as a function of damage size and should consider the capabilities of the potential operators of the helicopter and the environment in which the inspections will be conducted.

(iv) Indirect Detection of Damage. Several damage detection procedures are available that could be used as “Approved Equivalent Means” to support substantiation of a structure [reference paragraph f(10)]. These procedures, if systematically required and conducted by knowledgeable personnel, can be used in conjunction with the methods presented in paragraph f(8) to achieve the substantiation. Examples of this type of substantiation are:

(A) In-flight damage detectable by vibration, noise, or observing a blade-out-of-track tip path plane. Consideration should be given to the background levels of

noise and vibration, as well as whether the indication is of a different character (more detectable) rather than just a change in level (less detectable).

(B) Damage that is obvious in a preflight check or routine visual examination. This could include obvious flaws or cracking, but also could include structure that is found to be loose, broken, or soft when deflected by hand. Other obvious damage detection could include fluid leaks, missing fasteners, structure bent or out of alignment, or jamming of mechanical parts.

(C) Damage that is indicated following flight completion. Spectrographic oil analysis would be an example.

(D) Damage detection by automated means. This includes crack detection by foil, fiber, or wire break, load monitoring (to detect a change in internal load distribution), acoustic emission monitoring, or other on-board sensors that meet the goals of damage detectability and reliability.

(7) RETIREMENT TIMES. Each of the four methods below provides a means to establish a retirement time for each PSE. The determination of the fatigue tolerance characteristics should include an assessment using the conventional Safe-Life methodology. In addition, this serves as a baseline for comparison to retirement times determined with flaws and defects included, and should be used as the structure's retirement time if it is the lowest calculated time.

(i) The conventional Safe-Life methodology accounts for damage induced by fatigue loading but does not account for flaws and defects due to manufacturing and in-service conditions. If the retirement time is established using this method, then the damage identified in paragraph f(5) (as required by § 29.571(d)(iii)) must be addressed by inspections or other equivalent means. Information to guide a fatigue evaluation based on a conventional Safe-Life approach is provided in detail in AC 27–1B MG 11. The method consists of:

(A) Establishing mean fatigue curves (e.g., stress-life or strain-life) based on crack initiation in constant-amplitude or spectrum testing of as-manufactured structure;

(B) Establishing working fatigue curves with strength and life margins; and

(C) Conducting a cumulative damage working life calculation using known flight loads and estimated usage.

(ii) A Safe-Life retirement time substantiation with BDF provides a safe period of operation of a structure with probable flaws that may remain in place without detection for that period. Barely detectable flaws are intended to conservatively represent a worst-case of undetectable flaws. The substantiation is accomplished by testing and analysis employing conventional Safe-Life methodology except that an

intrinsic and discrete critical flaw in critical locations on the structure is considered. It should be noted that this method, since it is a Safe-Life (crack initiation) method, is not appropriate for use when the flaw being considered is already a crack.

(A) The types, sizes, and locations of flaws to be considered are determined by the threat assessment (paragraph f(5)). These flaws may be represented by "equivalent flaws" if it is demonstrated that they have the same or a more severe strength-reducing effect than the corresponding representative flaws.

(B) The mean fatigue strength of the structure with flaws may be determined by one of the following three methods:

(1) Testing a full-scale structure with flaws:

(i) Representative flaws as determined by the threat assessment, or equivalent flaws if substantiated, are imposed at the critical locations on the structure where flaws are likely to occur.

(ii) S-N or spectrum safe-life fatigue testing is conducted, see paragraph e of AC 27-1B MG 11.

(iii) A mean S-N curve with flaws is derived directly from this data.

(2) As-manufactured structure strength modified by the effect of flaws.

(i) A mean strength for as-manufactured structure (without flaws) can be determined using full-scale S-N or spectrum safe-life fatigue testing.

(ii) The effect of flaws may be determined by analysis, by similarity to components where the effect of the flaws has previously been determined, or by a specimen test program incorporating the pertinent features of the full-scale component. Consideration should be given to the material form, geometric features, surface finish, and steady and vibratory load levels, in combination with flaws representative of those identified in the threat assessment.

(iii) The effect of the flaws is combined with the fatigue result determined on the as-manufactured structure without flaws.

(3) Analytical mean strength modified by the effect of flaws:

(i) A mean strength for as-manufactured structure (without flaws) can be determined analytically, provided that correlation with a similar design can be accomplished, or if additional conservatism is included in the working curve reductions employed in paragraph f(7)(ii)(D).

(ii) The effect of flaws may be determined by analysis, by similarity to components where the effect of the flaws has previously been determined, or by a specimen test program incorporating the pertinent features of the full-scale component. Consideration should be given to the material form, geometric features, surface finish, and steady and vibratory load levels in combination with flaws representative of those identified in the threat assessment.

(iii) The effect of the flaws is combined with the fatigue result analytically determined for the as-manufactured structure without flaws.

(C) Working Curve Determination. Reduction factors should be applied to the mean curve determined above to derive a working fatigue curve. As outlined in AC 27-1B, MG 11, working curve reduction factors should include consideration of the number of specimens tested, variability (scatter), previous test data on the same materials or similar structures, as well as service experience. Different reduction factors from those used for conventional Safe-Life methodology may be employed if justified to the FAA/AUTHORITY.

