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Sustainment and Continued Airworthiness for Aircraft Structures
3-day Course Summary of Content

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Objective:

This three-day course provides an introduction to aircraft sustainment and continued airworthiness requirements as well as use of basic fatigue and damage tolerance analysis methods for repairs and alterations. The instructor will provide best practices for setting up fatigue management programs. The instructor will include case studies when explaining aspects of the processes. The instructor will discuss regulations, compliance policy and guidance, and technical references.

Participants will become familiar with sustainment and airworthiness requirements and technical evaluations necessary for compliance. They will learn about the range of effects that influence continued airworthiness from related accident/incident case studies. They will learn about non-destructive inspection (NDI), its requirements, and limitations. Class exercises provide hands-on experience of simple analysis methods.

Relevant reference material is provided with class notes.

Major topics include:

- Background of sustainment requirements. Focus on evolution of FAA design, maintenance and inspection regulations related to continued airworthiness.
- Overview of fatigue management programs (FMPs). Similarity between civil and military requirements.
- Static strength design requirements.
- Aircraft flight profiles and spectrum development (class exercise).
- Aircraft fatigue analysis for repairs using basic concepts - material properties, stress concentrations, Miner's rule, etc. (class exercise).
- Aircraft damage tolerance analysis for repairs using basic concepts - material properties, stress intensity factors, residual strength, crack growth, etc. (class exercise).

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- Introduction to common non-destructive inspection (NDI) methods and their importance to damage tolerance based inspection programs and FMPs. Discussion about reliability and probability of detection (POD) (class exercise).
- FMPs -- how static strength, fatigue strength, damage tolerance, inspection reliability and Instructions for Continued Airworthiness (ICA) fit together. Address widespread fatigue damage (WFD) and limitations of FMPs (several case studies).
- Risk assessment and risk management concepts (including a case study).
- Corrosion as it relates to sustainment.

Chapter by Chapter Summary:

Chapter 1, Introductions: student expectations, course objectives, course outline. (Approx. :20)

Chapter 2, Airworthiness Requirements Overview: This chapter covers FAA certification and operational regulations applicable to sustainment and continued airworthiness. The second half of the chapter focuses on the history of FAA fatigue requirements. This chapter also includes discussion of military requirements and new FAA "performance-based" regulations for small airplanes. (Approx :50)

Chapter 3, Fatigue Management Programs – Overview: This chapter sets the stage for the content of the rest of the course. It is an overview of fatigue management programs (FMP) as they relate to structural sustainment. It covers four major fatigue related accidents and how they led to requirements changes. It provides a bridge between the requirements and the physics of fatigue. Similarity between civil and military requirements is discussed. (Approx :50)

Chapter 4, Static Strength Requirements and Analysis: This chapter reviews the FAA regulations for static loads, then summarizes the static margins of safety for two simple repair/modifications used as class exercises in Chapters 5-8. (Approx :40)

Chapter 5, Usage: This chapter covers aircraft usage and how to develop usage spectra applied to fatigue analysis. The basics are presented and followed by class exercises to develop spectra for the class exercise situations of Chapter 4. The exercises will involve a lot of hands-on engineering calculations. Both fixed wing and rotorcraft flight profiles are discussed. (Approx 2:30)

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Chapter 6, Fatigue: This chapter is almost completely spent on the engineering aspects of fatigue. Common terms, a little bit of theory, material properties, and related influences are covered. After the basics are presented, class exercises use the usage spectra developed in Chapter 5 to calculate fatigue lives for the two class exercises of repairs/mods introduced in Chapter 4. (Approx 2:50)

Chapter 7, Damage Tolerance: This chapter is almost completely spent on the engineering aspects of damage tolerance. The physics of fracture mechanics are introduced, including material properties and geometry considerations. Then the class exercises build on the same problems from prior chapters with calculations of residual strength and crack growth for the two repairs/mods. Good damage tolerant structure design is addressed by evaluating the results of the analysis done in the exercises. Rotorcraft flaw tolerance is discussed. (Approx 3:00)

Chapter 8, Nondestructive Inspection: This chapter presents information about various inspection techniques and how they are used. It addresses probability of detection (POD), inspection reliability, and the care with which detectable crack sizes must be determined. It also uses the results of the crack growth life calculations from Chapter 7. Students will determine inspection thresholds and intervals for the two class exercises. This chapter addresses the importance of inspections to a good fatigue management program. It covers detectable cracks sizes related to FAA and USAF policies. (Approx 2:20)

Chapter 9, Fatigue Management Programs – in Practice: This chapter pulls together everything that has been presented thus far. It explains the importance of the static, fatigue, and damage tolerance evaluations, and inspections and how all this information is documented in the instructions for continued airworthiness. Several case studies are discussed, including some involving military aircraft. It covers the civil requirements and engineering aspects of widespread fatigue damage (WFD). WFD and Limit of Validity (LOV) are explained and discussed. (Approx 2:10)

Chapter 10, Risk Assessment and Risk Management: This chapter discusses some risk assessment concepts for continued airworthiness. One case study is described in detail and the FAA's approach to risk assessment for continued airworthiness is expanded beyond what was introduced in Chapter 11 of the FAA Certification segment. A simple class exercise demonstrates the FAA's concept. Some probabilistic approaches are introduced, including one research project currently funded by the FAA. (Approx 2:00)

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Chapter 11, Corrosion: this chapter presents information on the types of corrosion and how corrosion should be controlled. Some case studies are described. (Approx :30)

NOTE: Chapter times are approximate. Times will vary according to class questions and discussion. Approximate total lecture length is 18 hours.