

Airplane Fuselage Structural Integrity Forum



Panel 3 Design Requirements and Validation

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Bombardier CRJ Family has 4 aircraft models

- CRJ700



- CRJ900



- CRJ1000



- CRJ100/200



Currently in production as Challenger 850

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Process to Establish Structural Inspection Intervals

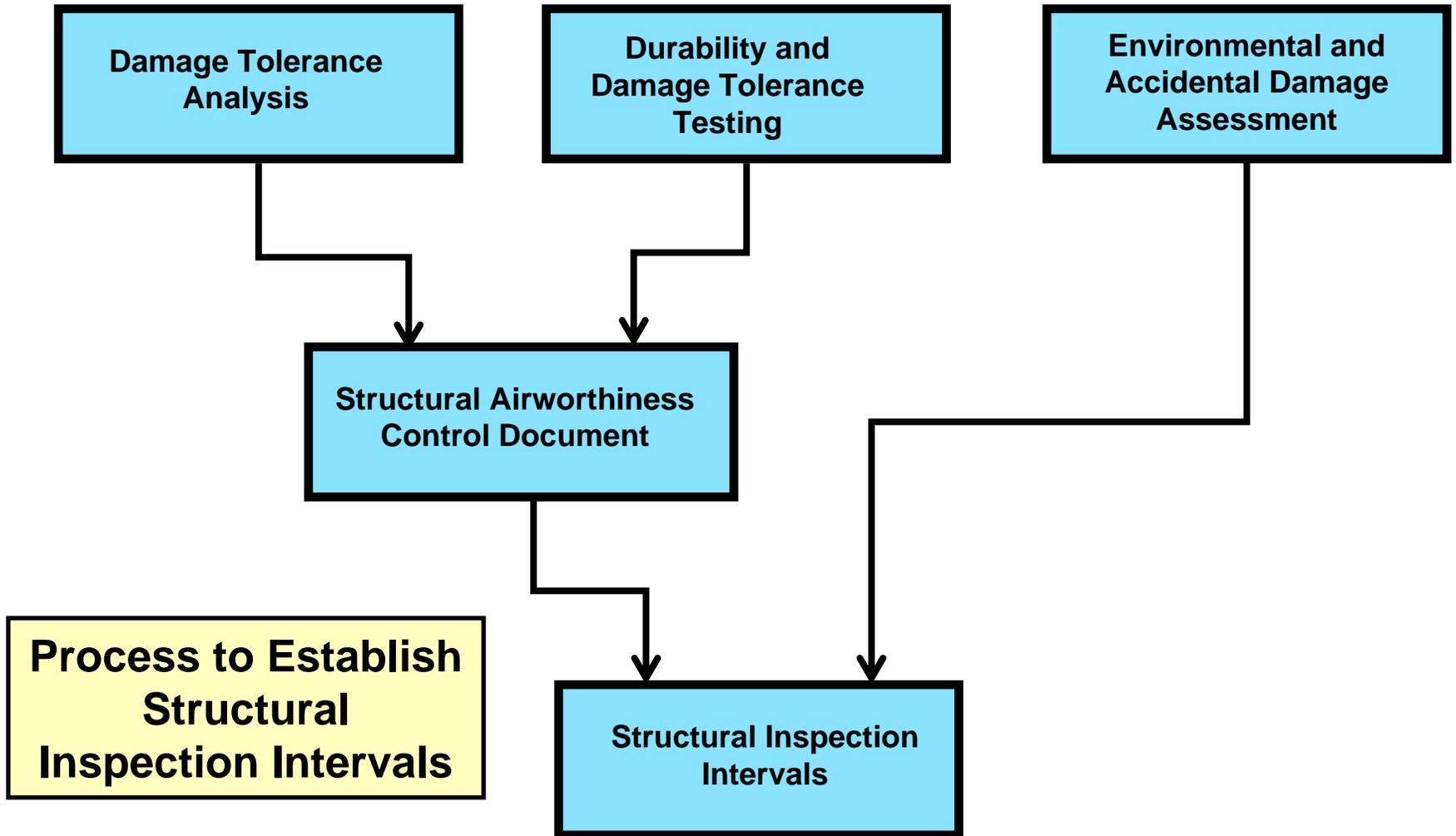
- Design Service Goal (DSG) is 80000 Flights for CRJ700, CRJ900 & CRJ200
- Design Service Goal (DSG) is 60000 Flights for CRJ1000

- CRJ Fuselage is designed to be Damage Tolerant (DT).

- There are approximately 65 Primary Structural Elements (PSEs) in the pressure cabin.