(D) Retirement Time Determination. The working fatigue curve, flight loads (paragraph f(3)), and usage spectrum (paragraph f(4)) are used with a cumulative damage analysis such as shown in AC 27-1B, MG 11, to calculate a safe retirement time.

(iii) Safe-Life Retirements with Clearly Detectable Flaws.

(A) A retirement time may also be based on flaws larger than the BDF case, up to the clearly detectable size described in paragraph f(5), if the applicant chooses. This could be the case, for example, if it was desired to allow a specific manufacturing-related flaw of detectable size to remain in place for the life of the structure without further inspection.

(B) The substantiation for this case can be the same as described in paragraph f(7)(ii), except that the larger flaws selected for the replacement time substantiation are used instead of the BDFs.

(iv) Crack Growth Retirement.

(A) General.

(1) This approach depends on retirement rather than inspection to ensure the continued airworthiness of a PSE. The retirement time is established based on consideration of crack growth characteristics. Fatigue with damage is addressed by timely retirement and there are no explicit inspection requirements that are derived from this approach.

(2) This approach requires demonstration either by analysis, testing, or both, that the BEC (a_{BEC}), the most severe crack consistent with manufacturing, maintenance, and service environment, will not grow or will not grow to critical size (a_{CRIT}) under the service loading and environment before the structure is retired. The critical crack size (a_{CRIT}) is established by limit load. The crack should be assumed at the critical location, as defined by the largest stress intensity factor range under the expected service loading range including the ground–air–ground cycle. It is recommended that full scale fatigue testing be undertaken to provide an understanding of the fatigue behavior of the component in support of the chosen methodology. In particular it ensures hot spots are identified, which experience has shown analysis often fails to identify.

(3) A threat assessment (see paragraph f(5)) should be performed to support establishing the BEC size to be used. It is intended that the BEC conservatively bounds the most severe defect resulting from manufacturing, maintenance, or the service environment. That is, there should be no probable defect, from any source, that would lead to failure of the part in less time than it would take the BEC to reach critical size. It should be noted that the resulting crack is a mathematical expedient that may not represent a true physical crack. If the BEC is defined by analytical back calculations from coupon or service fatigue life data, it will be highly dependent on the predictive tool used (i.e., growth algorithm, material data, etc.). Therefore, the same predictive tool must be used to perform the fatigue tolerance evaluation. When the BEC is based upon test or service data, it must account for material variability in initiation and growth.

(4) To determine the retirement, the BEC should be assumed at the critical location and the crack growth characteristics should be determined for the expected load and environment spectrum. There are three different scenarios that could result from a crack growth assessment and be used for establishing a retirement time. These scenarios are illustrated in Figure AC 29.571B-2, Figure AC 29.571B-3, and Figure AC 29.571B-4.

(B) No Growth. The no crack growth scenario is illustrated in Figure AC 29.571B-2. Here the BEC does not grow when using top-of-scatter crack growth rate data. In this case the retirement time should not exceed the design service life (L_{DES}).

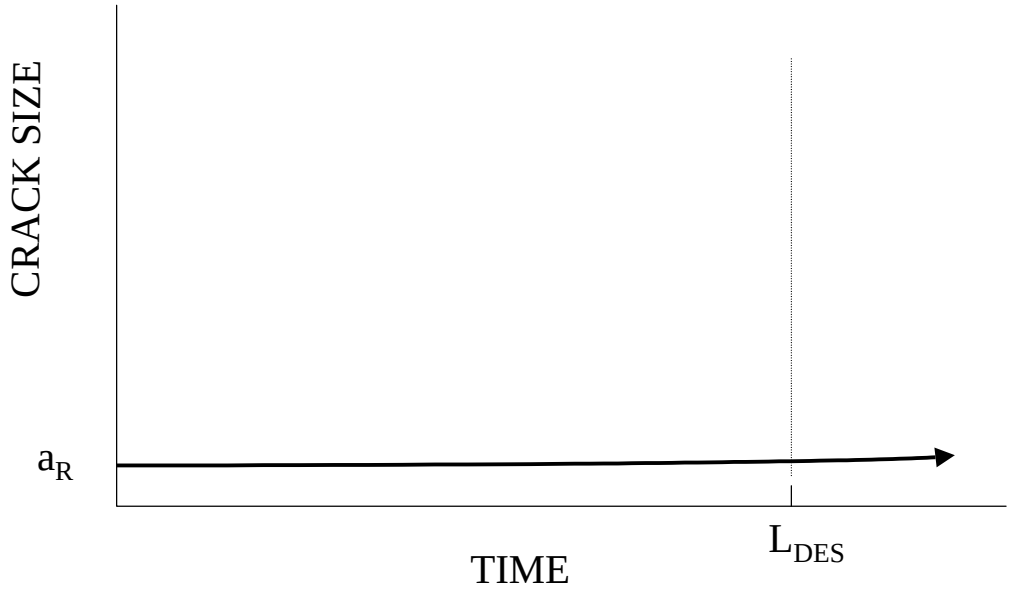

Figure AC 29.571B-2. No Growth

(C) Slow Growth of Undetectable Crack. Figure AC 29.571B-3 illustrates the scenario where the BEC grows relatively slowly but becomes critical prior to becoming detectable (a_{DET}). In this case, the retirement time should be set equal to the total crack growth life (L_T) divided by a factor N.

