Advanced Spectrum & DTA Applications Course

This is a full 40 hours course taught by both Dr. Scott Fawaz and Mr. James Burd both of which have over 35 years' experience in both military and commercial Damage Tolerance Analysis. The course is of great benefit to engineers entering the field of Damage Tolerance, experienced Damage Tolerance engineers and also military and civil regulators, DERs and Unit Members finding compliance with Damage Tolerance Requirements. A certificate of completion will be issued to each student upon completion of the course.

In the first three days, the class steps the student thru a thorough review of the commercial and military damage tolerance regulations as well as advisory guidance. Then the course provides a unique and in-depth study of the establishment of mission profiles, usage, fatigue external and internal loads development, load histories and finally describes in detail the methods for spectra development. Following this, the student is exposed to the details of fracture mechanics to include materials, stress intensity development and crack growth analysis methods. Residual strength concepts and widespread fatigue damage are also addressed. Finally, the development of corresponding inspection requirements and procedures is reviewed. Following these topics, the final two days walk the student thru 14 in-depth real world damage tolerance examples demonstrating the use of the previously reviewed methods on wing, fuselage and empennage structure to include special examples dealing with antenna installations, sonic fatigue and helicopters.

The students are provided with the analytical files for each of the examples for self-study which are in Afgrow format and are given two weeks access to Aeronautica's Aspec spectrum development software. This course is a full 40 hours and the equivalent of a semester long graduate level course. The student is provided a full hardcopy of the course which will be of invaluable use throughout their career. The course manual includes a large listing of invaluable references for the practicing damage tolerance engineer. Additional access is also provided for many of the public technical references via the Aeronautica web cloud thru the assignment of access accounts to each individual student for download purposes.

DTA Course Outline

1. Certification
    a. FAA Requirements
    b. Military Requirements
    c. Options for Fatigue Management
    d. Repairs and Alterations
    e. Part 26 Requirements
    f. New Requirements – Radomes
    g. Part 25.571 and AC 25.571-1D
2. Service Usage
    a. Detailed Review of Large Transport Fatigue Loads Usage
    b. Detailed Review of General Aviation Fatigue Loads Usage
    c. Detailed Review of Military and Restricted Category Fatigue Loads Usage
3. Fatigue Loads Part I
    a. Discussion of Aircraft Sources of Fatigue Loading
    b. Review of Importance of Service History
    c. Examples of Various Aircraft Source of Fatigue Loading
4. Fatigue Loads Part II
    a. Review of Mission Profiles and Usage Load Histories
    b. Methods & Development of External Aircraft Level Fatigue Loads
    c. Methods & Development of Internal Airframe Fatigue Loads
5. Environmental Effects
    a. Dynamic Ground Condition Effects
    b. Dynamic Flight Condition Effects
    c. Discrete Load Source Events
6. Spectrum Development
    a. Example Development of Spectra for a Large Transport
    b. Example Development of Spectra for a Narrow Body Transport
    c. Comparison of Flight-by-Flight Spectra versus Single Cycle Spectra
7. Special Considerations
    a. Acoustic/Sonic Fatigue
    b. Effects of Buffet Loading
    c. Accounting for Aerodynamic Loading
    d. Composite Structures
    e. Impact of Fuselage Interior Loading and External Stores
8. ASPEC Overview
    a. Background of Flight-by-Flight Spectrum Generation Code Aspec
    b. Overview of Aspec Capabilities
9. DTA Process
    a. Overview of the fatigue problem
    b. Crack initiation and crack growth
    c. Microstructurally small cracks
    d. Industry Standard Methods
    e. DTA
        i. Select detail to analyze
        ii. Stress analysis
        iii. Initial flaw assumptions
        iv. Equivalent initial flaw size
        v. Probabilistic methods
10. Stress Intensity Solutions
    a. Similitude
    b. Superposition
    c. Compounding
    d. Bending restraint
    e. Bulging
    f. Lugs
11. Material Data
    a. MPDS
    b. Resistance to stress corrosion cracking
    c. Design considerations
    d. Fatigue crack growth rate data
    e. Plane stress vs plane strain
    f. Approximating data
    g. Metallic material data for DTA
12. DTA & ICA
    a. Cracking scenarios
    b. Crack growth models
    c. Detectable flaw sizes

d. NDI Methods
e. Inspection threshold and intervals
f. Inspection program
g. Residual strength
h. DTA Examples
    i. Small antenna installation
    ii. Spot welded joints
    iii. Horizontal stabilizer chordwise joint

13. Problem 1 – Wing Strut 172
    a. Objective: To demonstrate the full development of fatigue spectra for general aviation from external loads, to internal loads, to spectra and finally to analysis.
14. Problem 2 – Wing Attach T28
    a. Objective: To illustrate a case history of a wing failure due to severe load usage and the resulting redesign to improve the fatigue life.
15. Problem 3 – Wing Spar P2V
    a. Objective: To show a case history example where the critical detail originated at a critical detail on the lower front spar due to poor design detail and poo manufacturing quality control.
16. Problem 4 – Wing Panel P3A
    a. Objective: To illustrate the impact of the variability in manufacturing quality on wing structure subject to a severe utilization.
17. Problem 5 – Wing Spar DC-6
    a. Objective: To illustrate a case history of wing fatigue cracking due to high loading in a redundant airframe wing structure.
18. Problem 6 – Wing Panel Splice 707
    a. Objective: Illustrative example of lower wing structure exhibiting fatigue cracking due to fastener shear load transfer in a longitudinal skin splice. Also provides a detailed example for structures with complex loading and the use of multi-channel spectra.
19. Problem 7 – Fuselage Attach OV10A
    a. Objective: Illustrative example showing the analysis for a critical wing to fuselage attach fitting and the impact of variation in mission utilization.
20. Problem 8 – Fuselage Frame A320
    a. Objective: To show the impact that internal cabin equipment can have on the fatigue life of fuselage structure.
21. Problem 9 – Fuselage Stringer Splice 737
    a. Objective: Illustrative example showing how to address the airframe impact resulting from major modifications to portions of the interior of the fuselage structure.
22. Problem 10 – Fuselage Panel 777
    a. Objective: Example to demonstrate the method for the flight-by-flight spectrum development for the crown on a wide body transport and the resulting damage tolerance analysis for multiple load path structure.
23. Problem 11 – Vertical Tail Attach P2V
    a. Objective: To illustrate the development for fatigue spectra of vertical fins and the resulting damage tolerance analysis.
24. Problem 12 – Fuselage Antenna A321
    a. Objective: To demonstrate the development of fatigue spectra for the installation of large antennas on fuselage structure.
25. Problem 13 – Fuselage Sonic Fatigue G3
    a. Objective: To demonstrate the development of sonic fatigue spectra and its incorporation into the basic airframe spectra and the resulting analysis.
26. Problem 14 – Helo Fuselage CH47
    a. Objective: To demonstrate the development of fatigue spectra for helicopters and the resulting analysis.
27. Takeaways
    a. General
    b. Stress analysis
    c. DTA and fracture mechanics
    d. Fatigue loads and spectrum
    e. Certification and airworthiness