- Process is to derive inspection intervals by **analysis validated by test.**

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Process to Establish Structural Inspection Intervals (cont)

- Initial Maintenance Requirements Manual (MRM) interim inspection intervals were set based on fatigue test progress. Raised as test progressed in agreement with Transport Canada. Currently for CRJ700 most MRM Threshold Intervals are set at 26000 cycles based on completion of all fatigue testing.
- Final intervals in MRM will not be published until completion of test validation exercise (currently in work).
- Target Inspection Intervals
 - **Threshold = 40000 cycles**
 - **Repeat = minimum 6000 cycles (C Check or multiple thereof).**

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Regional Jet Family Test History

- CRJ Test Program covered various levels of Testing Pyramid
 - Development & Certification
 - Static & DADT



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Regional Jet Family Test History - DADT

For the CRJ700 and CRJ900 the philosophy is to test to 2 x DSG i.e. 160000 flight cycles (FC).

- **CRJ700 (three main test articles)**
 - A/C 0004 (forward fuselage) 160000 cycles and Residual Strength Test (RST) completed. Teardown in work.
 - A/C 0005 (centre fuselage and wing) 160000 cycles and RST completed. Teardown not started.
 - A/C 0006 (aft fuselage and empennage) 160000 cycles and RST completed. Teardown in work.

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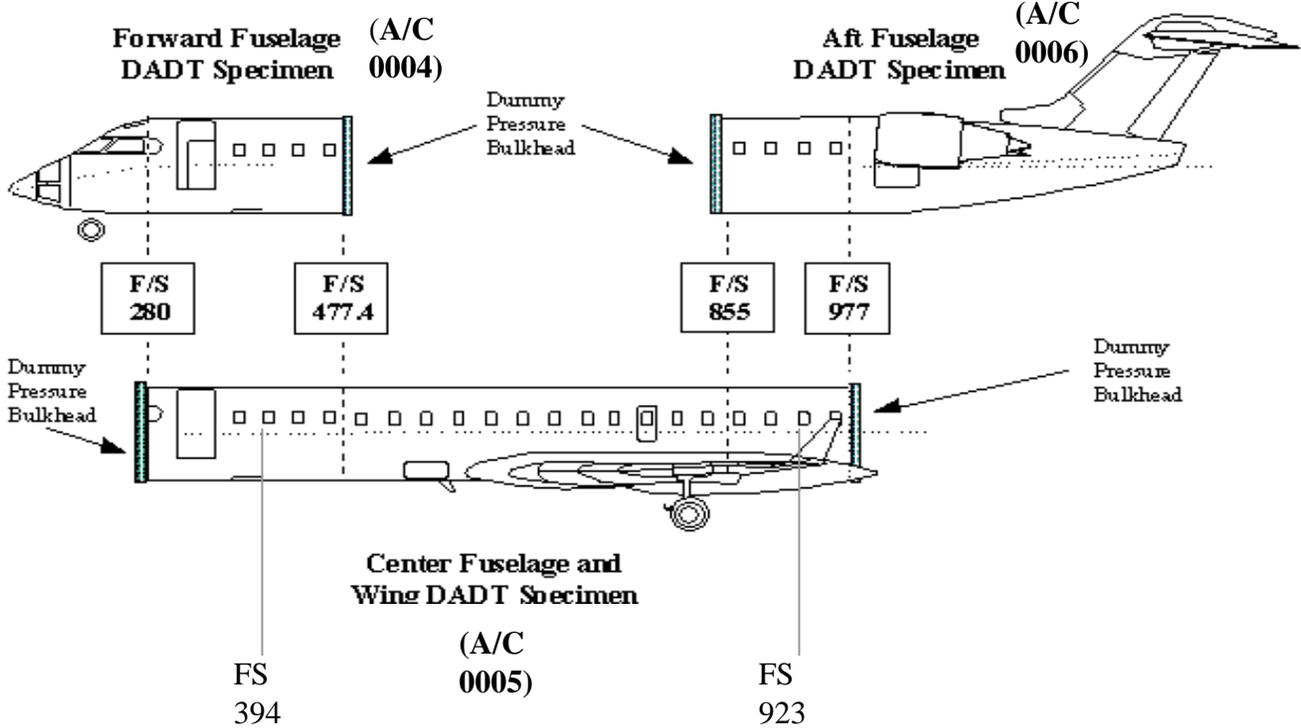
Regional Jet Family Test History

- **CRJ900**
 - One main test article for CRJ900 (A/C 15995) centre fuselage and wing.
 - Main reason for testing because of double over wing emergency exit doors.
 - To date the test has completed 141000 cycles.

- **CRJ1000**
 - No fuselage/wing test specimen.