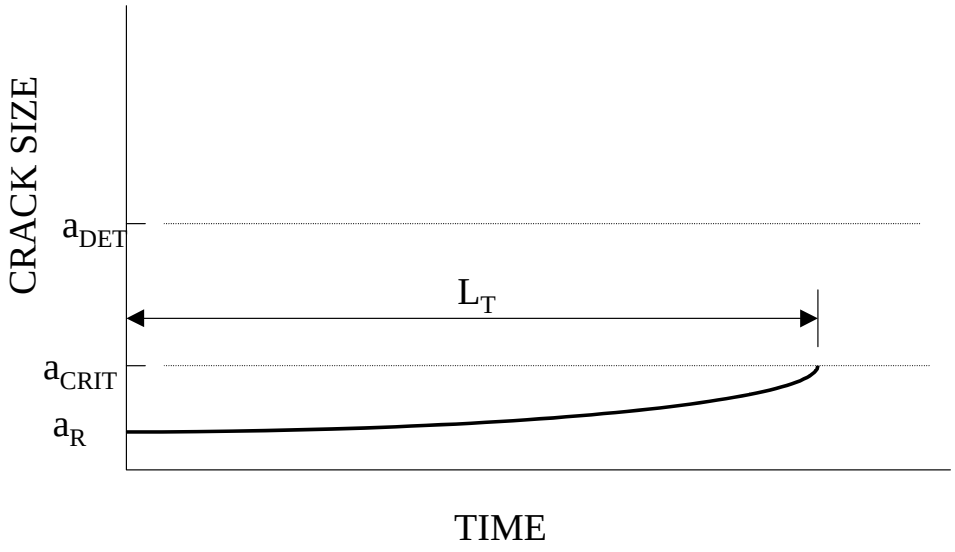

Figure AC 29.571B-3. Slow Growth of Undetectable Crack

(D) Slow Growth of Detectable Crack. Figure AC 29.571B-4 illustrates the scenario where the BEC grows to a detectable size (at L_1) before becoming critical (at L_1+L_2). In this case, the retirement time should be set equal to the total crack growth life (L_1+L_2) divided by a factor N.

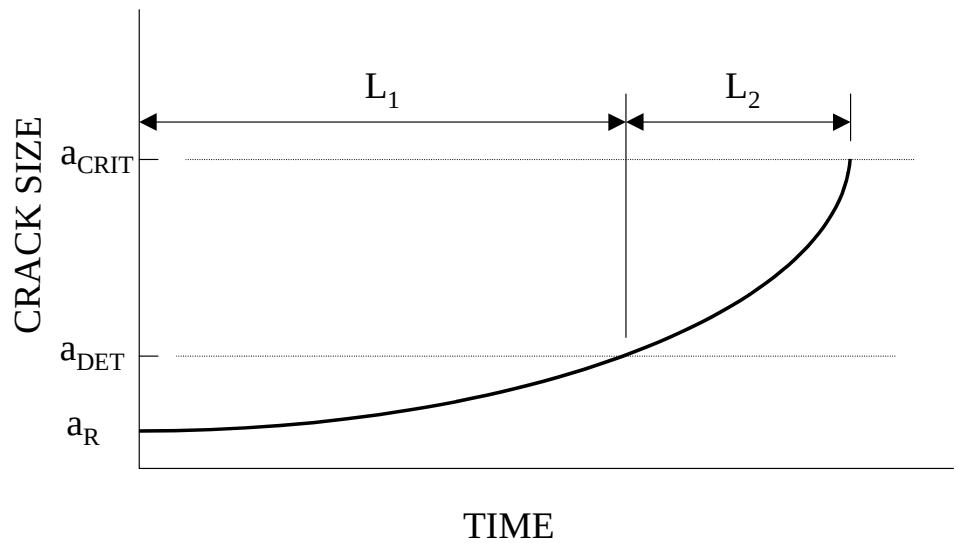

Figure AC29.571B-4. Slow Growth of detectable Crack

(E) Life Factors for Crack Growth Retirement.

(1) In determining the factor of N to be used for determining the retirement time, consideration should be given to the crack growth data used (e.g., top of scatter data versus average data, number of specimens used to generate data, etc.).

(2) The minimum suggested N value should be N=2 in the case where the conservative top-of-scatter crack growth data are used in the crack growth analysis, or N=4 when the average crack growth data are used in the crack growth analysis, or N=4 when the crack growth life is obtained from the crack growth test of one specimen (for two or more full scale specimens, N=3 of the shortest crack growth life can be used).

(3) It should also be noted that with this approach, the validity of the crack growth threshold, ΔK_{th}, is especially important since there is no element of inspection to ensure continued airworthiness. Consistent with this, additional attention may be required for validating the crack growth threshold value(s) used in the analyses. Consideration should be given to the influence of the test procedure used to develop values, microstructure, heat treatment, crack size, loading conditions, environment, grain size and orientation, etc. In general, a coupon-testing program may be necessary

to develop a consistent ΔK_{th} database and the use of published data may require additional conservatism.

(8) INSPECTION INTERVALS. Each of the following three methods provides a means to establish inspection intervals for detectable damage or detectable damage growth. The time of the first inspection should coincide with the repetitive interval established unless the applicant can substantiate an alternate time.

(i) Safe-Life Inspection for a CDF provides a safe interval of operation between repetitive inspections for the presence of probable detectable flaws. The substantiation is accomplished by testing and analysis employing conventional Safe-Life methodology except that intrinsic and discrete critical flaws are considered. The size of flaws considered should be “clearly detectable”, which is intended to be a conservative representation of detectable flaws that could remain in place for the entire interval in spite of routine inspections for general condition. It should be noted that this method, since it is a safe-life (crack initiation) method, is not appropriate for use when the flaw being considered is already a crack.

(A) The method described in paragraph f(7)(iii), Safe-Life Retirements with Clearly Detectable Flaws, may be employed for this case, except that the calculated retirement time is used as a repetitive inspection interval.

(B) The repetitive inspection consists of examination of the structure for the presence of the flaw using the substantiated inspection method. If no flaw is found, the structure may be returned to service for another inspection interval period, up to the established retirement time. If the flaw is found, the structure is retired; or, if a repair procedure for the specific flaw type has been substantiated, the structure is repaired and returned to service for another inspection interval period, up to the established retirement time for the structure.

(C) Substantiation of repairs should include careful consideration as to whether undetectable cracks may now exist and whether the original certification approach is still applicable.

(ii) Crack Growth Inspection. This approach depends on detection of cracks before they become critical to ensure the continued airworthiness of a PSE. While any inspections that are capable of detecting cracks with high reliability may be used with this approach, the criteria stated in paragraph f(6), Inspectability and Inspection Methods, should be considered in making the selection. The inspection method chosen will define the initial inspectable crack that will be used to perform the fatigue tolerance evaluation. Once the initial inspectable crack is defined, crack growth, and residual strength assessments must be performed to determine the time for the initial inspectable crack (a_{DET}) to grow to a size (a_{CRIT}) that would result in a catastrophic failure of the rotorcraft if limit loads were applied. This assessment could be theoretically done analytically or by test; however, in most cases it is performed analytically using fracture mechanics methods. The resulting life for a_{DET} to grow to

a_{CRIT} is used to set the inspection interval. This general process applies to both single and multiple load path structure regardless of the level of inspection (e.g., for complete load path failure or less than load path failure in a multiple load path structure). The details of defining the interval once the crack growth life has been determined are discussed later.

(A) Single Load Path Structure. The time for a detectable crack (a_{DET}) to grow to critical size (a_{CRIT}) in a structure is denoted as L_2 in Figure AC 29.571B-4. If this were a single load path structure, the inspection interval would be established as L_2 divided by N. (See paragraph f(8)(ii)(C) for guidance on values of N.) This interval is valid until the part is retired.

(B) Multiple Element Structure.

(1) Depending on inspectability considerations and residual life characteristics of the structure following a load path failure, it may be beneficial to take advantage of the redundancy of a multiple load path structure. On the other hand, the safety of a multiple load path structure can be managed without taking advantage of its redundancy. In this case, each load path would be considered independently and inspection intervals established for each load path consistent with paragraph f(8)(ii)(A). This may be necessary for similarly stressed load paths when damage according to the threat assessment could occur in each element at the same time.

(2) When considering redundancy in a multiple load path structure, two scenarios might be possible; one where the required inspection is for a completely failed load path and one where the inspection is for less than a load path failure. In either case, the remaining life of the secondary load path after primary load path failure is used to determine the inspection interval. Consistent with this, the resulting intervals are only valid until the cumulative fatigue damage or crack growth in the intact structure is taken into account. This issue is illustrated in a crack growth context in Figure AC 29.571B-5. Crack growth in the secondary load path from an initial crack as detailed in paragraph f(8)(ii)(B)(3)(i) will proceed along curve A-B as long as the primary load path remains intact and load redistribution is negligible. However, at the time of primary load path failure, loading on the secondary load path will increase due to load redistribution and crack growth will be accelerated (e.g., subsequent growth from point 1, 2, or 3 depending on if the failure occurs at time t_1, t_2 or t_3). Note that the residual life, L_r, in the secondary load path is inversely proportional to the time at which primary load path failure occurs. This should be considered whenever L_r is used in establishing repeat inspection intervals.