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CRJ700 Test Articles



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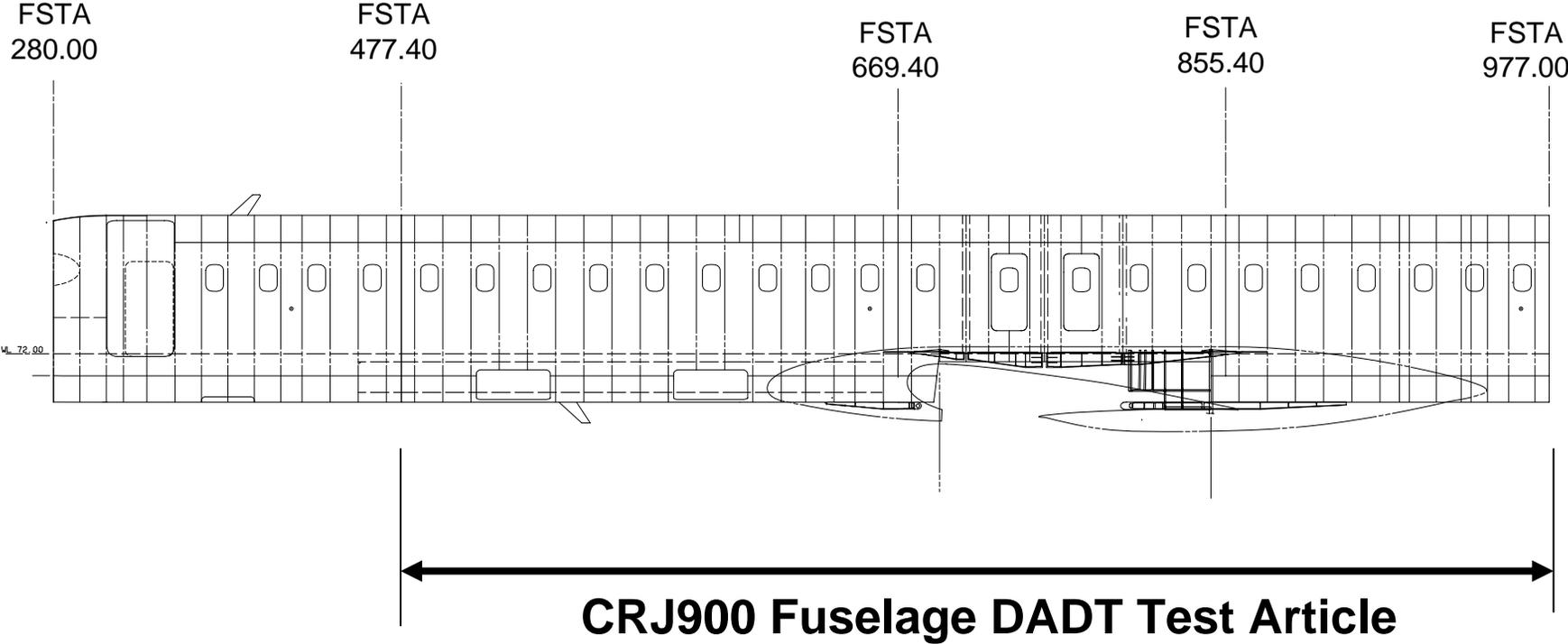
CRJ700 DADT Test Article



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CRJ900 Test Article (Centre Fuselage and Wing)



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CRJ900 DADT Test Article



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Regional Jet Family Test History

Test Phases

- Durability Phase, first life 0 to 80000 cycles.
 - Looking for natural cracks
 - Fit strain gauges at specific locations to measure actual stresses, e.g. door surround corners.
 - Design and test modifications as a result of any early natural cracking.
- Damage Tolerance Phase 80000 to 160000 cycles.
 - At 80k cycles introduce saw cuts at PSE locations. Typical flaw size 0.050 and 0.005 inch.
 - If no cracks induced extend saw cuts at 120000 cycles to maximise repeat inspection intervals and reduce maintenance burden for the operator.
 - Limited further extensions at 140k cycles.
- **Main purpose is to promote crack growth to enable correlation with analysis.**

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Regional Jet Family Test History

Test Phases (continued)

- Residual Strength Phase on completion of 160000 cycles.
 - Test any natural cracks that have reached critical crack length for appropriate RST case.
 - Extend any saw cut locations that haven't cracked to the critical crack length.
- **Main purpose is to validate analysis by demonstrating a safe critical crack length.**

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Regional Jet Family Test History

- **CRJ200 (AC # 7041)**
 - No fatigue test specimen for certification (based on Challenger test).
 - Fleet leader taken from in-service at 21,807 flight cycles (FC) in 2003.
 - Fatigue test performed with all non structural components removed .
 - Load spectrum based on in-service usage data.
 - In service usage 21,807 FC rounded down to 20,000 for the fatigue test

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Regional Jet Family Test History

- **CRJ200 AC # 7041**
 - Phase 1 60000 FC (20000 to 80000) cabin pressurisation and flight loading.
 - Phase 2 57000 FC (80000 to 137000) cabin pressurisation only and RST.
 - Phase 3 40000 FC (80000 to 120000) flight loading only, no cabin pressurisation.
 - RST successfully performed at 17.36 psi.
 - Teardown currently in work.