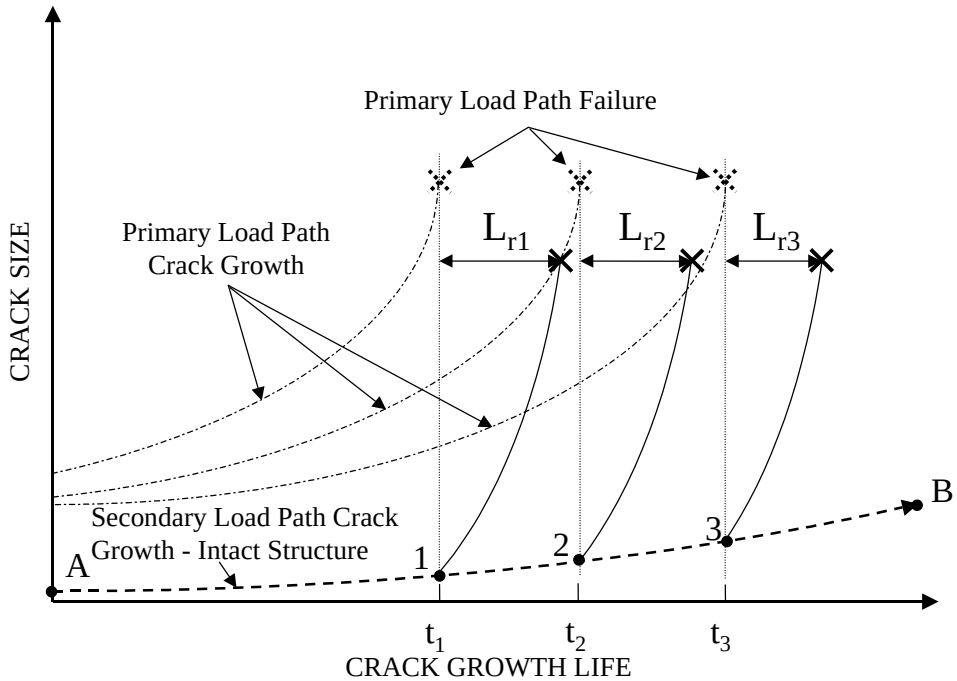

Figure AC 29.571B-5. Decreasing Residual Life in Secondary Load Path for Multiple Element Crack Growth with Inspections.

(3) Inspect for Load Path Failure. If a failed load path is easily detectable and the residual life and strength of the remaining structure is sufficient, this approach may be optimum. Analysis or tests as described in the following paragraphs can determine the inspection interval.

(i) Evaluation by analysis. Figure AC 29.571B-6 illustrates an example of multiple load path structure for which a completely failed load path is easily detectable. The inspection interval is based on the life of the secondary load path (L_r) after primary load path failure at time N_F. Consistent with this, damage accumulated in the secondary load path prior to primary load path failure must be accounted for in the analysis. In order to do this within the context of a crack growth analysis, it is necessary to assume some initial crack, of size a_i, exists in the secondary load path at time zero. This initial crack size should be representative of a normal manufacturing quality unless the threat assessment indicates that larger damage could exist. Crack growth accumulated prior to a load path failure is accounted for by calculating the amount of growth, (Δa_i), between time zero and N_F. Load redistribution that may occur prior to N_F should be considered. The residual life, (L_r), then becomes the time for a crack of size $a_i + \Delta a_i$ to grow to critical size, assuming a complete load path failure has occurred (i.e., "failed" condition loads used). It should be noted that the assumed time of load path failure would also represent an upper limit of validity for any repeat inspection period based on L_r. It is therefore recommended that N_F be assumed equal to the retirement time for the structure being inspected or the rotorcraft design life if the structure has no declared retirement time. Based on the above,

(A)Inspection Interval = L_r/N [For N refer to paragraph f(8)(ii)(C)]

(B) Limit of validity = N_F (i.e., repetitive inspection time would not be valid for operation beyond N_F)

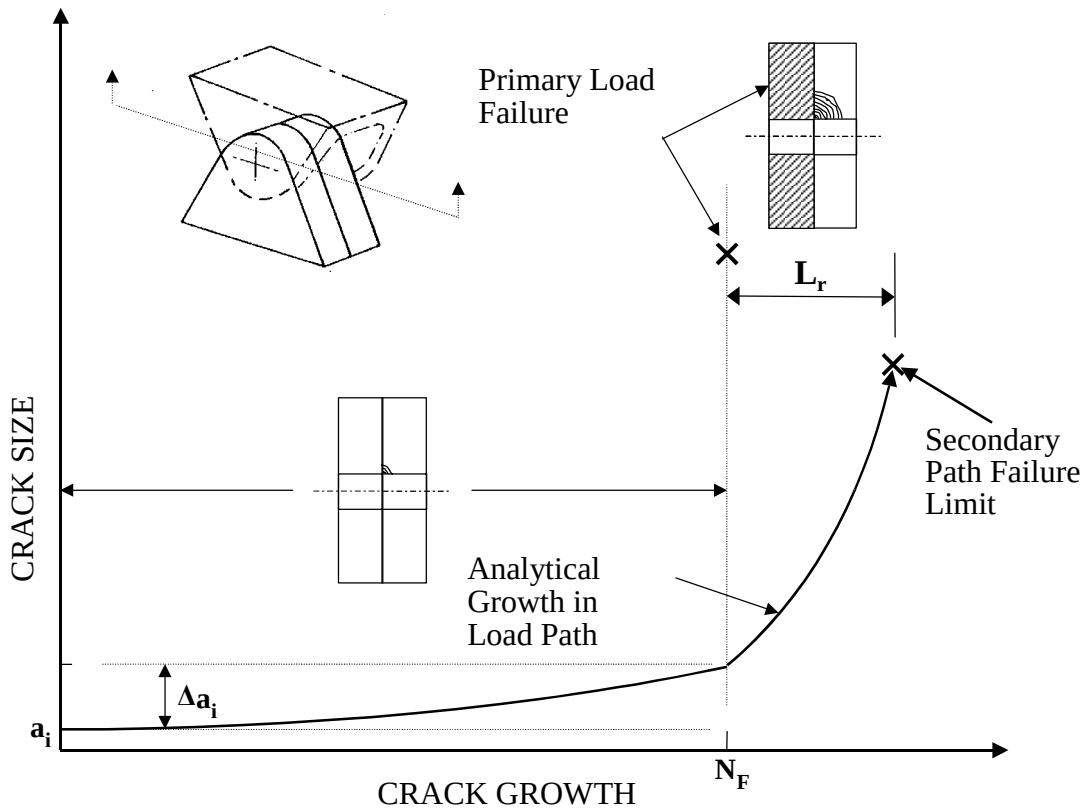

Figure AC 29.571B-6. Multiple Load Path Structure Analytical Evaluation to Support Inspection for a Failed Load Path.

(ii) Evaluation by Test. Figure AC 29.571B-7 illustrates some key points if an inspection for a complete load path failure is to be developed based on testing. The inspection interval is based on the test demonstrated residual life (L_r) subsequent to load path failure. Because the residual life decreases with the time accumulated prior to a load path failure, there will be a limit of validity to the L_r and it will be dependent on the time at which a load path failure is simulated, (N_D).

(A) The test article should consist of as-manufactured production parts. Representative "well" condition loading should be applied for some predetermined period of time, (N_D). It is recommended that the "well" condition loading be of sufficient duration so that N_D/L_{SF} is not less than the retirement time minus one inspection interval for the structure being inspected or the rotorcraft design life if the structure has no declared retirement time. At the end of this period, the load path that is to be inspected for complete failure should be disabled (e.g., saw cutting, attachment(s) removal, member removal) to simulate its failure. The test should then be restarted with a

representative "failed" condition loading. (Note that the external loads may be the same as for the "well" condition if the member failure simulation results in the correct "failed" condition internal load redistribution.) The test should continue until the desired residual life has been achieved or to the time at which the secondary load path can no longer support limit loads without failure, whichever is less, (N_0).

(B) In developing the test spectrum, consideration should be given to proper use of representative loads, truncation of non-damaging loads, inclusion of ground-air-ground cycles, clipping of high magnitude loads, and load sequence.

(C) Based on the above,

(a) Demonstrated residual life = $L_r = N_0 - N_D$

(b) Repetitive inspection time = L_r/N [For N refer to paragraph f(8)(ii)(C)]

(c) Limit of validity = N_D/L_{SF}

(d) $L_{SF} = 2$, Life safety factor

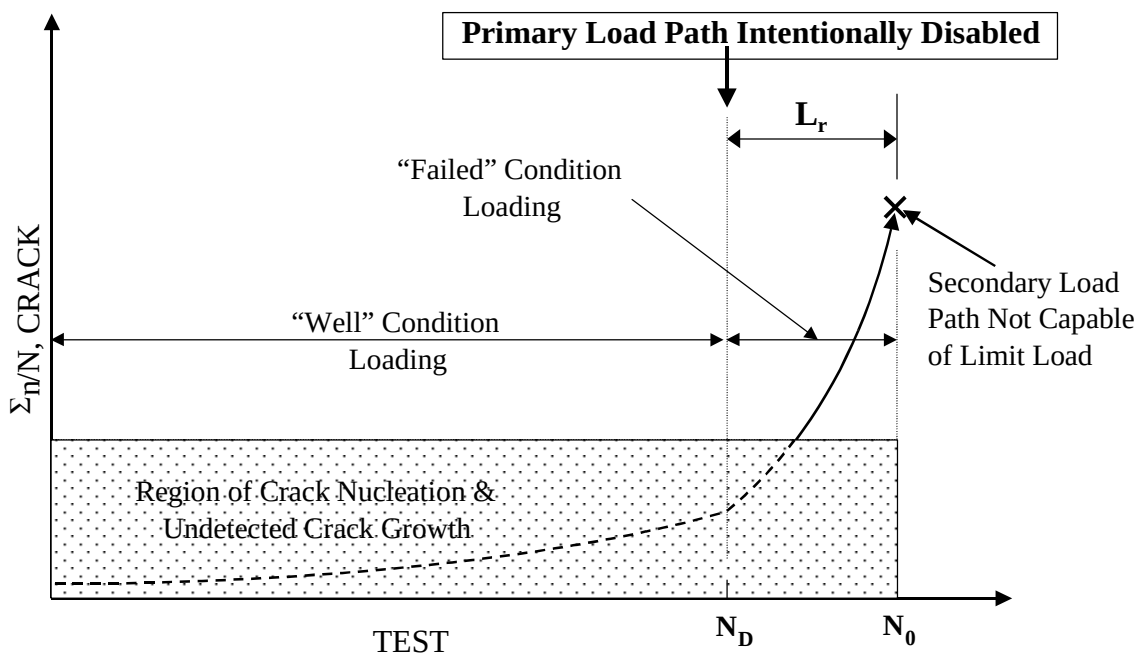

Figure AC 29.571B-7. Multiple Load Path Structure Evaluation by Test to Support Inspection for a Failed Load Path.

(4) Inspect for Less Than a Load Path Failure. Inspection for less than a load path failure may require special non-destructive Inspection (NDI) procedures but will result in longer inspection intervals. Figure AC 29.571B-8 illustrates how inspection

intervals could be established on the basis of crack growth and residual strength evaluation.

(i) In this case the inspection interval is based on the life of the secondary load path (L_r) subsequent to primary load path failure at N_F plus the time (L_P) for a detectable crack (a_{DET}) in the primary load path to grow to critical size under in-service loads. The determination of L_r is the same as discussed in paragraph f(8)(ii)(B)(3)(i).

(ii) Based on the above,

(A) Repetitive Inspection = $(L_P + L_r)/N$ [For N refer to paragraph f(8)(ii)(C)]

(B) Limit of validity = N_F

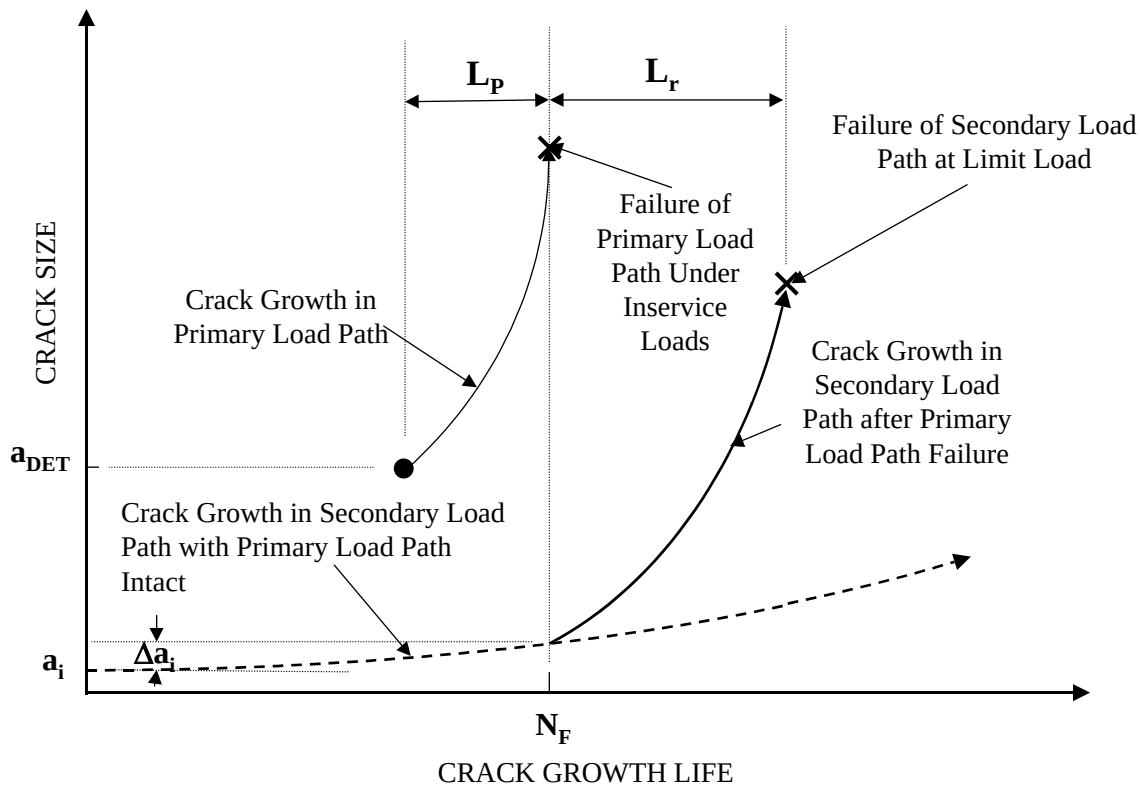

Figure AC 29.571B-8. Multiple Load Path Structure Analytical Evaluation to Support Inspection for Less than a Failed Load Path.

(C) Safety Factors.

(1) In determining the factor of N to be used for determining the inspection time, consideration should be given to the crack growth data used (e.g., top of scatter data versus average data, number of specimens used to generate data, etc.) and the capability of the inspection procedure.

(2) The minimum suggested N value should be N=2 in the case where the conservative top-of-scatter crack growth data are used in the crack growth analysis, or N=4 when the average crack growth data are used in the crack growth analysis, or when the crack growth life is obtained from the crack growth test of one specimen (for two or more full scale specimens, N=3 of the shortest crack growth life can be used).

(iii) Safe-Life Inspection for a Failed Element.

(A) A Safe-Life Inspection substantiation for a Failed Load Path provides a safe interval of operation between repetitive inspections for the failed load path. The substantiation is accomplished by testing and analysis employing conventional safe-life methodology except that the configuration of the structure substantiated is with the critical load path inoperative and appropriate flaws imposed on the remainder of the structure, as determined by the threat assessment.

(B) The method described in paragraph f(8)(i) can be employed for this case with the following differences:

(1) The principal “flaw” considered is failure or loss of the most critical load path. The load path failure can be the result of fatigue cracking, static failure, or a fractured or missing fastener, as determined by the threat assessment, paragraph f(5).

(2) The remainder of the structure may be representative of normal manufacturing quality unless the threat assessment indicates that larger damage should exist.

(3) The mean strength for the substantiation should be based on the number of cycles from the first load path failure to the first initiation of cracking at any other point in the remaining structure. Any applied load changes or load distribution changes that occur as a consequence of the load path failure should also be included (bending due to increased deflection, for example).

(4) When the remaining structure may have some pre-existing fatigue damage at the time the first load path fails (due to both load paths being highly loaded, for example), this should be factored into the analysis.

(5) The remaining structure after first load path failure must be shown to have limit load capability, considered as the ultimate loading, except in some cases where no retirement life is provided and fatigue damage is expected (see paragraph f(10).

(6) The inspection conducted is for the failed or missing load path.

(9) RETIREMENT TIME AND INSPECTION INTERVAL SCHEDULES.

(i) Based on the evaluations required by § 29.571, inspections, retirement times, combinations thereof, or other procedures have been established as necessary to avoid catastrophic failure. These inspections, retirement times, or approved equivalent means must be included in the Airworthiness Limitations Section (ALS) of the Instructions for Continued Airworthiness (ICA) as required by § 29.1529 and Appendix A29.4 of the regulatory requirements. These inspections, retirement times, or a combination of both are normally stated in hours time-in-service, but may be stated in other terms, such as engine starts, landings, external lifts, etc.

(ii) The design service life should be specified in the fatigue evaluation methodology that must be approved by the FAA/AUTHORITY. In any case, routine inspections for wear, fretting, corrosion, cracking, and service damage are appropriate. These routine inspections should be noted in the ICAs (maintenance manual) but are not required to be contained within the ALS of the ICAs unless they are structural inspection intervals or related structural inspection procedures approved under § 29.571.

(10) APPROVED EQUIVALENT MEANS. The requirement includes the possibility that in place of setting retirement times or inspections for damage, some other means may be used. All proposals for 'equivalent means' must be submitted to the FAA/AUTHORITY for approval. Potentially equivalent means to inspection include, but are not limited to:

(i) Indirect detection of damage used to establish a period of safe operation for a structure with the damage present. In this case, the detection is based on the effect of the damage, which may be recognized through:

(A) A warning in flight or during maintenance from a specific feature, sensor, or health monitor, including: oil analysis, chip detector, crack detection wire or foil, health monitoring, fluid leaks or pressure change in a sealed chamber; or by

(B) Pilot sensitivity to a change in the rotorcraft's behavior (such as poor blade tracking, noise generation, vibration generation) provided it is well defined and does not require exceptional piloting skills to recognize these behaviors.

(ii) In all cases, an adequate level of residual strength is demonstrated for the period of operation concerned. Generally, limit load will be considered the minimum residual strength requirement. However, load levels less than the critical limit load conditions may be acceptable for consideration of obvious damage sustained in flight and for the completion of that flight only, provided it allows for continued safe flight and landing.

(iii) Two instances are considered here where it may not be necessary to provide a retirement time in the ALS of the ICAs. However, this does not preclude the investigation of fatigue behavior throughout the life of the rotorcraft or of the part if longer.

(A) When fatigue cracking occurs or is expected to occur for a specific PSE while in service, then the first approach allows the PSE to operate until the damage is found. Therefore, the inspection must find the damage prior to loss of ultimate load capability. This approach may not be appropriate for a single load path structure. For such a process to be safe, the behavior of the part and associated parts that influence its fatigue behavior must be substantiated for as long as they remain in service. All potential failure modes throughout the life of the rotorcraft must be identified and shown to be consistent, repeatable and addressed by the inspection program. In order to meet the intent of the new fatigue tolerance requirements, a high probability of ultimate load capability is required throughout the lifetime of the component. Therefore, for cracks or other damage that are allowed or highly likely to exist, ultimate load capability should be substantiated for that damage and any growth that may occur during the subsequent inspection period.

(B) It may be acceptable that a PSE does not have a specific retirement time when the fatigue tolerance of the part, including any damage not controlled by an acceptable inspection program, has been demonstrated to be in excess of the rotorcraft design life to such an extent that no safety benefit arises from imposing that requirement.

(11) SUPPLEMENTAL PROCEDURES.

(i) The requirement states that if inspections, for any of the damage types identified during the threat assessment, cannot be established within the limitations of geometry, inspectability or good design practice, then supplemental procedures must be established that will minimize the risk of each of these types of damage being present or leading to catastrophic failure. When assessing good design practice, measures such as improved protection against impact, scratches, and corrosion should already have been considered. If the part cannot be redesigned to reduce the acquisition and influence of damage, then supplemental procedures should be introduced.

(ii) Supplemental procedures that should be considered include, but are not limited to:

(A) Specifying shorter than usual calendar inspection intervals to reduce the probability of occurrence and the extent of the damage.

(B) Improving control of maintenance processes associated with the component and damage type, such as by providing specifically designed tooling and requiring additional quality checks after each operation is performed.

(C) Introducing an overhaul program.

(D) Restricting the allowable repair limits for the part.

(E) Modify the PSE design based on service experience if this shows the original design assumptions to be overly conservative with respect to demonstrating impracticality at certification.

(F) Specifying a conservative inspection interval, if the calculated interval cannot be established and there are no other alternatives.

FAA Action: FAA is working on an NPRM as 07/05.